Southern California Range Complex

Draft Environmental Impact Statement/
Overseas Environmental Impact Statement

Volume 2 of 2: Chapters 4-9 and Appendices A-F

April 2008

Commander
United States Navy Pacific Fleet
www.socalrangecomplexeis.com

This Page Intentionally Left Blank

Southern California Range Complex

Draft
Environmental Impact Statement /
Overseas Environmental Impact Statement

Lead Agency:
Department of the Navy
Action Proponent:
United States Pacific Fleet

Cooperating Agency:
Department of Commerce
National Oceanographic and Atmospheric Administration
National Marine Fisheries Service

Volume 2
Chapters 4-9
Appendices A-F

April 2008

This Page Intentionally Left Blank

Table of Contents

This Page Intentionally Left Blank

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

There are no figures in this section.

There are no figures in this section.

LIST OF TABLES

This Page Intentionally Left Blank

4 Cumulative Impacts

This Page Intentionally Left Blank

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

This page intentionally left blank.

4 CUMULATIVE IMPACTS

4.1 PRINCIPLES OF CUMULATIVE IMPACTS ANALYSIS

The approach taken to analysis of cumulative impacts (or cumulative effects)[1] follows the objectives of the National Environmental Policy Act (NEPA) of 1969, Council on Environmental Quality (CEQ) regulations and CEQ guidance. CEQ regulations (40 Code of Federal Regulations [CFR] §§ 1500-1508) provide the implementing procedures for NEPA. The regulations define "cumulative effects" as:

> ". . . the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 CFR 1508.7).

CEQ provides guidance on cumulative impacts analysis in *Considering Cumulative Effects Under the National Environmental Policy Act* (CEQ 1997). This guidance further identifies cumulative effects as those environmental effects resulting "from spatial and temporal crowding of environmental perturbations. The effects of human activities will accumulate when a second perturbation occurs at a site before the ecosystem can fully rebound from the effects of the first perturbation." Noting that environmental impacts result from a diversity of sources and processes, this CEQ guidance observes that "no universally accepted framework for cumulative effects analysis exists," while noting that certain general principles have gained acceptance. One such principal provides that "cumulative effects analysis should be conducted within the context of resource, ecosystem, and community thresholds—levels of stress beyond which the desired condition degrades." Thus, "each resource, ecosystem, and human community must be analyzed in terms of its ability to accommodate additional effects, based on its own time and space parameters." Therefore, cumulative effects analysis normally will encompass geographic boundaries beyond the immediate area of the Proposed Action, and a time frame including past actions and foreseeable future actions, in order to capture these additional effects. Bounding the cumulative effects analysis is a complex undertaking, appropriately limited by practical considerations. Thus, CEQ guidelines observe, "[i]t is not practical to analyze cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful."

4.1.1 Identifying Geographical Boundaries for Cumulative Impacts Analysis

Geographic boundaries for analyses of cumulative impacts in this Draft Environmental Impact Statement (EIS) / Overseas Environmental Impact Statement (OEIS) (hereafter referred to as "EIS/OEIS") vary for different resources and environmental media. For air quality, the potentially affected air quality regions are the appropriate boundaries for assessment of cumulative impacts from releases of pollutants into the atmosphere. For wide-ranging or migratory wildlife, specifically marine mammals and sea turtles, any impacts from the Proposed Action or alternatives might combine with impacts from other sources within the range of the population. Therefore, identification of impacts elsewhere in the range of a potentially affected population is appropriate. For terrestrial biological resources, San Clemente Island (SCI) is the appropriate geographical area for assessing cumulative impacts. For all other ocean resources, the ocean ecosystem of the Southern California Bight (SCB) is the appropriate geographic area for analysis

[1] CEQ Regulations provide that the terms "cumulative impacts" and "cumulative effects" are synonymous (40 CFR § 1508.8(b)); the terms are use interchangeably.

of cumulative impacts. The following table identifies the geographic scope of this cumulative impacts analysis, by resource area.

Table 4-1: Geographic Areas for Cumulative Impacts Analysis

Resource	Area for Impacts Analysis
Geology and Soils	SCI
Air Quality	South Coast Air Basin San Diego Air Basin South Central Coast Air Basin
Hazardous Materials and Hazardous Wastes	SCI and SCB
Water Resources	SCI and SCB
Marine Plants and Invertebrates	SCB
Fish	SCB
Sea Turtles	Pacific Range
Marine Mammals	Pacific Range
Sea Birds	SCB
Terrestrial Biological Resources	SCI
Cultural Resources	SCI and SCB
Traffic	SCB
Socioeconomics	SCB
Environmental Justice	SCB
Public Safety	SCB

4.1.2 Past, Present, and Reasonably Foreseeable Future Actions

Identifiable present effects of past actions are analyzed, to the extent they may be additive to impacts of the Proposed Action. In general, the Navy need not list or analyze the effects of individual past actions; cumulative impacts analysis appropriately focuses on aggregate effects of past actions. Reasonably foreseeable future actions that may have impacts additive to the effects of the Proposed Action also are to be analyzed.

4.2 ENVIRONMENT POTENTIALLY AFFECTED BY CUMULATIVE IMPACTS

4.2.1 Air Basins

Three air basins, the South Coast Air Basin (SCAB), South Central Coast Air Basin (SCCAB), and San Diego Air Basin (SDAB), are potentially affected by the Proposed Action.

4.1.2.1 South Coast Air Basin

The South Coast Air Basin (SCAB) is comprised of Orange County and substantial portions of Los Angeles, Riverside, and San Bernardino Counties, and includes the largest urban area in the western United States. With 15 million inhabitants, the SCAB encompasses 43 percent of California's population, and accounts for 40 percent of all vehicle miles traveled, and one-third of all air pollutants emitted in the State (California Air Resources Board [CARB] 2006). Motor vehicles are the largest category of emission sources of carbon monoxide (CO), nitrogen oxides (NO_x), and reactive organic gases (ROG). A heavy concentration of industrial facilities, several major airports, two major shipping ports, and a dense freeway and surface street network are located in the SCAB.

The SCAB, which includes waters contiguous to SCI, is classified as: a severe non-attainment area for the 8-hour National Ambient Air Quality Standard (NAAQS) for ozone (O_3), a serious non-attainment area for CO, a maintenance area for nitrogen dioxide (NO_2); a serious non-attainment area for particulate matter under 10 microns (PM_{10}), and a non-attainment area for particulate matter under 2.5 microns ($PM_{2.5}$)..It should be noted, however, that in its Draft Final 2007 Air Quality Management Plan (AQMP), the South Coast Air Quality Management District states it is seeking re-designation as an extreme non-attainment area for the 8-hour NAAQS for O_3 (SCAQMD Air Quality Management Plan [2007]).

Air quality in surrounding Air Basins can be affected and even dominated by pollution transported from the SCAB. Offshore winds cause pollution from the SCAB to impact offshore ocean areas, as winds sweep pollutants out over the sea. Further, pollution from the SCAB can impact San Diego when onshore winds blow these pollutants into San Diego. Pollution from the SCAB is also transported over the ocean into Ventura County (i.e., the SCCAB) by wind blowing to the northwest from the SCAB.

4.1.2.2 San Diego Air Basin

The San Diego Air Basin (SDAB) is comprised of San Diego County., and encompasses 8 percent of the state's population; with a growth rate of 54 percent since 1981, San Diego is one of the fastest growing areas of the State. SDAB accounts for about 9 percent of vehicle miles driven in California, and includes industrial facilities, an international airport, and a significant seaport. Presently, 7 percent of California's air pollution is generated within the SDAB (CARB 2006).

Air quality in the SDAB is impacted by transport of air pollutants from the SCAB. The quality of the air in SDAB also is impacted by pollution from Tijuana, a city of over 1.2 million inhabitants immediately adjacent to the City of San Diego. For regulatory purposes, the SDAB includes only the County of San Diego but Tijuana and San Diego in fact lie within the same geographically bounded air basin, and each city's emissions affect both cities.

The SDAB is classified as a basic non-attainment area for the 8-hour ozone NAAQS, and a maintenance area for CO.

4.1.2.3 South Central Coast Air Basin

The SCCAB encompasses Ventura, Santa Barbara, and San Luis Obispo Counties on California's central coast. Four percent of the State's population lives within the SCCAB. Power plants, oil extraction and refining, transportation, and agricultural operations are the major sources of air pollution in the SCCAB. Motor vehicles in the basin account for about 4 percent of vehicle miles driven in California (CARB 2007).

4.2.2 Southern California Bight

The SCB is the ocean area bounded on the north, east, and southeast by a long curve of the California coastline extending from Point Conception in Santa Barbara County, southeast 357 miles (mi) (578 kilometers [km]) to Cabo Colnett, Baja California in Mexico. The western border of the SCB is marked by the California Current, which flows southeastward along the coast, continuing the clockwise transport of water in the North Pacific Ocean.

Oceanography

Water current regimes in the SCB are complex and variable on seasonal and longer time scales. In general, because of the eastward indentation of the coast, a surface counterclockwise gyre, the Southern California Eddy, breaks off the California Current and carries water northward through the central SCB (Jones 1971; Hickey 1979). Closer to the shore along the continental shelf, prevailing onshore winds reverse this flow, resulting in a net along-shore surface flow toward the southeast (Lentz and Winant 1979). There is also a very-nearshore circulation pattern caused by surf along the beaches (Jones, 1971). Below about 500 feet (ft), there is a northwestward current flow inshore of the California Current. This water is of equatorial Pacific origin and has higher temperature, salinity, and phosphate concentrations and a lower oxygen concentration than the deep water in the California Current located at the same depth but farther offshore (Jones 1971). Surface waters in the bight maintain an annual temperature range of 13° to 20°C. Temperature drops with increasing water depth to about 4°C in the deeper basins. Dissolved oxygen concentration also tends to decrease with depth.

An important feature throughout the SCB is that deep water is close to shore. The bathymetry underlying the SCB includes an alternating series of 2,000- to 8,000-ft-deep basins and surfacing mountains that form 9 offshore islands or island groups and several large submerged banks and seamounts. Nearshore, 12 large canyons influence movement of sediments and other materials deposited on the bottom. There are also 32 canyons on the continental slope bordering the United States (U.S.) (Emery 1960). Offshore, there are 18 marine basins, 3 of which (Santa Monica, San Pedro, and Santa Barbara) are essentially devoid of oxygen and are virtually devoid of higher life forms. These canyons and deep basins are important sites of accumulation of fine-grained sediments and particulate materials from land runoff, ocean discharges, and ocean dumping.

El Nino

Many environmental changes in the SCB are connected with long-term, low-frequency, inter-annual oceanographic patterns. Displacement of cool surface waters—and their inhabitants—by clear, nutrient-poor warm water is correlated with periodic warm-water events off the coast of Peru and in the tropical Pacific. These are the El Niño events, which occur several times per decade (e.g., 1976, 1979, 1982-84, 1986-87, 1991-92, 1993, 1994, 1997-98, 2002-03, 2006-07 (NOAA 2007)) and are characterized by warm water, a deeper surface-mixed layer, elevated sea levels, increased abundance of southern planktonic and pelagic organisms, alterations of benthic community structure, and degeneration of coastal kelp beds (Jackson, 1986).

Bays and Wetlands

The most important bays in the SCB are Santa Monica Bay, San Pedro Bay, San Diego Bay, and Todos Santos Bay in Baja, California. There are at least 26 wetland systems in coastal lagoons and at the mouths of transient streams and rivers in the U.S. portion of the SCB (Zedler 1984). The total area of these coastal wetlands is only about 129 square miles (mi^2), an estimated 25 percent of the area they encompassed when the first Europeans arrived in Southern California in the late 1500s.

Drainage Basin

The onshore mainland drainage basin of the SCB is bordered on the north by the Santa Monica, San Gabriel, and San Bernardino Mountains; and on the east by coastal ranges that continue southward down the length of the Baja Peninsula. Because of the semiarid nature of the drainage basin and the highly seasonal pattern of annual precipitation, most of the rivers draining into the bight are small and are dry for much of the year. From north to south, the major rivers in the drainage basin are the Santa Clara, Los Angeles, San Gabriel, Santa Ana, Santa Margarita, San Luis Rey, San Diego, and Tijuana rivers. Much of the Los Angeles and San Gabriel River beds and other major drainages are lined with concrete.

Fresh water enters the Southern California Bight from a variety of sources. Riverine runoff from rain and melting snow is seasonal. Surface and subterranean runoff including storm drain inputs (non-point sources), and discharges of waste water also are transported into the bight. The volumes of water entering the bight from wastewater discharges are comparable to those from riverine and storm drain inputs. Because stormwater flow is more variable than wastewater flow, in dry seasons and years wastewater flow far exceeds that of storm water. Wastewater flows are strictly regulated to protect water quality; however, non-point source runoff is more difficult to regulate. Such flows may contain chemical contaminants and pathogens.

Habitats and Other Natural Resources

Natural habitats and resources characteristic of the SCB include abundant deep water close to shore, extensive coastal and offshore oil reserves, commercially or recreationally valuable fish and shellfish stocks, wildlife breeding and overwintering areas, kelp beds, beach and water recreation areas, and a temperate climate. These habitats and resources are described in detail in Chapter 3, and are briefly summarized here.

As a result of the local oceanographic regime, particularly the Southern California Eddy, the SCB bight is an enclave of communities of marine life specific to the area (although diminished during El Niño years). Numerous types of marine mammals are present, including both regional and migratory populations. Four species of sea turtles may be present, at least periodically. Numerous sea birds are present in the bight, and Channel Islands provide breeding habitat for some species of sea birds. Commercially exploitable stocks of fish spawn and grow primarily in the bight. Deeper waters of the bight host a diversity of mesopelagic fishes that spend parts of their life cycles in surface waters. The benthic fauna of the continental shelf, especially polychaetes and crustaceans, are diverse and constitute an important food source for many fish species. Rocky intertidal and subtidal areas, which cover large areas of the shoreline of the bight, host diverse epifauna (snails, mussels, crabs, etc.) and attached seaweeds.

Beds of the giant kelp *Macrocystis pyrifera*, which attach to the bottom and can grow to over 164 ft in length, extend along the coast of the bight. There are 33 locations in the bight between Point Conception and San Diego where kelp beds are found at least periodically at water depths ranging from 20 to 65 ft. From the 1930s to 1979, individual kelp beds occupied up to 2,720 acres (ac), with the total area occupied by kelp beds in the range of 12,000 to 15,000 ac (Foster and Schiel 1985). The size and distribution of kelp beds varies spatially and temporally in response to changes in natural and anthropogenic conditions. Natural changes in surface water temperature and nutrient concentrations associated with El Niño events, and possibly with longer-term ocean warming trends, have resulted in declining kelp beds in some areas, and winter storms can devastate large kelp beds. These storms probably are the most important factor influencing the condition and extent of kelp beds, but human activities—such as kelp harvests, boat traffic, and possibly wastewater discharges--have also affected local giant kelp beds.

The SCB is contains undersea oil deposits. Oil and tar continuously ooze from undersea seeps, periodically creating large marine oil slicks.

Frequent brush fires on land, fed by northeasterly Santa Ana winds, deposit ash and soot onto the sea.

4.2.3 Anthropogenic Activities

Fishing

Commercial and recreational fishing constitutes a significant non-military use of the ocean areas of the SOCAL Range Complex. As discussed in Section 3.7, the California Department of Fish and Game (CDFG) maintains commercial landings statistics for statistical blocks that are 5 degrees latitude by 5 degrees longitude in area (about 81 square nautical miles [nm^2]) for nearshore areas and larger for offshore waters. Commercial landings were obtained for CDFG statistical blocks within the SOCAL Range Complex (Figure 3.8-1). The annual catch of fish and invertebrates in the SOCAL Range Complex from 2002 to 2005 amounted to approximately 64,000 pounds (see Table 3.7-7). In 1993, landings data represented approximately 50 percent of the actual catch, and landings in other years have represented approximately 80 percent or more of the actual catch. Pelagic species account for approximately 97 percent of the average annual catch within the SOCAL Range Complex. Flatfish, demersal fish, and other fish associated with the bottom account for only about 3 percent of the average annual catch of fish. Other commercial fishing targets include crustaceans (lobster and half spot prawns) and squid.

Fishing can adversely affect fish habitat and managed species. Potential impacts of commercial fishing include over-fishing of targeted species and by-catch, both of which negatively affect fish stocks. Mobile fishing gears such as bottom trawls disturb the seafloor and reduce structural complexity. Indirect effects 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. Recreational fishing also has the potential to affect fish habitats because of the large number of participants and the intense, the concentrated use of specific habitats.

Removal of fish by fishing can have a profound influence on individual populations. In a recent 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, they concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance to coastal ecosystems including pollution and anthropogenic climatic change.

Natural stresses include storms and climate-based environmental shifts, such as algal blooms and hypoxia. Disturbance from ship traffic and exposure to biotoxins and anthropogenic contaminants may stress animals, weakening their immune systems, and making them vulnerable to parasites and diseases that would not normally compromise natural activities or be fatal.

Commercial and Recreational Marine Traffic

A significant amount of ocean traffic, consisting of both large and small vessels, transits through the SCB. The Port of Los Angeles is the busiest port in the U.S. (by volume of cargo). The Port of Long Beach is the second-busiest U.S. port. Taken together, these two ports (which are contiguous) would constitute the fifth-busiest port in the world. The Port of San Diego also is an important commercial cargo port. Cruise ships make daily use of these port facilities. In 2006, San Diego recorded 219 cruise ship calls (619,000 passengers) while Los Angeles recorded 1.2 million cruise passengers served. Together, these three port recorded about 8500 vessel (cargo and cruise ship) calls in 2006. For commercial vessels, the major trans-oceanic routes to the southwest pass north and south of SCI (Figure 3.14-2). The approach and departure routes into San Diego and the ports of Los Angeles-Long Beach pass between SCI and Santa Catalina Island.

Commercial vessels are sources of pollutants introduced into the waters and air basin of the SCB. Additionally, commercial vessels are a source of ship strikes on marine mammals, and are implicated, for example in the deaths of three blue whales in the Santa Barbara Channel in September 2007. (Information about ship strikes and other marine mammal stranding events, and about introduction of pollutants into the bight, is provided below).

A very substantial volume of small craft traffic, primarily recreational, occurs throughout southern California. The region's estimated 40,000 recreational boats are concentrated primarily in marinas on Santa Monica Bay, Alamitos Bay, Long Beach Marina, Huntington Harbor, Balboa-Newport Harbors, San Diego Bay, and Mission Bay; and secondarily in marinas at Oceanside and Dana Point, and in Oxnard, Ventura, and Santa Barbara. Because pleasure boats are sources of fuel leaks and toxins from antifouling paints, they constitute a potential environmental concern that has not been quantified. (Information about pollutants and hazardous wastes introduced into the SCB is provided below).

Oil Extraction

Oil extraction has occurred for eight decades offshore of the coast near Goleta, Carpinteria, Ventura, Oxnard, Santa Monica, Redondo Beach, Wilmington, San Pedro, Long Beach, Seal Beach, and Huntington Beach. Offshore oil extraction from shore-based facilities began near the turn of the century along the Santa Barbara Channel and slightly later in southern Los Angeles and Orange Counties. Oil production from offshore platforms began 35 years ago on nearby shelves (1 to 3 mi from shore) and now extends nearly to the shelf break. An extensive shore-based infrastructure exists to support offshore oil production activities, including pipelines, refineries, and oil terminals.

Seventy-nine offshore oil production leases occupying a total of about 400,000 acres are active in the Santa Barbara Channel / Santa Maria Basin area. California has a long-standing moratorium on new oil drilling platforms within the State's 3-mi jurisdictional limit. A federal moratorium on new oil drilling platforms is in place; however, periodically and as recently as 2006, legislation has been proposed to rescind a 25-year-old moratorium on oil and gas development off all of the nation's coastlines. Within federal waters offshore of southern California lie 36 undeveloped federal oil leases. Developing these leases could result in several new oil platforms off of the coast. No specific proposals for new oil platforms are now under consideration.

Oil extraction carries risks of accidental oil spills. In 1969, an industrial accident (pressurized “blowout”) on an offshore oil rig caused 3 million gallons of oil to be discharged into the Santa Barbara Channel. Long-term environmental impacts of this event have dissipated.

Natural seeps along the coasts of Santa Barbara, Ventura, Los Angeles, and Orange Counties intermittently or continuously discharge large quantities of oil and tar to nearshore waters of the SCB. Fischer (1978) estimated that as few as 2,000 and as many as 30,000 metric tons (10 million galllons) of oil enter the Santa Barbara Channel each year from natural seeps. (By comparison, the 1989 Exxon Valdez oil spill in Prince William Sound, Alaska, leaked 11 million gal of oil into marine waters.) The intertidal zone at Goleta is chronically contaminated with oil and tar from this seep. One hundred years ago, the U.S. Fish Commission steamer Albatross dispatched an observer to report on a huge fish kill extending from Santa Barbara to San Diego. He counted thousands of pelagic and demersal fish on the Santa Monica Bay beaches, many of them smelling of petroleum, and suggested that the event was caused by seepage from offshore "oil springs" (Eichbaum et al. 1990).

Liquid Natural Gas Terminals

Liquid Natural Gas (LNG) facilities have been proposed at several locations on the Pacific coast of North America in recent years in response to the quickly escalating domestic demand for this fuel. Sites under consideration range from British Columbia to Mexico, with at six locations under consideration within the SCB (see Table 4-2).

Table 4-2: LNG Projects and Proposals

SCB LNG Projects and Proposals[A]	
Proposed LNG Terminals	**Location**
Cabrillo Deepwater Port LNG Facility	Offshore Ventura County
Clearwater Port LNG Project	Offshore Ventura County
Long Beach LNG Facility	Long Beach Harbor
Ocean Way LNG Terminal	Offshore Long Beach

SCB LNG Projects and Proposals[A]	
Esperanza Energy LLC	Offshore Long Beach
Terminal GNL Mar Adento de Baja	Offshore Tijuana, Mexico
Moss Maritime LNG	Offshore Rosarito, Mexico
Notes: (a) Excerpted from CA Energy Commission: http://www.energy.ca.gov/lng/projects.html	

Potential environmental impacts include those associated with additional ship traffic generally, and potential releases of LNG. Releases of LNG can result from equipment leaks or spills during operations. Releases can be accidental (e.g., ship collision), or intentional (i.e., from sabotage or terrorist acts). Most accident scenarios are complex, or multi-stage events with cascading impacts. For example, a spill followed by a pool fire, or a leak followed by a vapor cloud ignition. The rate at which the LNG is released, the total size of the release, wind speed and direction, and the location of the nearest ignition source are all important factors in determining the consequences of the release.

Ocean Pollution

Environmental contaminants in the form of waste materials, sewage, and toxins are present in, and continue to be released into, the oceans off southern California. Polluted runoff, or non-point source pollution, is considered the major cause of impairment of California’s ocean waters. Stormwater runoff from coastal urban areas and beaches carries waste such as plastics and Styrofoam into coastal waters. Sewer outfalls also are a source of ocean pollution in southern California. Sewage can be treated to eliminate potentially harmful releases of contaminants; however, releases of untreated sewage occur due to infrastructure malfunctions, resulting in releases of bacteria usually associated with feces, such as *Escerichia coli* and *enterococci*. 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 in southern California. While such dumping has long been forbidden by law, the practice left ocean outflow sites contaminated. In a 1994 report, the U.S. Geological Survey identified elevated levels of dichloro-diphenyl-trichloroethane (DDT) and polychlorinated biphenyls (PCBs), both classified as persistent organic pollutants, in a 17 square-mile area of ocean near Palos Verdes, south of Santa Monica Bay. Sewage treatment facilities generally do not treat or remove persistent organic pollutants. Plastic and Styrofoam waste in the ocean chemically attracts hydrocarbon pollutants such as PCBs and DDT, which accumulate up to 1 million times more in plastic than in ocean water. Fish, other marine animals, and birds consume these wastes containing elevated levels of toxins. DDT mimics estrogen in its effects on some animals, possibly causing the development of female characteristics in male hornyhead turbots and English sole, according to a study by the Southern California Coastal Water Research Project. The California Office of Environmental Health Hazard Assessment currently has consumption warnings for several species including white croaker, corbina, sculpin, rock fish and kelp bass, primarily due to concerns about DDT and PCBs in the southern California region.

Regulatory activities have made progress in reducing both non-point source pollution such as runoff, and point source pollution such as that which may emanate from sewer outfall sites. In 2000, California received federal approval of its Coastal Nonpoint Source Pollution Control Program from the U.S. Environmental Protection Agency and the National Oceanic and Atmospheric Administration (the agencies that administer the Clean Water Act and Coastal Zone Management Act, respectively). The program includes the coordinated participation of the

Coastal Commission, the State Water Resources Control Board, and the Regional Water Quality Control Boards. The current plan covers the years 2003 to 2008.

Pollution from vessels is a source of ocean contamination. Sewage, sludge, blackwater, graywater, bilge water, plastics and other trash components and waste materials are routinely discharged from vessels into coastal and ocean waters in southern California. In 2003, the California Legislature passed legislation (Assembly Bills (AB) 121 and 906), which prohibits certain waste discharges from large passenger vessels (cruise ships) into State waters.

Coastal Development

Coastal development intensifies use of coastal resources, resulting in potential impacts on water quality, wildlife and fish habitat, air quality, and intensity of land and ocean use. Coastal development is therefore closely regulated in California. (See Section 6.1.1 for a detailed discussion of regulation of activities in the coastal zone.) New development in the coastal zone may require a permit from the California Coastal Commission, or a local government to which permitting authority has been delegated by the Coastal Commission. A Coastal Development Permit is generally required for any project in the Coastal Zone that includes:

- the placement of any solid material or structure;
- a change in land use density or intensity (including any land division);
- change in the intensity of water use or access to water; or
- removal of major vegetation.

Some types of development are exempt from coastal permitting requirements, including in many cases, repairs and improvements to single-family homes, certain "temporary events," and, under specified conditions, replacement of structures destroyed by natural disaster.

Local Coastal Programs (LCPs) identify the locations, types, densities and other ground rules for future development in the coastal-zone portions of the 73 cities and counties along the coast. Each LCP includes a land-use plan and its implementing measures (e.g., zoning ordinances). Prepared by local government and approved by the Coastal Commission, these programs govern decisions that affect the conservation and use of coastal resources. While each LCP reflects the unique characteristics of individual local coastal communities, regional and statewide concerns must also be addressed in conformity with the goals and policies of the State Coastal Act.

LCPs are basic planning tools used by local governments to guide development in the coastal zone, in partnership with the Coastal Commission. LCPs contain the ground rules for future development and protection of coastal resources in the 73 coastal cities and counties, including Los Angeles, Orange, and San Diego Counties. The LCPs specify appropriate location, type, and scale of new or changed uses of land and water. Each LCP includes a land use plan and measures to implement the plan (such as zoning ordinances). Following adoption by a city council or county board of supervisors, an LCP is submitted to the Coastal Commission for review for consistency with Coastal Act requirements.

Coastal development in southern California is both intensive and extensive, and the coast adjacent to the SOCAL Range Complex is densely populated. This development has impacted and continues to impact coastal resources in EIS Study Area including through: point source and non-point source pollution; intensive boating and other recreational use; intensive commercial and recreational sport fishing; intensive ship traffic using major port facilities at Los Angeles, Long Beach, and San Diego; and offshore oil and gas facilities (both existing and proposed). Regulation of these activities through the Coastal Development programs discussed above serves primarily to limit new development; however, the coastal zone is already fully developed in many areas, with associated ongoing impacts.

Scientific Research

There are currently 30 scientific research permits and General Authorizations for research issued by the National Marine Fisheries Service (NMFS) for cetacean work in the wild in the North Pacific. The most invasive research involves tagging or biopsy while the remainder focuses on vessel and aerial surveys and close approach for photo-identification. Species covered by these permits and authorizations include small odontocetes, sperm whales and large mysticetes. One permit issued to the Office of Protected Resources of NMFS allows for responses to strandings and entanglements of listed marine mammals. NMFS has also issued General Authorizations for commercial photography of non-listed marine mammals, provided that the activity does not rise to Level A Harassment of the animals. These authorizations are usually issued for no more than 1 or 2 years, depending on the project.

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

Commercial and General Aviation

Southern California is served by several large commercial airports. Los Angeles International (LAX), Long Beach International (Long Beach), John Wayne International (Santa Ana), and Lindbergh Field (San Diego) are situated on or nearby the coastline, while Los Angeles / Ontario International Airport is situated in San Bernardino County, approximately 50 miles west of LAX. The following airport traffic statistics, developed by Airports Council International (ACI 2006), provide data on "total movements" (landing plus takeoff of one aircraft equals a "movement") at these five airports:

Table 4-3: Landings / Takeoffs (Total Movements) at Five Regional Airports,2006

Airport	Total Movements (2006)	National Rank	% Increase Over 2005
LAX	656,842	4	1%
Long Beach	369,738	24	4.7%
Santa Ana	347,194	27	(0.8%)
San Diego	220,839	52	0.3%
Ontario	136,261	85	4.9%

The City of San Diego operates two general aviation airports: Montgomery Field, located in northeastern San Diego, and Brown Field, located in southern San Diego near the border with Mexico. San Diego County operates eight general aviation airports. Two general aviation airports are located in Orange County. Los Angeles County operates numerous general aviation airports, including the airport at Avalon, Santa Catalina Island. Numerous municipal landing fields are located in the region.

Aircraft operating under visual flight rules (VFR) can fly along the coast between San Diego and Orange County and out to Santa Catalina Island largely unconstrained, except by safety requirements and mandated traffic flow requirements. Aircraft operating under IFR clearances, authorized by the FAA, normally fly on the airway route structures. In southern California these routes include both high- and low- altitude routes between San Diego and Los Angeles and to Santa Catalina Island. There are two Control Area Extensions (CAE) from southern California through or nearby W-291 to facilitate access to the airways to Hawaii and other trans-Pacific locations. CAE 1177 extends from Santa Catalina Island southwest between W-291 and the Pt. Mugu Sea Range. CAE 1156 extends west from San Diego through the northern portion of W-291. When W-291 is active, CAE 1156 is normally closed. CAE 1177, the more important route through the coastal Warning Areas, is closed only when weapons hazard patterns extend into the area, and this closure is fully coordinated with the FAA. When W-291 is active, aircraft on IFR clearances are precluded from entering W-291 by the FAA. However, since W-291 is located entirely over international waters, nonparticipating aircraft operating under VFR are not prohibited from entering the area. Examples of aircraft flights of this nature include light aircraft, fish spotters, and whale watchers.

Air Quality Factors

In their emission inventories by category (California Air Resources Board (ARB) 2000) for 2004 and 2020, the SCAB, SDAB, and the SCCAB include emissions from aircraft, ships, and commercial boats. Emission estimates are based on emissions from onshore or nearshore operations (for example, operations within Los Angeles Harbor for ship emissions). These emissions would account for a small percentage of the overall air emissions budgets for each of the air basins. These emissions are generally not included in the SIP emissions budget and in air quality planning because they are assumed to have a negligible effect on the ambient air quality, and because reductions in emissions from these sources would not generate a great improvement in the ambient air quality.

4.2.4 San Clemente Island

SCI is the southernmost of the eight California Channel Islands. It lies 55 nm south of Long Beach and 68 nm west of San Diego. The island is approximately 21 nm long and is 4-1/2 nm across at its widest point. Since 1934, the island has been owned and operated by the U.S. Navy as a training site. Presently, and for the foreseeable future, only activities in support of military training are or will be permitted to occur on SCI. Impacts from these activities generally are confined to the island and its immediate nearshore vicinity. Table 4-4 identifies past and present projects undertaken by the Navy at SCI. These activities are addressed, as appropriate in separate environmental analyses, and impacts from these activities generally are temporary and localized.

Table 4-4: Past, Present, and Planned Projects on San Clemente Island

Number	Project Title	Description
1	Southern California Anti-Submarine Warfare Range (SOAR) Cable Refurbishment	Refurbishment of underwater cable arrays and associated range equipment at SOAR involving the installation of hydrophones, array cables, and associated hardware within the existing coverage of the range. The area of SOAR proposed under this activity is located off of West Cove, in the northwestern portion of SCI. The offshore area proposed for range refurbishment extends seaward from West Cove.
2	Wilson Cove Moorings	Installation of 3 Class "E" 50,000 lb moors, and four 9,000 12,000 lb moors, removal of an existing moor at Wilson Cove at SCI, and repair of two existing moors.
3	Commercial Cell Towers Installation	Construction of three cell towers on SCI has been completed.
4	Waste Water Treatment Plant Upgrades	Construction of an effluent outfall extension to an existing Waste Water Treatment Plant and discharge pipe to allow for an increase in capacity and increase in permit requirements.
5	Tomahawk Missile Launch Facility	Construction of an underwater launch facility for the launch of Tomahawk cruise missiles (one per year) on flight tracks over the Point Mugu Sea Range near NOTS Pier at SCI. The missiles would be recovered after landing by parachute on San Nicolas Island.
6	P-763 - MOUT Facility	Construction of building shells for a variety of building types from residential to business to industrial for urban special operations training at San Clemente Island.
7	P-740 Bachelors Quarters	Construction of two 45-unit bachelors quarters buildings (MILCON Projects P740 and P471) and demolition of five bachelor quarters existing buildings (60111, 60116, 60121, 60133, and 60153) at San Clemente Island.
8	P- 493 Ridge Road	Road improvements phased over five years consisting of re-surfacing and widening, construction of an extended Assault Vehicle Maneuver Road, and quarrying and laydown area to provide materials for and facilitate road projects.
9	SCI Runway Upgrades	Repair of runway, taxiway, and parking apron and provision of various lighting and electrical repairs to support safe aircraft operations at the NALF at SCI.
10	Various Maintenance Projects	Maintenance projects such as hangar door replacement, concrete replacement, exterior painting of buildings, and replacement of lighting fixtures.
11	Live-Fire Training Areas and MOUT Facility	Development of three live-fire training areas on SCI and the construction of a Military Operations on Urban Terrain (MOUT) facility. Training activities include direct action, live-fire over-the-beach tactical training, small arms firing, and land demolition.
12	Tomahawk Land Attack Missile Testing in the SCI Missile Impact Range	Testing of live and inert warheads at the Missile Impact Range (MIR) and the use of an underwater translator launch site for missiles off the eastern side of SCI.
13	Joint Standoff Weapon	Live-fire testing (scheduled from 1996 to 2007) for the JSOW program at the SCI MIR. The JSOW is launched from an aircraft.
14	Land Attack Standard Missile (LASM)	Inert testing of LASM launched from ships positioned 75 nm west of SCI with missile termination at the MIR. Testing involved four non live-fire launches and was completed in 2000.

Number	Project Title	Description
16	Distributed Explosive Technology (DET)	One-time operational test of DET (used to clear bottom-laid and submerged mines) in littoral waters in Horse Beach Cove off of SCI.
17	Surface Ship Radiated Noise Measurement (SSRNM) Array	Installation of hydrophone array with tri-moor configuration 5000 yds off eastern shore of SCI, for use in measuring sound from transiting ships
18	Modular Housing	Construction of two single-story modular buildings to be used as temporary military housing
19	Unmanned Aerial Vehicle (UAV) Infrastructure Construction	Construction of three buildings (60,000 sf), water and fuel storage facilities, and road improvements for use as UAV training center.
20	Storage Facility Construction	Construction of storage facility near Northern Light pier .
21	Antennae Installation	Install antennae and construct associated small shelter near airfield.
22	Building Demolition	Demolish 17 structures at Wilson Cove (site preparation for boat facility construction).
23	Boat Facility Construction	Construct boat maintenance facility and boat storage facility (2 structures) at Wilson Cove
24	Missile Launches	Two launches at VC-3, proposed to occur in the July to October 2007 timeframe. The missile booster impact would occur at the MIR. The missile would then fly pre-planned waypoints over the island at an altitude of approximately 330 ft (91 m) above ground level and over the ocean and then return and impact into the MIR. It is estimated that the first and second missile launches would fly over the ocean at a distance of 21 miles (18 nm) and 31 miles (27 nm), respectively, from the SCI shoreline.

4.2.5 Habitats of Migratory Marine Animals

Migratory or wide-ranging marine mammals and sea turtles that may be present in the SOCAL Range Complex may be affected by natural events and anthropogenic activities that occur in areas far removed from southern California, on breeding grounds, migration routes, wintering areas, or other habitats within a species' range. Events and activities that affect the habitats of these marine species outside the SCB / SOCAL Range Complex include:

- Disease
- Natural toxins
- Weather and climatic influences
- Navigation errors
- Natural predation
- Fishing
- Hunting (including sea turtle egg predation)
- Ocean pollution
- Habitat modification or destruction
- Ship traffic

These stressors on marine habitats and associated effects on marine mammals and sea turtles are discussed in detail in Sections 4.3.8 and 4.3.9, below.

4.3 CUMULATIVE IMPACT ANALYSIS

4.3.1 Geology and Soils

The Proposed Action would affect marine geology and sediments in the SOCAL Range Complex chiefly by depositing training debris on bottom sediments and disturbing previously disturbed surface soils in existing training areas on SCI. These effects were determined to be less than significant in the context of the existing environment.

Cumulative impacts on marine geology and sediments would consist of the effects of the Proposed Action in concert with other projects, actions, and processes that deposit sediment or debris, or disturb ocean bottom sediments. Relevant effects would include debris contributions from recreational and commercial fishing, offshore oil and gas development, dredging and sand replenishment projects, and other ocean industries. The effects of these activities on the geology and soils within the SOCAL Range Complex are known only in a very general sense.

Commercial ocean industries, such as fishing, are dispersed over broad areas of the ocean, as are the effects of the Proposed Action. Dredging mostly occurs in nearshore areas, whereas most of the Navy training takes place in remote areas of the open ocean. No major offshore oil and gas or LNG facilities are located in the SOCAL Range Complex, and no permit applications for such facilities are under consideration by State or federal agencies. Cumulative development projects along the southern California coast would contribute to increased rates of sediment discharge into nearshore waters, but no substantial changes in bottom contours or sediment deposits are expected. In summary, cumulative effects on marine geology and sediments in the open-ocean portions of the SOCAL Range Complex are less than significant.

SCI's nearshore ocean bottom sediments would be disturbed by projects such as the SOAR Cable Refurbishment, SWTR installation, new moorings at Wilson Cove, and an underwater missile launch facility, in addition to the effects of the Proposed Action. These areas would soon be returned to their previous condition by wave action and currents, but the new structures would permanently alter the bottom topography. The new structures would occupy very small portions of the nearshore ocean bottom. The cumulative impact of these projects, in conjunction with the Proposed Action, would be insignificant.

Cumulative impacts on terrestrial SCI geology and soils would consist of the effects of the Proposed Action in concert with other Navy actions that disturbed surface soils, such as new construction (see Table 4-4, above). New or expanded training activities that would increase foot traffic could trample and eliminate vegetation and compact surface soils, which in turn could increase surface runoff during rain storms. New construction could remove ground cover, disturb surface soils, alter surface drainage patterns, and, by increasing the ground coverage of impervious surfaces, increase the volume of surface water flows during storms.

While each new activity or construction project on SCI could contribute locally and incrementally to increased runoff and erosion, the cumulative effects would be negligible. Construction projects would include drainage improvements, road improvements, and revegetation of exposed soils, and impacts would predominantly occur in areas of existing development. In addition, Best Management Practices (BMPs) for soil-disturbing activities would be implemented for any construction activity. Foot traffic would be directed to existing roads and trails to the extent practicable.

4.3.2 Air Quality

Activities affecting air quality in the region include, but are not limited to, mobile sources such as automobiles and aircraft, and stationary sources such as power generating stations, manufacturing operations and other industry, and the like. In CARB emission inventories by category (CARB 2000) for 2004 and 2020, the SCAB, SDAB, and SCCAB include emissions from aircraft, ships, and commercial boats. These emissions are included in the mobile source category. Traditionally, the emission estimates are based on emissions from onshore or nearshore operations (for example, operations within Los Angeles Harbor for ship emissions). Emission estimates for these sources are summarized in Table 4-2.

These emissions would account for a small percentage of the overall air emissions budgets for each of the air basins. They do not include marine vessel emissions for vessels operating outside of U.S. territorial waters. These emissions are generally not included in the SIP emissions budget and in air quality planning because they are assumed to have a negligible effect on the ambient air quality, and because reductions in emissions from these sources would not generate a great improvement in the ambient air quality.

Table 4-5: Emissions Estimates for Aircraft and Marine Vessels (CARB 2000)

	South Central Coast		South Coast		San Diego	
	2004	2020	2004	2020	2004	2020
Aircraft						
ROG	2	2	8	9	3	3
CO	16	18	56	76	20	21
NOx	1	1	16	28	5	6
PM10	<1	<1	1	1	2	2
Marine Vessels						
ROG	5	2	39	19	10	5
CO	23	19	192	166	72	67
NOx	4	4	57	87	7	7
PM10	1	1	6	9	1	2

Units: Tons per day

Source: California Air Resource Board, Air Emissions Inventories, Emissions by Category, 2004 and 2020. www.arb.ca.gov.

As indicated by the data in Table 4-5, above, the trends in southern California in all three of the Air Basins onshore indicate that air quality is improving. For example, the number of exceedances of the NAAQS for ozone in the SCAB decreased from a high of 187 in 1981 to 60 in 1998. Likewise, in the SDAB there has been a decrease from a high of 88 exceedances of the one-hour ozone standard in 1980 to 9 in 1998, and the number of exceedances in the SCCAB has decreased from 85 in 1981 to 6 in 1998. These trends indicate that progress is being made toward attainment of the NAAQS for ozone without imposing emission limitations on offshore emissions from ships and aircraft. Accordingly, cumulative impacts on air quality would be less than significant.

4.3.3 Hazardous Materials and Wastes

The primary impact of cumulative hazardous materials use in the SOCAL Range Complex would be to increase the amounts of hazardous constituents that are released to the environment. Hazardous materials settling out of the water column would contribute to contamination of ocean bottom sediments. Relevant activities would include releases of hazardous constituents from fishing vessels, other ocean vessels, wastewater treatment plant outfalls, and non-point source pollution from terrestrial sources. The effects of these activities in the SOCAL Range Complex are known only in a very general sense.

Commercial ocean industries, such as fishing and ocean transport, are dispersed over broad areas of the ocean. Discharges of hazardous constituents from non-point source runoff and treatment plant outfalls mostly effect the waters within 3 nm of the coast, whereas most of the Navy activities occur beyond the 12 nm limit of federal waters. The quantities of contaminants released, however, would be cumulatively insignificant relative to the volume of the water and the area of bottom sediments affected. The use of hazardous materials by the Navy under the Proposed Action, when added to that of other projects, would not significantly impact resources in the SOCAL Range Complex.

The primary impact of hazardous materials on SCI would be to contribute contaminants to surface soils and to surface runoff into the ocean. Construction projects and maintenance activities on SCI beyond those included in the Proposed Action could also contribute minor amounts of hazardous contaminants to surface soils. The contributions of these other projects would be very minor, however, in comparison to the effects of the training and testing activities. Thus, the cumulative impacts would be substantially the same as the impacts described for the Proposed Action.

The primary impact of increased hazardous waste generation resulting from the Proposed Action would be a need for increased hazardous waste storage, transport, and disposal ashore. Other offshore and SCI Navy activities would also contribute to the Navy's overall hazardous waste streams. The Navy's hazardous waste management system and procedures are adequate to accommodate these increases. Other hazardous waste generators in the region, along with the Navy, would require the services of hazardous waste transporters and treatment, storage, and disposal facilities. While the costs for hazardous waste transport, treatment, storage, and disposal could increase substantially in response to increased cumulative demand, the hazardous waste management industry in the region has sufficient physical capacity to respond to this increased demand. Accordingly, cumulative impacts on hazardous waste management would be less than significant.

4.3.4 Water Resources

The Proposed Action would release water pollutants to the marine environment. It also would release chemical contaminants to surface soils; these contaminants could migrate into groundwater aquifers or via surface flows to the marine environment. These effects of the Proposed Action, however, have been determined not to be significant.

Cumulative impacts on ocean water quality would consist of the effects of the Proposed Action in concert with other marine projects, actions, and processes that contributed to water pollutants. Such activities would include recreational and commercial fishing, offshore oil and gas development, and other ocean industries. The effects of these activities on the SOCAL Range Complex are known only in a very general sense.

Commercial ocean industries, such as fishing and ocean transport, are dispersed over broad areas of the ocean, as are the effects of the Proposed Action. Most of the Navy training takes place in remote areas of the open ocean. No major offshore oil and gas facilities are located in the SOCAL Range Complex, and no permit applications for such facilities are under consideration by State or federal agencies. In summary, cumulative effects on marine water quality in the SOCAL Range Complex are expected to be less than significant.

Cumulative impacts on terrestrial SCI water quality would consist of the effects of the Proposed Action in conjunction with other Navy on-island actions that contributed contaminants to surface soils. On-island maintenance activities would involve the use of potential water pollutants, but facilities and procedures in compliance with federal and state regulations would limit the release of such contaminants to *de minimis* amounts. New construction similarly would require the use and application of potential water pollutants, but construction procedures in compliance with federal and state regulations would limit any releases of contaminants. A proposed increase in the capacity (and thus discharge volume) of SCI's wastewater treatment plant would require a discharge permit; the permitting process would assure that ocean water quality objectives would continue to be met. Overall, the cumulative effects would be similar to the effects anticipated for the Proposed Action, and would be less than significant.

4.3.5 Acoustic Environment (Airborne)

The Proposed Action activities in the SOCAL Range Complex were deemed to have insignificant effects on the marine (airborne) noise environment, due in large part to the absence of human sensitive receptors on these sea ranges. Commercial ship and aircraft traffic, oil and gas development, and recreational activities all would contribute occasional, short-term noise to small portions of the ocean operating area of the SOCAL Range Complex. The airborne noises they generate would consist chiefly of short-term intrusive noise events in different locations at different times, similar to those of the Proposed Action. Thus, little or no overlap in location or time of discrete noise events would be expected. Peak and average community noise levels would remain largely unchanged. Additionally, human noise receptors would still be absent. Accordingly, cumulative impacts on the marine noise environment would be less than significant.

Cumulative noise sources on SCI would include range operations, training, and maintenance activities not included in the Proposed Action, along with numerous planned construction projects. Noise from these activities generally would consist of short-term, intrusive noise events in different locations. Because these activities would occur relatively near to each other, some potential exists for an additive effect and a modest increase in average hourly noise levels during the day. The only noise-sensitive receptors, however, would be military personnel and their civilian contractors; members of the general public would not be exposed to this cumulative noise environment.

The noise-sensitive receptors most likely to be exposed to cumulative noise from on-island and nearshore Navy activities would be fishermen, fishing and dive charters, and other commercial and recreational vessels in the nearshore waters around SCI. While these individuals could be exposed to high noise levels from naval training activities, especially the use of live ordnance on SCI, they generally would not be exposed to high noise levels from on-island construction projects. Both distance attenuation and topographic shielding generally would substantially reduce the noise level between its source and the closest receptors. Projects such as the SOAR Cable Refurbishment, new moorings at Wilson Cove, and an underwater missile launch facility would generate very little atmospheric noise, and any construction noise would be short in duration. Thus, the cumulative noise environment would be similar to that for the Proposed Action alone, which has been determined to have less than significant impacts.

Proposed upgrades of SCI's NALF would increase total air operations, expanding the +65-decibel noise contour over portions of the ocean. The increase would be modest and the effected area would be small, however, and the exposure of any one vessel to aircraft noise while traversing the area would be short. In addition, little or no overlap between aircraft noise from NALF and noise from noise-intensive training activities such as ordnance delivery would occur, however, because the air field is located on the northern end of SCI and these noise-intensive training activities are concentrated in SHOBA on the southern end of the island.

In the area of airborne sound, the primary impacts of proposed Navy activities are geographically isolated from population centers and otherwise will not affect natural resources. There would be no significant cumulative impact from these proposed activities.

4.3.6 Marine Plants and Invertebrates

Potential cumulative impacts on marine plants and invertebrates in the SOCAL Range Complex include releases of chemicals into the ocean, introduction of debris into the water column and onto the seafloor, and mortality and injury of marine organisms near the detonation or impact point of ordnance or explosives. The presence of persistent organic compounds such as DDT and PCBs are of particular concern. In light of these concerns, Navy activities would have small or negligible potential impacts. There would be no long-term changes to species abundance or diversity, no loss or degradation of sensitive habitats, and no effects to threatened and endangered species. None of the potential impacts would affect the sustainability of resources, the regional ecosystem, or the human community.

4.3.7 Fish

Potential cumulative impacts of Navy training exercises include release of chemicals into the ocean, introduction of debris into the water column and onto the seafloor, mortality and injury of marine organisms near the detonation or impact point of ordnance or explosives, and, physical and acoustic impacts of vessel activity. The overall effect on fish stocks would be negligible additions to impacts of commercial and recreational fishing in the SOCAL Range Complex.

Due to the wide geographic separation of most of the operations, Navy activities would have small or negligible potential impact, and their potential impacts are not additive or synergistic. Relatively small numbers of fish would be killed by shock waves from mines, inert bombs, and intact missiles and targets hitting the water surface. These and several other types of activities common to many exercises or tests have less-than-significant effects on fish: aircraft, missile, and target overflights; muzzle blast from 5-in naval guns; releases of munitions constituents; falling debris and small arms rounds; entanglement in military-related debris; and chaff and flares. There would be no long-term changes in species abundance or diversity, no loss or degradation of sensitive habitats, and no effects to threatened and endangered species. None of the potential impacts would affect Essential Fish Habitat, sustainability of resources, the regional ecosystem, or the human community.

4.3.8 Sea Turtles

Four species of sea turtles, leatherback, loggerhead, olive ridley, and green, may occur in the SOCAL Range Complex. Each of these species is globally distributed, and each is listed as threatened or endangered.

Distribution and Conservation Status

Olive ridley turtles are globally distributed in the tropical regions of the South Atlantic, Pacific, and Indian Oceans. In the South Atlantic Ocean, they are found along the Atlantic coasts of West Africa and South America. In the Eastern Pacific, they occur from Southern California to Northern Chile. Olive ridleys often migrate great distances between feeding and breeding grounds. In two separate satellite telemetry studies, both male and female olive ridleys leaving the breeding and nesting grounds off the Pacific coast of Costa Rica migrated out to the deep waters of the Pacific Ocean. Both sexes migrated to waters deeper than 9800 ft (3000 m). The results did not indicate a directed migration to a specific foraging area, instead it appears the olive ridley forages opportunistically in deep ocean waters (Plotkin et al. 1994). Olive Ridley populations are listed as endangered or threatened worldwide (NOAA 2007).

The green turtle is globally distributed and generally found in tropical and subtropical waters along continental coasts and islands between 30° North and 30° South. Nesting occurs in over 80 countries throughout the year (though not throughout the year at each specific location). Green turtles are thought to inhabit coastal areas of more than 140 countries. In the eastern North

Pacific, green turtles have been sighted from Baja California to southern Alaska, but most commonly occur from San Diego south. In the central Pacific, green turtles occur around most tropical islands, including the Hawaiian Islands. Green turtle populations are listed as endangered or threatened throughout their range (NOAA 2007).

Leatherback turtles are globally distributed. Leatherback turtle nesting grounds are located around the world, with the largest remaining nesting assemblages found on the coasts of northern South America and west Africa. The U.S. Caribbean, primarily Puerto Rico and the U.S. Virgin Islands, and southeast Florida support minor nesting colonies, but represent the most significant nesting activity within the United States. Adult leatherbacks are capable of tolerating a wide range of water temperatures, and have been sighted along the entire continental coast of the United States as far north as the Gulf of Maine and south to Puerto Rico, the U.S. Virgin Islands, and into the Gulf of Mexico. The Pacific Ocean leatherback population is generally smaller in size than that in the Atlantic Ocean. Leatherback turtles are endangered throughout their range (NOAA 2007).

Loggerheads turtles are circumglobal, occurring throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. Loggerheads are the most abundant species of sea turtle found in U.S. coastal waters.

In the eastern Pacific, loggerheads have been reported as far north as Alaska, and as far south as Chile. In the U.S., occasional sightings are reported from the coasts of Washington and Oregon, but most records are of juveniles off the coast of California. The west coast of Mexico, including the Baja Peninsula, provides critically important developmental habitats for juvenile loggerheads. The only known nesting areas for loggerheads in the North Pacific are found in southern Japan. Loggerhead turtles are threatened throughout their range (NOAA 2007).

Impacts on Sea Turtles

Incidental take in fishing operations, or bycatch, is one of the most serious threats to sea turtle populations. In the Pacific, NMFS requires measures (e.g., gear modifications, changes to fishing practices, and time/area closures) to reduce sea turtle bycatch in the Hawaii- and California-based pelagic longline fisheries and the California/Oregon drift gillnet fishery.

Marine debris affects marine turtles, which commonly ingest or become entangled in marine debris (e.g., tar balls, plastic bags, plastic pellets, balloons, and ghost fishing gear) as they feed along oceanographic fronts, where debris and their natural food items converge. Marine pollution from coastal runoff, marina and dock construction, dredging, aquaculture, oil and gas exploration and extraction, increased underwater noise, and boat traffic can degrade marine habitats used by marine turtles. Turtles swimming or feeding at or just beneath the surface of the water are vulnerable to boat and vessel strikes, which can result in serious propeller injuries and death. Disease**,** specifically fibropapillomatosis (FP), is a major threat to green turtles in some areas of the world. In addition, scientists have documented FP in populations of loggerhead, olive ridley, and flatback turtles. The effects of FP at the population level are not well understood. How some marine turtle species function within the marine ecosystem is still poorly understood. Global warming could potentially have an extensive impact on all aspects of a turtle's life cycle, as well as impact the abundance and distribution of prey items. Loss or degradation of nesting habitat resulting from erosion control through beach nourishment and armoring, beachfront development, artificial lighting, and non-native vegetation is a serious threat affecting nesting females and hatchlings (NOAA 2007).

Cumulative Impacts

Sea turtles are generally uncommon in the SOCAL Range Complex and do not nest there, but may forage in or transit through the area. Temporary disturbance incidents associated with SOCAL Range Complex activities could result in an incremental contribution to cumulative impacts on sea turtles. The mitigation measures identified in Section 3.8.1.1.2 would minimize any potential adverse effects on sea turtles. The impacts of the No Action and Proposed Action alternatives are not likely to affect the species' or stock's annual rates of recruitment or survival. Therefore, the incremental impacts of the No Action and Proposed Action alternatives would not present a significant contribution to the effects on sea turtles when added to effects on sea turtles from other past, present, and reasonably foreseeable future actions.

4.3.9 Marine Mammals

Risks to marine mammals emanate primarily from ship strikes, exposure to chemical toxins or biotoxins, exposure to fishing equipment that may result in entanglements, and disruption or depletion of food sources from fishing pressure and other environmental factors. Potential cumulative impacts of Navy activities on marine mammals would result primarily from possible ship strikes and sonar use.

Stressors on marine mammals and marine mammal populations can include both natural and human-influenced causes listed below and described in the following sections:

<u>Natural Stressors</u>

- Disease
- Natural toxins
- Weather and climatic influences
- Navigation errors
- Social cohesion

<u>Human-Influenced Stressors</u>

- Ship strikes
- Pollution and ingestion
- Noise

Natural Stressors

Significant natural causes of mortality, die-offs, and stranding discussed below include disease and parasitism; marine neurotoxins from algae; navigation errors that lead to inadvertent stranding; and climatic influences that impact the distribution and abundance of potential food resources (i.e., starvation). Stranding also is caused by predation by other species such as sharks (Cockcroft et al. 1989; Heithaus, 2001), killer whales (Constantine et al. 1998; Guinet et al. 2000; Pitman et al. 2001), and some species of pinniped (Hiruki et al.,\ 1999; Robinson et al. 1999).

<u>Disease</u>

Like other mammals, marine mammals frequently suffer from a variety of diseases of viral, bacterial, and fungal origin (Visser et al., 1991; Dunn et al., 2001; Harwood, 2002). Gulland and Hall (2005, 2007) provide a summary of individual and population effects of marine mammal diseases.

<u>Marine Neurotoxins</u>

Some single-celled marine algae common in coastal waters, such as dinoflagellates and diatoms, produce toxic compounds that can bio-accumulate in the flesh and organs of fish and invertebrates (Geraci et al., 1999; Harwood, 2002). Marine mammals become exposed to these compounds when they eat prey contaminated by these naturally produced toxins (Van Dolah, 2005).

Weather Events and Climate Influences

Severe storms, hurricanes, typhoons, and prolonged temperature extremes may lead to local marine mammal strandings (Geraci et al. 1999; Walsh et al. 2001). Storms in 1982-1983 along the California coast led to deaths of 2,000 northern elephant seal pups (Le Boeuf and Reiter 1991). Seasonal oceanographic conditions in terms of weather, frontal systems, and local currents may also play a role in stranding (Walker et al. 2005).

The effect of large-scale climatic changes to the world's oceans and how these changes impact marine mammals and influence strandings are difficult to quantify, given the broad spatial and temporal scales involved, and the cryptic movement patterns of marine mammals (Moore 2005; Learmonth et al. 2006). The most immediate, although indirect, effect is decreased prey availability during unusual conditions. This, in turn, results in increased search effort required by marine mammals (Crocker et al. 2006), potential starvation if not successful, and corresponding stranding due directly to starvation or succumbing to disease or predation while in a weakened, stressed state (Selzer and Payne 1988; Geraci et al. 1999; Moore, 2005; Learmonth et al. 2006; Weise et al. 2006).

Navigational Error

Geomagnetism- Like some land animals and birds, marine mammals may be able to orient to the Earth's magnetic field as a navigational cue, and areas of local magnetic anomalies may influence strandings (Bauer et al., 1985; Klinowska 1985; Kirschvink et al. 1986; Klinowska 1986; Walker et al., 1992; Wartzok and Ketten 1999).

Echolocation Disruption in Shallow Water- Some researchers believe stranding may result from reductions in the effectiveness of echolocation in shallow water, especially in the pelagic species of odontocetes who may be less familiar with coastlines (Dudok van Heel, 1966; Chambers and James, 2005). For an odontocete, echoes from echolocation signals contain important information on the location and identity of underwater objects and the shoreline. The authors postulate that the gradual slope of a beach may present difficulties to the navigational systems of some cetaceans, since live strandings commonly occur along beaches with shallow, sandy gradients (Brabyn and McLean 1992; Mazzuca et al. 1999; Maldini et al. 2005; Walker et al. 2005). A factor contributing to echolocation interference in turbulent, shallow water is the presence of microbubbles from the interaction of wind, breaking waves, and currents. Additionally, ocean water near the shoreline can have an increased turbidity (e.g., floating sand or silt, particulate plant matter) due to the run-off of fresh water into the ocean, either from rainfall or from freshwater outflows (e.g., rivers and creeks). Collectively, these factors can reduce and scatter the sound energy in echolocation signals and reduce the perceptibility of returning echoes of interest.

Social Cohesion

Many pelagic species such as sperm whales, pilot whales, melon-head whales, and false killer whales, and some dolphins occur in large groups with strong social bonds between individuals. When one or more animals strand due to any number of causative events, then the entire pod may follow suit out of social cohesion (Geraci et al. 1999; Conner 2000; Perrin and Geraci 2002; NMFS, 2007).

Table 4-6: Marine Mammal Unusual Mortality Events in the Pacfic Attributed to or suspected from Natural Causes 1978-2005

Year	Species and number	Location	Cause
1978	Hawaiian monk seals (50)	NW Hawaiian Islands	Ciguatoxin and maitotoxin
1983	Multiple pinniped species	West coast of U.S., Galapagos	El Nino
1984	California sea lions (226)	California	Leptospirosis
1987	Sea otters (34)	Alaska	Saxitoxin
1995	California sea lions (222)	California	Leptospirosis
1997-98	California sea lions (100s)	California	El Nino
1998	California sea lions (70)	California	Domoic acid
1998	Hooker's sea lions (60% of pups)	New Zealand	Unknown, bacteria likely
2000	California sea lions (178)	California	Leptospirosis
2000	California sea lions (184)	California	Domoic acid
2000	Harbor seals (26)	California	Unknown; Viral pneumonia suspected
2002	Multispecies (common dolphins, California sea lions, sea otters) (approx. 500)	California	Domoic acid
2002	Hooker's sea lions	New Zealand	Pneumonia
2003	Multispecies (common dolphins, California sea lions, sea otters) (approx. 500)	California	Domoic acid
2003	Beluga whales (20)	Alaska	Ecological factors
2003	Sea otters	California	Ecological factors
2004	California sea lions (405)	Canada, U.S. West Coast	Leptospirosis
2005	California sea lions; Northern fur seals	California	Domoic acid

Note: Data from Gulland and Hall (2007); citations for each event contained in Gulland and Hall (2007)

Anthropogenic Stressors

During the past few decades there has been an increase in marine mammal mortalities associated with a variety of human activities (Geraci et al. 1999; NMFS, 2007). These activities include fisheries interactions (bycatch and directed catch), pollution (marine debris, toxic compounds), habitat modification (degradation, prey reduction), ship strikes (Laist et al., 2001), and gunshots.

Fisheries Interaction: By-Catch, Directed Catch, and Entanglement

The incidental catch of marine mammals in commercial fisheries is a significant threat to the survival and recovery of many populations of marine mammals (Geraci et al. 1999; Baird, 2002; Culik 2002; Carretta et al., 2004; Geraci and Lounsbury 2005; NMFS, 2007). Interactions with fisheries and entanglement in discarded or lost gear continue to be a major factor in marine mammal deaths worldwide (Geraci et al. 1999; Nieri et al., 1999; Geraci and Lounsbury 2005; Read et al., 2006; Zeeber et al., 2006). For instance, baleen whales and pinnipeds have been found entangled in nets, ropes, monofilament line, and other fishing gear that has been discarded out at sea (Geraci et al., 1999; Campagna et al., 2007).

Bycatch- Bycatch is the catching of non-target species within a given fishing operation and can include non-commercially used invertebrates, fish, sea turtles, birds, and marine mammals (NRC, 2006). Read et al. (2006) attempted to estimate the magnitude of marine mammal bycatch in U.S. and global fisheries. Within U.S. fisheries, between 1990 and 1999 the mean annual bycatch of marine mammals was 6,215 animals. Eighty-four percent of cetacean bycatch occurred in gill-net fisheries, with dolphins and porpoises constituting most of the cetacean bycatch (Read et al., 2006). Over the decade there was a 40 percent decline in marine mammal bycatch, primarily due to effective conservation measures that were implemented during this time period.

Read et al. (2006) extrapolated data for the same period (1990-1999) and calculated an annual estimate of 653,365 of marine mammals globally, with most of the world's bycatch occurring in gill-net fisheries. With global marine mammal bycatch likely to be in the hundreds of thousands every year, bycatch in fisheries will be the single greatest threat to many marine mammal populations around the world (Read et al. 2006).

Entanglement- Entanglement in active fishing gear is a major cause of death or severe injury among the endangered whales in the action area. Entangled marine mammals may die as a result of drowning, escape with pieces of gear still attached to their bodies, or manage to be set free either of their own accord or by fishermen. Many large whales carry off gear after becoming entangled (Read et al. 2006). When a marine mammal swims off with gear attached, the result can be fatal. The gear may become too cumbersome for the animal, or it can be wrapped around a crucial body part and tighten over time. Stranded marine mammals frequently exhibit signs of previous fishery interaction, such as scarring or gear attached to their bodies. For stranded marine mammals, death is often attributed to such interactions (Baird and Gorgone, 2005). Because marine mammals that die due to fisheries interactions may not wash ashore and not all animals that do wash ashore exhibit clear signs of interactions, data probably underestimate fishery-related mortality and serious injury (NMFS, 2005a).

An estimated 78 baleen whales were killed annually in the offshore southern California/Oregon drift gillnet fishery during the 1980s (Heyning and Lewis 1990). From 1998-2005, based on observer records, five fin whales (CA/OR/WA stock), 12 humpback whales (ENP stock), and six sperm whales (CA/OR/WA stock) were either seriously injured or killed in fisheries off the west coast of the U.S. (California Marine Mammal Stranding Network Database 2006).

Ship Strike

Ship strikes of marine mammals are another cause of mortality and stranding (Laist et al., 2001; Geraci and Lounsbury, 2005; de Stephanis and Urquiola, 2006). An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. The severity of injuries typically depends on the size and speed of the vessel and the size of the animal (Knowlton and Kraus, 2001; Laist et al., 2001; Vanderlaan and Taggart, 2007).

The growth in commercial ports and associated commercial vessel traffic is a result of the globalization in trade. The Final Report of the NOAA International Symposium on "Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology" stated that the worldwide commercial fleet has grown from approximately 30,000 vessels in 1950 to over 85,000 vessels in 1998 (NRC, 2003; Southall, 2005). It is unknown how international shipping volumes and densities will continue to grow. However, current statistics support the prediction that the international shipping fleet will continue to grow at the current rate or at greater rates in the future. Shipping densities in specific areas and trends in routing and vessel design are as, or more, significant than the total number of vessels. Densities along existing coastal routes are expected to increase both domestically and internationally. New routes are also expected to develop as new ports are opened and existing ports are expanded. Vessel propulsion systems are also advancing toward faster ships operating in higher sea states for lower operating costs; and container ships are expected to become larger along certain routes (Southall, 2005).

While there are reports and statistics of whales struck by vessels in U.S. waters, the magnitude of the risks that commercial ship traffic poses to marine mammal populations is difficult to quantify or estimate. In addition, there is limited information on vessel strike interactions between ships and marine mammals outside of U.S. waters (de Stephanis and Urquiola, 2006). Laist et al. (2001) concluded that ship collisions may have a negligible effect on most marine mammal populations in general, except for regionally-based small populations where the significance of low numbers of collisions would be greater, given smaller populations or populations segments.

U.S. Navy vessel traffic is a small fraction of the overall U.S. commercial and fishing vessel traffic. While U.S. Navy vessel movements may contribute to the ship strike threat, given the lookout and mitigation measures adopted by the U.S. Navy, probability of vessel strikes is greatly reduced. Furthermore, actions to avoid close interaction of U.S. Navy ships and marine mammals and sea turtles, such as maneuvering to keep away from any observed marine mammal and sea turtle are part of existing at-sea protocols and standard operating procedures. Navy ships have up to three or more dedicated and trained lookouts as well as two to three bridge watchstanders during at-sea movements who would be searching for any whales, sea turtles, or other obstacles on the water surface. Such lookouts are expected to further reduce the chances of a collision.

Ingestion of Plastic Objects and Other Marine Debris and Toxic Pollution Exposure

For many marine mammals, debris in the marine environment is a great hazard. Not only is debris a hazard because of possible entanglement, animals may mistake plastics and other debris for food (NMFS, 2007g). Sperm whales have been known to ingest plastic debris, such as plastic bags (Evans et al. 2003; Whitehead 2003). While this has led to mortality, the scale on which this is affecting sperm whale populations is unknown, but Whitehead (2003) suspects it is not substantial at this time.

High concentrations of potentially toxic substances within marine mammals along with an increase in new diseases have been documented in recent years. Scientists have begun to consider the possibility of a link between pollutants and marine mammal mortality events. NMFS takes part in a marine mammal bio-monitoring program not only to help assess the health and contaminant loads of marine mammals, but also to assist in determining anthropogenic impacts on marine mammals, marine food chains, and marine ecosystem health. Using strandings and bycatch animals, the program provides tissue/serum archiving, samples for analyses, disease monitoring and reporting, and additional response during disease investigations (NMFS, 2007).

The impacts of these activities are difficult to measure. However, some researchers have correlated contaminant exposure with possible adverse health effects in marine mammals (Borell 1993; O'Shea and Brownell 1994; O'Hara and Rice 1996; O'Hara et al. 1999).

The manmade chemical PCB (polychlorinated biphenyl), and the pesticide DDT (dichlorodiphyenyltrichloroethane), are both considered persistent organic pollutants that are currently banned in the United States for their harmful effects in wildlife and humans (NMFS, 2007c). Despite having been banned for decades, the levels of these compounds are still high in marine mammal tissue samples taken along U.S. coasts (Hickie et al. 2007; Krahn et al. 2007; NMFS, 2007c). Both compounds are long-lasting, reside in marine mammal fat tissues (especially in the blubber), and can have toxic effects such as reproductive impairment and immunosuppression (NMFS, 2007c).

In addition to direct effects, marine mammals are indirectly affected by habitat contamination that degrades prey species availability, or increases disease susceptibility (Geraci et al., 1999).

U.S. Navy vessel operation between ports and exercise locations has the potential to release small amounts of pollutant discharges into the water column. U.S. Navy vessels are not a typical source, however, of either pathogens or other contaminants with bioaccumulation potential such as pesticides and PCBs. Furthermore, any vessel discharges such as bilgewater and deck runoff associated with the vessels would be in accordance with international and U.S. requirements for eliminating or minimizing discharges of oil, garbage, and other substances, and not likely to contribute significant changes to ocean water quality or to affect marine mammals.

Anthropogenic Sound

As one of the potential stressors to marine mammal populations, noise and acoustic influences may disrupt marine mammal communication, navigational ability, and social patterns, and may or may not influence stranding. Many marine mammals use sound to communicate, navigate, locate prey, and sense their environment. Both anthropogenic and natural sounds may interfere with these functions, although comprehension of the type and magnitude of any behavioral or physiological responses resulting from man-made sound, and how these responses may contribute to strandings, is rudimentary at best (NMFS, 2007). Marine mammals may respond both behaviorally and physiologically to anthropogenic sound exposure, (e.g., Richardson et al., 1995; Finneran et al., 2000; Finneran et al., 2003; Finneran et al., 2005). However, the range and magnitude of the behavioral response of marine mammals to various sound sources is highly variable (Richardson et al., 1995) and appears to depend on the species involved, the experience of the animal with the sound source, the motivation of the animal (e.g., feeding, mating), and the context of the exposure.

Marine mammals are regularly exposed to several sources of natural and anthropogenic sounds. Anthropogenic noise that could affect ambient noise arises from the following general types of activities in and near the sea, any combination of which can contribute to the total noise at any one place and time. These noises include: transportation; dredging; construction; oil, gas, and mineral exploration in offshore areas; geophysical (seismic) surveys; sonar; explosions; and ocean research activities (Richardson et al., 1995). Commercial fishing vessels, cruise ships, transport boats, recreational boats, and aircraft, all contribute sound into the ocean (NRC, 2003; NRC, 2006). Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (NRC 1994, 1996, 2000, 2003, 2005; Richardson et al., 1995; Jasny et al., 2005; McDonald et al., 2006). Much of this increase is due to increased shipping due to ships becoming more numerous and of larger tonnage (NRC, 2003; McDonald et al., 2006). Andrew et al. (2002) compared ocean ambient sound from the 1960s with the 1990s for a receiver off the California coast. The data showed an increase in ambient noise of approximately 10 decibel (dB) in the frequency range of 20 to 80 Hertz (Hz) and 200 and 300 Hz, and about 3 dB at 100 Hz over a 33-year period.

Sound emitted from large vessels, particularly in the course of transit, is the principal source of noise in the ocean today, primarily due to the properties of sound emitted by civilian cargo vessels (Richardson et al., 1995; Arveson and Vendittis, 2000). Ship propulsion and electricity generation engines, engine gearing, compressors, bilge and ballast pumps, as well as hydrodynamic flow surrounding a ship's hull and any hull protrusions, contribute to a large vessels' noise emissions in the marine environment. Prop-driven vessels also generate noise through cavitation, which accounts much of the noise emitted by a large vessel depending on its travel speed. Military vessels underway or involved in naval operations or exercises, also introduce anthropogenic noise into the marine environment. Noise emitted by large vessels can be characterized as low-frequency, continuous, and tonal. The sound pressure levels at the vessel will vary according to speed, burden, capacity, and length (Richardson et al., 1995; Arveson and Vendittis, 2000). Vessels ranging from 135 to 337 meters generate peak source sound levels from 169 - 200 dB between 8 Hz and 430 Hz, although Arveson and Vendittis (2000) documented components of higher frequencies (10-30 kHz) as a function of newer merchant ship engines and faster transit speeds. Given the propagation of low-frequency sounds, a large vessel in this sound range can be heard 139-463 kilometers away (Ross 1976 in Polefka 2004). U.S. Navy vessels, however, have incorporated significant underwater ship quieting technology to reduce their acoustic signature (as compared to a similarly-sized vessel) and thus reduce their vulnerability to detection by enemy passive acoustics (Southall, 2005).

Airborne sound from a low-flying helicopter or airplane may be heard by marine mammals and turtles while at the surface or underwater. Due to the transient nature of sounds from aircraft involved in at-sea operations, such sounds would not likely cause physical effects but have the potential to affect behaviors. Responses by mammals and turtles could include hasty dives or turns, or decreased foraging (Soto et al., 2006). Whales may also slap the water with flukes or flippers, swim away from the aircraft track.

Naval sonars are designed for three primary functions: submarine hunting, mine hunting, and shipping surveillance. There are two classes of sonars employed by the U.S. Navy: active sonars and passive sonars. Most active military sonars operate in a limited number of areas, and are most likely not a significant contributor to a comprehensive global ocean noise budget (ICES 2005b).

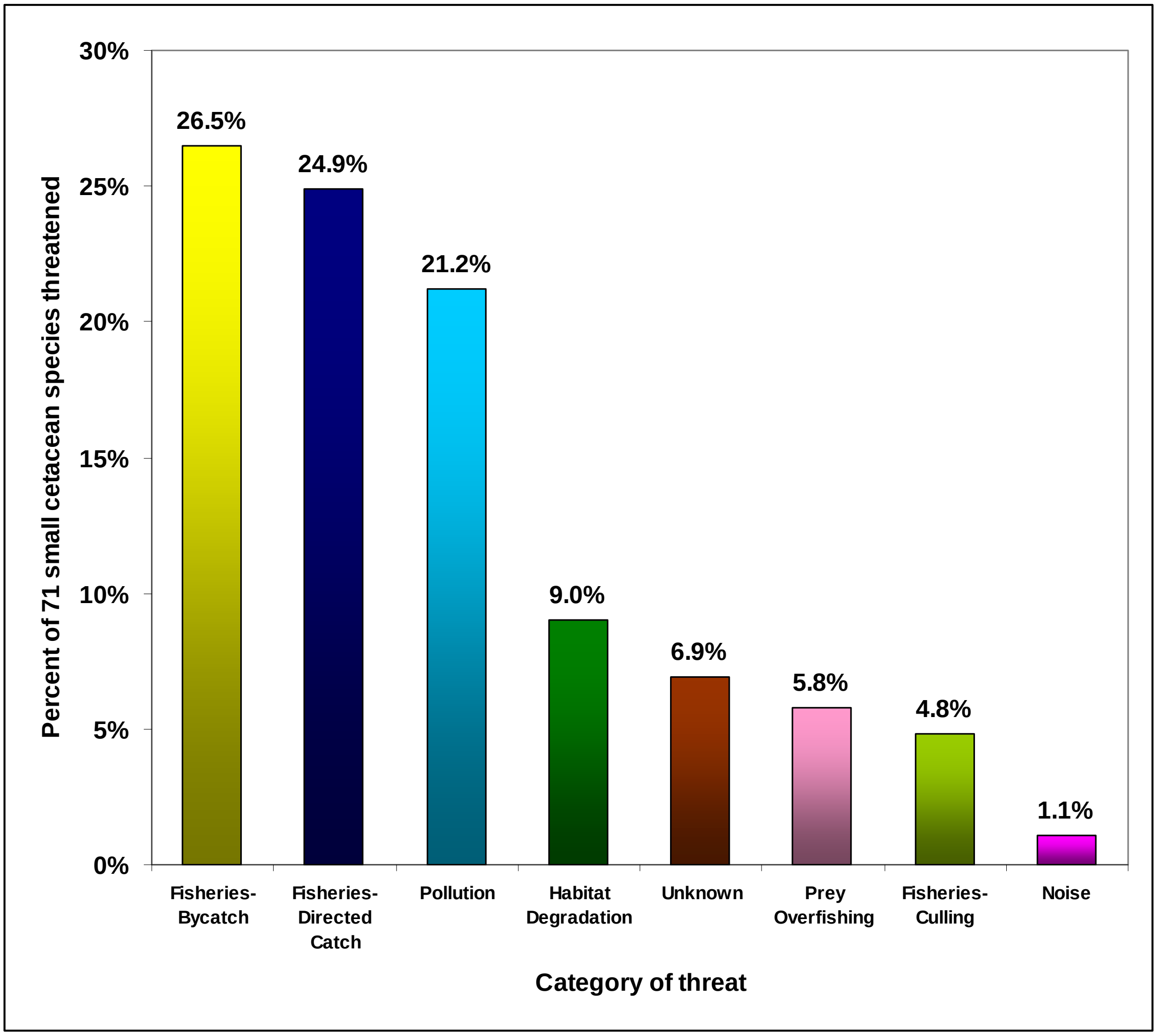


Figure 4-1: Human Threats to World-wide Small Cetacean Populations

Source: Culik 2002

Cumulative Impacts

Both natural and human-induced factors affect the health of marine mammal populations. Temporary disturbance incidents associated with Navy activities on the SOCAL Range Complex could result in an incremental contribution to cumulative impacts on mammals. The mitigation measures identified in Section 3.9.9 would be implemented to minimize any potential adverse effects to marine mammals from Navy activities. Impacts of the alternatives including the Proposed Action are not likely to affect the species through effects on annual rates of recruitment or survival. Therefore, the incremental impacts would not present a significant contribution to the effects on marine mammals when added to effects from other past, present, and reasonably foreseeable future actions.

4.3.10 Sea Birds

Seabird populations within the SOCAL Range Complex are affected by direct and indirect perturbations to breeding and foraging locations on the coastal mainland and offshore islands. The single greatest concern is the loss of suitable habitat for nesting and roosting seabirds throughout coastal California due to land development and human encroachment. Historically, seabird populations have sustained numerous impacts from pollution and human activities within the SCB from a variety of sources, including the discharge of hazardous chemicals and sewage. Though the Proposed Action does not directly reduce available seabird habitat within the SOCAL Range Complex, current seabird populations residing within the Range Complex become more susceptible to potential impacts due to the concentrated nature of those populations. By default, open space within military installations in coastal locations has become vital to the persistence of seabird breeding and roosting populations.

Land range operations could affect breeding seabirds if the operational footprint encompassed nesting areas during breeding seasons. Current data on breeding seabird populations that overlap with training operations in or near coastal areas, San Clemente, or Santa Catalina Islands are either unavailable or incomplete, making a comprehensive effects analysis difficult. Though most offshore operations take place in oceanic waters well offshore, are of short duration, and have a small operational footprint, the importance of avoiding sensitive seabird colonies and reducing disturbance should be paramount when accessing new or ongoing training activities.

Training activities concentrated in or near coastal areas or offshore islands, or taking place at regular intervals, would disturb local seabird roosting colonies. The coastal and offshore island areas within the SOCAL Range Complex provide suitable seabird habitat adjacent to training areas, allowing potentially affected seabirds adequate alternative locations to avoid interactions with training operations. Continued expansion of commercial and private aircraft and ocean-going vessels through the Range Complex, together with increased SOCAL Range Complex training activities, elevates the potential for direct and indirect impacts on isolated seabird populations. The control of non-native plants and animals within coastal areas and on islands must continue to be addressed by land owners to ensure further degradation of seabird populations does not occur. Large-scale effects on seabird populations such as global warming, reduced fish populations, and development in other regions or countries are not well defined for individual species but have been attributed to the overall decline of seabirds.

The Proposed Action would not significantly impact any individual seabird population, its overall foraging success, or breeding opportunities within the SOCAL Range Complex. Terrestrial Biological Resources

The analysis for cumulative impacts to terrestrial biology focuses on fire, invasive species, erosion, and habitat degradation.

4.3.11 Terrestrial Biological Resources

Fire

Numerous activities having the potential to ignite wildfires have been described previously in this EIS/OEIS. These activities have a cumulative contribution to wildfire risk, and various measures identified in this document are intended to address the cumulative impacts of wildfire. The analyses of the individual activities that contribute to wildfire risk concluded that impacts of the individual operations on sensitive species could be mitigated to a less than significant level. This mitigation would be accomplished by implementing the SCI Wildland Fire Management Plan, which builds on recently implemented measures that have been reducing the frequency and size of operations-related fires. After mitigation, there would remain some potential for fire impacts associated with each operation. These remaining potential impacts on sensitive species, including the San Clemente loggerhead shrike, were judged to be less than significant individually. With implementation of the SCI Wildland Fire Management Plan, cumulative impacts of fire would be less than significant.

Invasive Species, Erosion, and Habitat Degradation

Several activities contribute cumulatively to habitat degradation, including disturbance to soils and vegetation, spread of invasive non-native species, erosion and sedimentation, and impacts on native plant species. Although individual impacts may be less than significant, collectively they have the potential to be significant over time and space. Some potential effects of invasive species are difficult to foresee (such as leading to a change in fire frequency or intensity). It is clear, however, that the potential for damage associated with introduction or spread of invasive plant species is high and increases over time with repeated training missions, especially exercises that cover a very large area. This is due to the difficulty in effectively monitoring for invasive establishment and achieving timely control. The Navy is addressing these effects in several important ways including implementation of the SCI Integrated Natural Resources Management Plan (INRMP), the SCI Wildland Fire Management Plan, and continued development and implementation of measures to prevent the establishment of invasive plant species by minimizing the potential for introductions of seed or other plant parts (propagules) of exotic species and finding and eliminating incipient populations before they are able to spread. Key measures include:

- Minimizing the amount of seed or propagules of non-native plant species introduced to the island through continued efforts to remove seed and soil from all vehicles, including contractor vehicles, coming to the island by pressure washing on the mainland, and stepped up efforts to ensure that imported construction materials such as sand, gravel, aggregate, or road base material are weed free.

- Regular monitoring and treatment to detect and eliminate exotic species, focusing on areas where equipment and construction materials come ashore (Wilson Cove vicinity, including equipment yards and construction laydown areas, vicinity of beaches where amphibious landings area conducted) and areas within which there is movement of equipment and personnel and soil disturbance which favor the spread and establishment of invasive species (e.g., along roadsides, disturbed areas, including the Assault Maneuver Corridor, and TARs).

- Effective measures to foster the reestablishment of native vegetation in areas where non-native vegetation is present.

- No living plant material would be brought to the island from the mainland (in order to avoid introduction of inappropriate genetic strains of native plants or exotic species, including weeds, insects and invertebrates such as snails).

- Continued operation of an on-island nursery to produce all plant material to be used on the island and continued exclusive use of on-island sources of indigenous plants for use in restoration. Because of the site–to-site variability in some of the native species, location-specific sources should be used in propagating many of the native species for use in restoration.

- Measures to correct developing erosion problems, such as correcting drainage from roads and culvert outlets where they contribute to concentration of flow potentially leading to gullying and measures designed to stop the progression of existing gullies associated with developed sites and roads.

- Maintenance of an up-to-date inventory of sensitive plant and wildlife species locations and consulting the inventory in all environmental reviews.

Navy projects at SCI other than the Proposed Action, such as those identified in Table 4-4, also could impact terrestrial biological resources. Any such project at SCI would be required to be in compliance with the established INRMP, SCI Wildland Fire Management Plan, and U.S. Fish and

Wildlife Service Biological Opinions issued after Endangered Species Act Section 7 consultation addressing direct, indirect, and cumulative impacts. As identified in Section 3.11, there are numerous potential impacts of the Proposed Action on terrestrial biology on SCI. These impacts have the potential for significant cumulative impact on such resources. Mitigation measures identified in this EIS/OEIS, considered together with any additional mitigation or conservation measures that might be appropriate after Section 7 consultation, however, will substantially mitigate direct, indirect, and cumulative effects of the Proposed Action.

4.3.12 Cultural Resources

This EIS/OEIS determined that the Proposed Action would have little or no potential to impact underwater cultural resources, primarily because most of the Proposed Action's activities were on or above the surface and cultural resources, if any, are on the ocean bottom. Project activities would not generally disturb areas where cultural resources are known or expected to be present. For the same reason, most other ongoing and anticipated ocean activities such as commercial ship traffic, fishing, oil and gas development, or scientific research, would not substantially affect underwater cultural resources.

This EIS/OEIS also examined the potential for impacts on cultural, archaeological, and historic sites on SCI. Due to the large number of known and estimated cultural sites on SCI and the widespread use of the island for training of ground combat forces, Naval Special Warfare, and missile operations, the Proposed Action could increase the potential for significant impacts. Mitigation strategies developed under the Draft Programmatic Agreement with the State Historic Preservation Office, such as avoidance or data recovery, should reduce impacts to a level less than significant. Any activities with the potential for significant impacts on cultural resources will require Section 106 consultation, and would be mitigated as required.

Other on-island construction projects and activities with the potential to disturb cultural resources would be required to evaluate their potential effects and, if necessary, implement mitigation measures similar to those described for the Proposed Action. Where avoidance was practiced, no cumulative effect would result because no contact with the resource would occur. Where data recovery was practiced, the cumulative effect would be that more cultural sites underwent data recovery and removal than would occur under the Proposed Action alone.

4.3.13 Traffic (Airspace)

The region that includes the SOCAL Range Complex is one of the busiest areas of the world in terms of air traffic. The Proposed Action does not propose any expansion of military Special Use Airspace, and would not produce any significant regional cumulative traffic impacts. While hazardous activities in W-291 are in progress, vessel traffic, forewarned through publication of the related Notice to Mariners (NOTMAR), would avoid the affected area. Although the resultant detour might be inconvenient, it would not preclude the affected vessel from arriving at his destination. Similarly for air traffic, when hazardous activities within W-291 close Control Area Extension (CAE) 1156, commercial and general aviation air traffic, operating under Instrument Flight Rules enroute to or from San Diego, would be routed to the north to transit CAE 1177. Although this slight detour might be inconvenient, it would not pose an increased safety hazard nor impose an additional burden on the air traffic control system. Coordination with the Federal Aviation Administration on all matters affecting airspace would significantly reduce or eliminate the possibility of indirect adverse impacts and associated cumulative impacts on civil aviation and airspace use.

4.3.14 Socioeconomics

Implementation of the Proposed Action would not produce any significant regional employment, income, housing, or infrastructure impacts. Effects on commercial and recreational fishermen, divers, and boaters would be short-term in nature and produce some temporary access limitations. Some offshore operations, especially if coincident with peak fishing locations and periods, could cause temporary displacement and potential economic loss to individual fishermen. However, most offshore operations are of short duration and have a small operational footprint. Effects on fishermen are mitigated by a series of Navy initiatives, including public notification of scheduled activities, near-real time schedule updates, prompt notification of schedule changes, and adjustment of hazardous operations areas. In selected instances where safety requires exclusive use of a specific area, fishermen may be asked to relocate to a safer nearby area for the duration of the exercise. These measures should not significantly impact any individual fisherman, overall commercial revenue, or public recreational opportunities. Therefore, the Proposed Action would not result in significant cumulative socioeconomic impacts.

4.3.15 Environmental Justice and Protection of Children

The Proposed Action would not affect minority or low-income populations, nor would children be exposed to increased noise levels or safety risks.

4.3.16 Public Safety

Environmental pollution (e.g., air pollutants, water pollutants, EMR) would have little potential to affect public health because they would be dispersed over large areas of ocean with few human receptors. Project activities (e.g., ship movements, live-firing of weapons) would have little potential to effect public safety because of the general absence of non-participating individuals. The same factors - the dispersed nature of the activities and general absence of non-participants within the area of effect at the time of the activity - would limit the public health and safety impacts of other ongoing or anticipated activities in the SOCAL Range Complex.

Impacts of the Proposed Action on public health and safety on SCI were determined to be minimal: (a) the public is generally excluded from SCI, and (b) danger zones and exclusion zones have been established in SCI's nearshore waters to assure that non-participants are not exposed to hazardous on-island activities. Other construction, maintenance, and training activities on the island would likewise be isolated from the public. Projects such as the SOAR Cable Refurbishment, SWTR instrumentation, and new moorings at Wilson Cove are not expected to pose any risks to individuals in public use areas around the island. An underwater missile launch facility proposed near NOTS Pier on SCI would be within a restricted zone, and would thus pose no risk to the public.

This Page Intentionally Left Blank

5 Mitigation Measures

This Page Intentionally Left Blank

TABLE OF CONTENTS

LIST OF FIGURES

There are no figures in this section.

LIST OF TABLES

There are no tables in this section.

5 MITIGATION MEASURES

As part of the Navy's commitment to sustainable use of resources and environmental stewardship, the Navy incorporates measures that are protective of the environment into all of its activities. These include employment of best management practice, standard operating procedures (SOPs), adoption of conservation recommendations, and other measures that mitigate the impacts of Navy activities on the environment. Some of these measures are generally applicable and others are designed to apply to certain geographic areas during certain times of year, for specific types of Navy training. Mitigation measures covering habitats and species occurring in the Southern California (SOCAL) Range Complex have been developed through various environmental analyses conducted by the Navy for land and sea ranges and adjacent coastal waters.

The Navy has implemented a variety of marine mammal mitigation measures over the last two decades. This following discussion briefly describes the genesis and status of those mitigation measures.

Since the 1990s, the Navy has developed and implemented mitigation measures either as a result of environmental analysis or in consultation with regulatory agencies for research, development, test and evaluation activities (RDT&E) and training exercises. These measures included visual detection by trained lookouts, power down and shut down procedures, the use of passive sensors to detect marine mammals, and avoidance of marine mammals.

In December 2000, the Navy issued a memorandum entitled "Compliance with Environmental Requirements in the Conduct of Naval Exercises or Training at Sea" (Department of the Navy [DoN] 2000). This memorandum clarified Navy policy for continued compliance with certain environmental requirements including preparation of environmental planning documents, consultations pursuant to the Endangered Species Act (ESA), and applications for "take" authorizations under the Marine Mammal Protection Act (MMPA).

In 2003, the Navy issued the Protective Measures Assessment Protocol (PMAP) that implemented Navy-wide mitigation measures for various types of routine training events. Following the implementation of PMAP, the Navy agreed to additional mitigation measures as part of MMPA authorization and ESA consultation processes for specific training exercises from 2004-2007.

Finally, as authorized by the MMPA, the Secretary of Defense has approved two National Defense Exemptions (NDE) from the requirements of the MMPA for certain military readiness activities that employ mid-frequency active sonar (MFAS). The NDE includes mitigation measures that must be observed for use of MFAS during major Navy training exercises and on established Navy ranges and OPAREAs. These measures were designed to strike a reasoned balance between environmental protection, military readiness activities and, ultimately, the Navy's mission of National security. The NDE is in effect through January 2009.

In order to make the findings necessary to issue the MMPA authorization, it may be necessary for the National Marine Fisheries Service (NMFS) to require additional mitigation or monitoring measures beyond those addressed in this Environmental Impact Statement (EIS)/ Overseas Environmental Impact Statement (OEIS) (hereafter referred to as "EIS/OEIS"). These could include measures considered, but eliminated in this EIS/OEIS, or as yet undeveloped measures. In addition to commenting on this EIS/OEIS, the public will have an opportunity to provide information to NMFS through the MMPA process, both during the comment period following NMFS' Notice of Receipt of the application for a Letter of Authorization (LOA), and during the comment period following publication of the proposed rule. NMFS may propose additional mitigation or monitoring measures in the proposed rule. Measures not considered in the EIS, but required through the MMPA process, may require evaluation in accordance with the National Environmental Policy Act (NEPA). As appropriate, NMFS may consider tiering off this EIS should subsequent environmental analysis of mitigation measures be warranted during the MMPA process.

Additionally, the Navy is engaging in consultation processes under the ESA with regard to listed species that may be affected by the activities described in this EIS/OEIS. Those processes could lead to adoption of additional mitigation measures by the Navy.

The Navy also will consider public comments on proposed mitigation measures described in this EIS/OEIS.

This Section describes mitigation measures applicable to Navy activities in the SOCAL Range Complex.

5.1 GEOLOGY AND SOILS

Existing plans and policies are in place to limit the effects of construction and training on the environment at San Clemente Island (SCI) on an island-wide basis. Specific to earth resources, the Integrated Natural Resources Management Plan (INRMP) identifies erosion as a primary management issue and presents policies to reduce the impacts of erosion on the island. The INRMP notes that "erosion and sedimentation continue, arising from inadequately constructed or maintained roads, or from ongoing damage instigated by past overgrazing by feral goats, exterminated around 1991" (DoN 2002). Policies and SOPs relation to geology and soils include:

- Managing and limiting construction activities, including road construction, through an established site approval process.
- Limiting vehicle travel to existing roads: on SCI, off-road vehicle use is not permitted except in designated off-road areas or on established trails approved by the Navy's regional Natural Resources Office (NRO).
- Prohibiting tracked vehicular maneuvering outside the boundaries of the Armored Vehicle Maneuver Corridor (AVMC). Additionally, tracked vehicle maneuvering and camping are prohibited inside marked environmentally sensitive areas.

Additionally, because SCI is managed as a federal property, island operations comply with the Federal Soil Conservation Act; thus the Navy is required to control and prevent erosion by conducting surveys and implementing conservation measures (Soil Conservation Act, 16 U.S.C. § 5901). In accordance with this mandate, the Navy is studying sedimentation and erosion associated with watersheds on SCI.

Protective measures proposed to minimize erosion effects on terrestrial biological resources are presented in Section 3.11.3. These include development and implementation of a program to monitor for erosion, dust generation, and deposition of dust in adjacent habitats. It is recommended that such a program include monitoring and provide a means for adaptive management of erosion associated with the existing roads and ranges. Specifically, an annual review of the erosion conditions of the Missile Impact Range (MIR), firebreak road, and camera locations would be conducted under coordination with the NRO. Examples of control measures to be considered include placing riprap in problem areas to provide energy dissipation of concentrated runoff from the MIR or the firebreak road or placement of water bars to prevent runoff from concentrating to the point where erosion could occur. A representative from NRO would be consulted to ensure that any proposed erosion control efforts would not adversely affect cultural resources.

5.2 AIR QUALITY

Emissions that may affect air quality are heavily regulated under the Clean Air Act and its implementing regulations, through a comprehensive Federal / State regulatory process (see Section 3.2). Consistent with these regulatory requirements and processes, the Navy has implemented comprehensive air quality management programs to ensure compliance.

5.3 HAZARDOUS MATERIALS AND WASTES

Releases or discharges of hazardous wastes or materials are heavily regulated through a comprehensive Federal / State regulatory process (see Section 3.3.2). Consistent with these regulatory requirements and process, the Navy has implemented comprehensive management programs to ensure compliance.

Shipboard and shore management of hazardous materials and waste is governed by Navy regulations. Environmental compliance policies and procedures applicable to operations ashore and afloat are defined in Navy instructions. These instructions reinforce regulatory prohibitions of the Clean Water Act against discharge of harmful quantities of hazardous substances into or upon U.S. waters out to 200 nm (371 km). These instructions include stringent hazardous waste discharge, storage, dumping, and pollution prevention requirements. Navy ships are required to conduct activities at sea in a manner that minimizes or eliminates any adverse impacts on the marine environment from hazardous materials or wastes.

The Navy has an active Pollution Prevention Program that applies to all aspects of its activities. It is Navy policy to conduct its facility management and acquisition programs so as to reduce to the maximum extent possible the quantity of toxic chemicals entering the environment. The Pollution Prevention Program is a comprehensive set of practices that reduce the volumes of wastes to be treated or transferred to the environment. The fundamental tenet of the Navy's Pollution Prevention Program is the reduction of hazardous materials and wastes at their source. This results in less hazardous waste for all waste streams. Pollution prevention practices include:

- Raw material substitution,
- Product reformulation,
- Process redesign or modification,
- Improved operation and maintenance, and
- Aggressive recycling programs.

5.4 WATER RESOURCES

Environmental compliance policies and procedures applicable to operations ashore are identified in Navy instructions that include directives regarding hazardous materials and waste management, pollution prevention, and recycling. Measures about management of hazardous materials and wastes at SCI, as discussed in Section 3.4.3.2.1 *et seq*., provide protections for surface waters and ocean waters. In addition to preventive measures, implementation of the Installation Restoration Program at SCI also provides protection to these water resources from consequences of past practices. With regard to reducing or avoiding water quality degradation from the expenditure of training materials, management practices include activities to remove training debris including unexploded ordnance from land ranges. Certain features of the training materials themselves are designed to reduce pollution, as required by Navy and Department of Defense (DoD) regulations (see Section 3.4.3.1.6).

5.5 ACOUSTIC ENVIRONMENT (AIRBORNE SOUND)

The Navy has developed detailed SOPs regarding sound in the ocean environment, particularly with respect to sonar and explosive sources. These measures are discussed in detail below in Section 5.8 with regard to potential effects of sound on marine mammals and sea turtles.

Military personnel who might be exposed to sound from military activities are required to take precautions, such as the wearing of protective equipment, to reduce or eliminate potential harmful effects of such exposure. With regard to potential exposure of non-military personnel in ocean areas (such as fishermen in the vicinity of SCI) precautions are taken pursuant to SOPs to prevent such exposure. These include advance notice of scheduled operations to the public and the commercial fishing community via the worldwide web, Notices to Mariners (NOTMARs), and Notices to Airmen (NOTAMs). In addition, range safety SOPs ensure that civilians are excluded from, and if necessary removed from areas of military operations, or that military activities do not occur when civilians are present. These procedures have proven effective at minimizing potential military / civilian interactions in the course of active training or other military activities.

5.6 MARINE PLANTS AND INVERTEBRATES

In order to reduce or eliminate potential effects of Navy activities on marine plants and invertebrates, buffer zones have been designated for training events using both explosive and non-explosive ordnance. Lookouts are posted to visually survey for floating kelp, plants, or algal mats. For training activities using explosive ordnance, the intended impact area shall not be within 600 yards (yds) (585 meters [m]) of known or observed live hard-bottom communities, kelp beds, floating plants, or algal mats. For training events using non-explosive ordnance, intended impact area shall not be within 200 yds (183 m) of known or observed live hard-bottom communities, kelp beds, floating plants, or algal mats. For air-to-surface missile exercises, the buffer zone is extended to 1,800 yds (1646 m) around hard bottom communities, kelp forests, floating plants, and algal mats, for both explosive and non-explosive ordnance

5.7 FISH

Mitigation measures for activities involving underwater detonations, implemented for marine mammals and sea turtles, also offer protections to habitats associated with fish communities. No additional mitigation measures are proposed or warranted because no substantial effects on fish or fish habitat were identified.

5.8 SEA TURTLES AND MARINE MAMMALS

As discussed in Section 3.8 and 3.9, the comprehensive suite of protective measures and SOPs implemented by the Navy to reduce impacts to marine mammals also serves to mitigate potential impacts on sea turtles. In particular, personnel and watchstander training, establishment of turtle-free exclusion zones for underwater detonations of explosives, and pre- and post-exercise surveys, all serve to reduce or eliminate potential impacts of Navy activities on sea turtles that may be present in the vicinity.

Effective training in the SOCAL Range Complex dictates that ship, submarine, and aircraft participants utilize their sensors and exercise weapons to their optimum capabilities as required by the mission. This section is a comprehensive list of mitigation measures that would be utilized for training activities analyzed in the SOCAL EIS/OEIS in order to minimize potential for impacts on marine mammals and sea turtles in the SOCAL Range Complex.

This section includes protective and mitigation measures that are followed for all types of exercises; those that are associated with a particular type of training event; and those that apply to a particular geographic region or season. For major exercises, the applicable mitigation measures are incorporated into a naval message which is disseminated to all of the units participating in the exercise or training event and applicable responsible commands. Appropriate measures are also provided to non-Navy participants (other DoD and allied forces) as information in order to ensure their use by these participants.

5.8.1 General Maritime Measures

5.8.1.1 Personnel Training – Watchstanders and Lookouts

The use of shipboard lookouts is a critical component of all Navy protective measures. Navy shipboard lookouts (also referred to as "watchstanders") are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the officer of the deck (OOD) (e.g., trash, a periscope, marine mammals, sea turtles) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water.

- All commanding officers (COs), executive officers (XOs), lookouts, OODs, junior OODs (JOODs), maritime patrol aircraft aircrews, and Anti-submarine Warfare (ASW)/Mine Warfare (MIW) helicopter crews will complete the NMFS-approved Marine Species Awareness Training (MSAT) by viewing the U.S. Navy MSAT digital versatile disk (DVD). MSAT may also be viewed on-line at https://mmrc.tecquest.net. All bridge watchstanders/lookouts will complete both parts one and two of the MSAT; part two is optional for other personnel. This training addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments and general observation information to aid in avoiding interactions with marine species.
- Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Education and Training Command [NAVEDTRA] 12968-B).
- Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts will complete the Personal Qualification Standard Program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). Personnel being trained as lookouts can be counted among those listed below as long as supervisors monitor their progress and performance.
- Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of protective measures if marine species are spotted.

5.8.1.2 Operating Procedures & Collision Avoidance

- Prior to major exercises, a Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order will be issued to further disseminate the personnel training requirement and general marine species protective measures.
- COs will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.
- While underway, surface vessels will have at least two lookouts with binoculars; surfaced submarines will have at least one lookout with binoculars. Lookouts already posted for safety of navigation and man-overboard precautions may be used to fill this requirement. As part of their regular duties, lookouts will watch for and report to the OOD the presence of marine mammals and sea turtles.

- On surface vessels equipped with a multi-function active sensor, pedestal mounted “Big Eye” (20x10) binoculars will be properly installed and in good working order to assist in the detection of marine mammals and sea turtles in the vicinity of the vessel.
- Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-B).
- After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook. (NAVEDTRA 12968-B)
- While in transit, naval vessels will be alert at all times, use extreme caution, and proceed at a “safe speed” so that the vessel can take proper and effective action to avoid a collision with any marine animal and can be stopped within a distance appropriate to the prevailing circumstances and conditions.
- When whales have been sighted in the area, Navy vessels will increase vigilance and take reasonable and practicable actions to avoid collisions and activities that might result in close interaction of naval assets and marine mammals. Actions may include changing speed and/or direction and are dictated by environmental and other conditions (e.g., safety, weather).
- Naval vessels will maneuver to keep at least 460 m (1,500 ft) away from any observed whale and avoid approaching whales head-on. This requirement does not apply if a vessel’s safety is threatened, such as when change of course will create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver. Restricted maneuverability includes, but is not limited to, situations when vessels are engaged in dredging, submerged operations, launching and recovering aircraft or landing craft, minesweeping operations, replenishment while underway and towing operations that severely restrict a vessel’s ability to deviate course. Vessels will take reasonable steps to alert other vessels in the vicinity of the whale.
- Where feasible and consistent with mission and safety, vessels will avoid closing to within 200-yd of sea turtles and marine mammals other than whales (whales addressed above).
- Floating weeds and kelp, algal mats, clusters of seabirds, and jellyfish are good indicators of sea turtles and marine mammals. Therefore, increased vigilance in watching for sea turtles and marine mammals will be taken where these are present.
- Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties. Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.
- All vessels will maintain logs and records documenting training operations should they be required for event reconstruction purposes. Logs and records will be kept for a period of 30 days following completion of a major training exercise.

5.8.2 Measures for Specific Training Events

5.8.2.1 Mid-Frequency Active Sonar Operations

5.8.2.1.1 General Maritime Mitigation Measures: Personnel Training

- All lookouts onboard platforms involved in ASW training events will review the NMFS-approved Marine Species Awareness Training material prior to use of mid-frequency active sonar.
- All COs, XOs, and officers standing watch on the bridge will have reviewed the Marine Species Awareness Training material prior to a training event employing the use of mid-frequency active sonar.
- Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Educational Training [NAVEDTRA], 12968-B).
- Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts will complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not forbid personnel being trained as lookouts from being counted as those listed in previous measures so long as supervisors monitor their progress and performance.
- Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of mitigation measures if marine species are spotted.

5.8.2.1.2 General Maritime Mitigation Measures: Lookout and Watchstander Responsibilities

- On the bridge of surface ships, there will always be at least three people on watch whose duties include observing the water surface around the vessel.
- All surface ships participating in ASW training events will, in addition to the three personnel on watch noted previously, have at all times during the exercise at least two additional personnel on watch as marine mammal lookouts.
- Personnel on lookout and officers on watch on the bridge will have at least one set of binoculars available for each person to aid in the detection of marine mammals.
- On surface vessels equipped with mid-frequency active sonar, pedestal mounted “Big Eye” (20x110) binoculars will be present and in good working order to assist in the detection of marine mammals in the vicinity of the vessel.
- Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-B).
- After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook.
- Personnel on lookout will be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew or indicative of a marine species that may need to be avoided as warranted.

5.8.2.1.3 Operating Procedures

- A Letter of Instruction, Mitigation Measures Message, or Environmental Annex to the Operational Order will be issued prior to the exercise to further disseminate the personnel training requirement and general marine mammal mitigation measures.
- COs will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.
- All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) will monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.
- During mid-frequency active sonar operations, personnel will utilize all available sensor and optical systems (such as night vision goggles) to aid in the detection of marine mammals.
- Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.
- Aircraft with deployed sonobuoys will use only the passive capability of sonobuoys when marine mammals are detected within 200 yds (183 m) of the sonobuoy.
- Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.
- Safety Zones—When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 1,000 yds (914 m) of the sonar dome (the bow), the ship or submarine will limit active transmission levels to at least 6 decibels (dB) below normal operating levels. (A 6 dB reduction equates to a 75 percent power reduction. The reason is that decibel levels are on a logarithmic scale, not a linear scale. Thus, a 6 dB reduction results in a power level only 25 percent of the original power.)
    - Ships and submarines will continue to limit maximum transmission levels by this 6-dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 m) beyond the location of the last detection.
    - Should a marine mammal be detected within or closing to inside 500 yds (457 m) of the sonar dome, active sonar transmissions will be limited to at least 10 dB below the equipment's normal operating level. (A 10 dB reduction equates to a 90 percent power reduction from normal operating levels.) Ships and submarines will continue to limit maximum ping levels by this 10-dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (457 m) beyond the location of the last detection.
    - Should the marine mammal be detected within or closing to inside 200 yds (183 m) of the sonar dome, active sonar transmissions will cease. Sonar will not resume until the animal has been seen to leave the area, has not been detected for

30 minutes, or the vessel has transited more than 2,000 yds (457 m) beyond the location of the last detection.

- Special conditions applicable for dolphins and porpoises only: If, after conducting an initial maneuver to avoid close quarters with dolphins or porpoises, the OOD concludes that dolphins or porpoises are deliberately closing to ride the vessel's bow wave, no further mitigation actions are necessary while the dolphins or porpoises continue to exhibit bow wave riding behavior.
- If the need for power-down should arise as detailed in “Safety Zones” above, the Navy shall follow the requirements as though they were operating at 235 dB—the normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 sonar was being operated).

- Prior to start up or restart of active sonar, operators will check that the Safety Zone radius around the sound source is clear of marine mammals.
- Sonar levels (generally)—Navy will operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.
- Helicopters shall observe/survey the vicinity of an ASW training event for 10 minutes before the first deployment of active (dipping) sonar in the water.
- Helicopters shall not dip their sonar within 200 yds (183 m) of a marine mammal and shall cease pinging if a marine mammal closes within 200 yds (183 m) after pinging has begun.
- Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW training events involving active mid-frequency sonar.
- Increased vigilance during ASW training events with tactical active sonar when critical conditions are present.

  Based on lessons learned from strandings in Bahamas 2000, Madeiras 2000, Canaries 2002 and Spain 2006, beaked whales are of particular concern since they have been associated with mid-frequency active sonar operations. The Navy should avoid planning Major ASW Training Exercises with mid-frequency active sonar in areas where they will encounter conditions which, in their aggregate, may contribute to a marine mammal stranding event.

  The conditions to be considered during exercise planning include:

  - Areas of at least 1,000-meter depth near a shoreline where there is a rapid change in bathymetry on the order of 1,000-6,000 yds (914-5486 m) occurring across a relatively short horizontal distance (e.g., 5 nautical miles [nm]).
  - Cases for which multiple ships or submarines (≥ 3) operating mid-frequency active sonar in the same area over extended periods of time (≥ 6 hours) in close proximity (≤ 10 nm apart).
  - An area surrounded by land masses, separated by less than 35 nm and at least 10 nm in length, or an embayment, wherein operations involving multiple ships/subs (≥ 3) employing mid-frequency active sonar near land may produce sound directed toward the channel or embayment that may cut off the lines of egress for marine mammals.

  - Though not as dominant a condition as bathymetric features, the historical presence of a significant surface duct (i.e., a mixed layer of constant water temperature extending from the sea surface to 100 or more feet [ft]).

If the Major Range Event is to occur in an area where the above conditions exist in their aggregate, these conditions must be fully analyzed in environmental planning documentation. The Navy will increase vigilance by undertaking the following additional mitigation measure:

- A dedicated aircraft (Navy asset or contracted aircraft) will undertake reconnaissance of the embayment or channel ahead of the exercise participants to detect marine mammals that may be in the area exposed to active sonar. Where practical, advance survey should occur within about 2 hours prior to mid-frequency active sonar use and periodic surveillance should continue for the duration of the exercise. Any unusual conditions (e.g., presence of sensitive species, groups of species milling out of habitat, and any stranded animals) shall be reported to the Office in Tactical Command, who should give consideration to delaying, suspending, or altering the exercise.
- All safety zone power down requirements described above will apply.
- The post-exercise report must include specific reference to any event conducted in areas where the above conditions exist, with exact location and time/duration of the event, and noting results of surveys conducted.

5.8.2.2 Surface-to-Surface Gunnery (5-inch, 76 mm, 20 mm, 25 mm and 30 mm explosive rounds)

- Lookouts will visually survey for floating weeds and kelp, and algal mats which may be inhabited by immature sea turtles in the target area. Intended impact shall not be within 600 yds (585 m) of known or observed floating weeds and kelp, and algal mats.
- For exercises using targets towed by a vessel or aircraft, target-towing vessels/aircraft shall maintain a trained lookout for marine mammals and sea turtles. If a marine mammal or sea turtle is sighted in the vicinity, the tow aircraft/vessel will immediately notify the firing vessel, which will suspend the exercise until the area is clear.
- A 600 yard radius buffer zone will be established around the intended target.
- From the intended firing position, trained lookouts will survey the buffer zone for marine mammals and sea turtles prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.
- The exercise will be conducted only when the buffer zone is visible and marine mammals and sea turtles are not detected within it.

5.8.2.3 Surface-to-Surface Gunnery (non-explosive rounds)

- Lookouts will visually survey for floating weeds and kelp, and algal mats which may be inhabited by immature sea turtles in the target area. Intended impact will not be within 200 yds (183 m) of known or observed floating weeds and kelp, and algal mats.
- A 200 yd (183 m) radius buffer zone will be established around the intended target.
- From the intended firing position, trained lookouts will survey the buffer zone for marine mammals and sea turtles prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts

are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.

- If applicable, target towing vessels will maintain a lookout. If a marine mammal or sea turtle is sighted in the vicinity of the exercise, the tow vessel will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.
- The exercise will be conducted only when the buffer zone is visible and marine mammals and sea turtles are not detected within the target area and the buffer zone.

5.8.2.4 Surface-to-Air Gunnery (explosive and non-explosive rounds)

- Vessels will orient the geometry of gunnery exercises in order to prevent debris from falling in the area of sighted marine mammals, sea turtles, algal mats, and floating kelp.
- Vessels will expedite the recovery of any parachute deploying aerial targets to reduce the potential for entanglement of marine mammals and sea turtles.
- Target towing aircraft shall maintain a lookout. If a marine mammal or sea turtle is sighted in the vicinity of the exercise, the tow aircraft will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

5.8.2.5 Air-to-Surface Gunnery (explosive and non-explosive rounds)

- If surface vessels are involved, lookouts will visually survey for floating kelp, which may be inhabited by immature sea turtles, in the target area. Impact should not occur within 200 yds (183 m) of known or observed floating weeds and kelp or algal mats.
- A 200 yd (183 m) radius buffer zone will be established around the intended target.
- If surface vessels are involved, lookout(s) will visually survey the buffer zone for marine mammals and sea turtles prior to and during the exercise.
- Aerial surveillance of the buffer zone for marine mammals and sea turtles will be conducted prior to commencement of the exercise. Aerial surveillance altitude of 500 feet to 1,500 feet (ft) (152 - 456 m) is optimum. Aircraft crew/pilot will maintain visual watch during exercises. Release of ordnance through cloud cover is prohibited: aircraft must be able to actually see ordnance impact areas.
- The exercise will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

5.8.2.6 Small Arms Training - (grenades, explosive and non-explosive rounds)

- Lookouts will visually survey for floating weeds or kelp, algal mats, marine mammals, and sea turtles. Weapons will not be fired in the direction of known or observed floating weeds or kelp, algal mats, marine mammals, sea turtles.

5.8.2.7 Air-to-Surface At-Sea Bombing Exercises (explosive bombs and cluster munitions, rockets)

- If surface vessels are involved, trained lookouts will survey for floating kelp, which may be inhabited by immature sea turtles. Ordnance shall not be targeted to impact within 1,000 yds (914 m) of known or observed floating kelp, sea turtles, or marine mammals.
- A buffer zone of 1,000 yd (914 m) radius will be established around the intended target.
- Aircraft will visually survey the target and buffer zone for marine mammals and sea turtles prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 feet or lower, if safe to do so, and at the slowest safe speed. Release of

ordnance through cloud cover is prohibited: aircraft must be able to actually see ordnance impact areas. Survey aircraft should employ most effective search tactics and capabilities.

- The exercises will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

5.8.2.8 Air-to-Surface At-Sea Bombing Exercises (non-explosive bombs and cluster munitions, rockets)

- If surface vessels are involved, trained lookouts will survey for floating kelp, which may be inhabited by immature sea turtles, and for sea turtles and marine mammals. Ordnance shall not be targeted to impact within 1,000 yds (914 m) of known or observed floating kelp, sea turtles, or marine mammals.
- A 1,000 yd (914 m) radius buffer zone will be established around the intended target.
- Aircraft will visually survey the target and buffer zone for marine mammals and sea turtles prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 ft (152 m) or lower, if safe to do so, and at the slowest safe speed. Release of ordnance through cloud cover is prohibited: aircraft must be able to actually see ordnance impact areas. Survey aircraft should employ most effective search tactics and capabilities.
- The exercise will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

5.8.2.9 Air-to-Surface Missile Exercises (explosive and non-explosive)

- Ordnance shall not be targeted to impact within 1,800 yds (1646 m) of known or observed floating kelp, which may be inhabited by immature sea turtles, or coral reefs.
- Aircraft will visually survey the target area for marine mammals and sea turtles. Visual inspection of the target area will be made by flying at 1,500 (457 m) feet or lower, if safe to do so, and at slowest safe speed. Firing or range clearance aircraft must be able to actually see ordnance impact areas. Explosive ordnance shall not be targeted to impact within 1,800 yds (1646 m) of sighted marine mammals and sea turtles.

5.8.2.10 Underwater Detonations (up to 20-lb charges)

To ensure protection of marine mammals and sea turtles during underwater detonation training, the operating area must be determined to be clear of marine mammals and sea turtles prior to detonation. Implementation of the following mitigation measures continue to ensure that marine mammals would not be exposed to temporary threshold shift (TTS), permanent threshold shift (PTS), or injury from physical contact with training mine shapes during Major Exercises.

5.8.2.10.1 Exclusion Zones

All Mine Warfare and Mine Countermeasures Operations involving the use of explosive charges must include exclusion zones for marine mammals and sea turtles to prevent physical and/or acoustic effects to those species. These exclusion zones shall extend in a 700-yard arc radius around the detonation site.

5.8.2.10.2 Pre-Exercise Surveys

For Demolition and Ship Mine Countermeasures Operations, pre-exercise survey shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any marine mammal or sea turtle. Should such an animal be present within the survey area, the exercise shall be paused until the animal voluntarily leaves the area. The Navy will suspend detonation exercises and ensure the area is clear for a full 30 minutes prior to detonation. Personnel will record any protected species marine mammal and sea turtle observations during the exercise as well as measures taken if species are detected within the exclusion zone.

5.8.2.10.3 Post-Exercise Surveys and Reporting

Surveys within the same radius shall also be conducted within 30 minutes after the completion of the explosive event.

If there is evidence that a marine mammal or sea turtle may have been stranded, injured or killed by the action, Navy training activities will be immediately suspended and the situation immediately reported by the participating unit to the Officer in Charge of the Exercise (OCE), who will follow Navy procedures for reporting the incident to to Commander, Pacific Fleet, Commander, Navy Region Southwest, Environmental Director, and the chain-of-command.

5.8.2.11 Mining Operations

Mining Operations involve aerial drops of inert training shapes on target points. Aircrews are scored for their ability to accurately hit the target points. This operation does not involve live ordnance. The probability of a marine species being in the exact spot in the ocean where an inert object is dropped is remote. However, as a conservative measure, initial target points will be briefly surveyed prior to inert ordnance release from an aircraft to ensure the intended drop area is clear of marine mammals and sea turtles. To the extent feasible, the Navy shall retrieve inert mine shapes dropped during Mining Operations.

5.8.2.12 Sink Exercise (SINKEX)

The selection of sites suitable for SINKEX involves a balance of operational suitability, requirements established under the Marine Protection, Research and Sanctuaries Act (MPRSA) permit granted to the Navy (40 Code of Federal Regulations § 229.2), and the identification of areas with a low likelihood of encountering Endangered Species Act (ESA) listed species. To meet operational suitability criteria, locations must be within a reasonable distance of the target vessels' originating location. The locations should also be close to active military bases to allow participating assets access to shore facilities. For safety purposes, these locations should also be in areas that are not generally used by non-military air or watercraft. The MPRSA permit requires vessels to be sunk in waters which are at least 1,000 fathoms (3,000 yds / 2742 m)) deep and at least 50 nm from land.

In general, most listed species prefer areas with strong bathymetric gradients and oceanographic fronts for significant biological activity such as feeding and reproduction. Typical locations include the continental shelf and shelf-edge.

5.8.2.12.1 SINKEX Mitigation Plan

The Navy has developed range clearance procedures to maximize the probability of sighting any ships or protected species in the vicinity of an exercise, which are as follows:

- All weapons firing would be conducted during the period 1 hour after official sunrise to 30 minutes before official sunset.
- Extensive range clearance operations would be conducted in the hours prior to commencement of the exercise, ensuring that no shipping is located within the hazard range of the longest-range weapon being fired for that event.
- Prior to conducting the exercise, remotely sensed sea surface temperature maps would be reviewed. SINKEX would not be conducted within areas where strong temperature

discontinuities are present, thereby indicating the existence of oceanographic fronts. These areas would be avoided because concentrations of some listed species, or their prey, are known to be associated with these oceanographic features.

- An exclusion zone with a radius of 1.0 nm would be established around each target. This exclusion zone is based on calculations using a 990-pound (lb) H6 net explosive weight high explosive source detonated 5 ft below the surface of the water, which yields a distance of 0.85 nm (cold season) and 0.89 nm (warm season) beyond which the received level is below the 182 decibels (dB) re: 1 micropascal squared-seconds (µPa2-s) threshold established for the WINSTON S. CHURCHILL (DDG 81) shock trials (DoN 2001). An additional buffer of 0.5 nm would be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which extends from the exclusion zone at 1.0 nm out an additional 0.5 nm, would be surveyed. Together, the zones extend out 2 nm from the target.
- A series of surveillance over-flights would be conducted within the exclusion and the safety zones, prior to and during the exercise, when feasible. Survey protocol would be as follows:
    - Overflights within the exclusion zone would be conducted in a manner that optimizes the surface area of the water observed. This may be accomplished through the use of the Navy's Search and Rescue Tactical Aid, which provides the best search altitude, ground speed, and track spacing for the discovery of small, possibly dark objects in the water based on the environmental conditions of the day. These environmental conditions include the angle of sun inclination, amount of daylight, cloud cover, visibility, and sea state.
    - All visual surveillance activities would be conducted by Navy personnel trained in visual surveillance. At least one member of the mitigation team would have completed the Navy's marine mammal training program for lookouts.
    - In addition to the overflights, the exclusion zone would be monitored by passive acoustic means, when assets are available. This passive acoustic monitoring would be maintained throughout the exercise. Potential assets include sonobuoys, which can be utilized to detect any vocalizing marine mammals (particularly sperm whales) in the vicinity of the exercise. The sonobuoys would be re-seeded as necessary throughout the exercise. Additionally, passive sonar onboard submarines may be utilized to detect any vocalizing marine mammals in the area. The OCE would be informed of any aural detection of marine mammals and would include this information in the determination of when it is safe to commence the exercise.
    - On each day of the exercise, aerial surveillance of the exclusion and safety zones would commence 2 hours prior to the first firing.
    - The results of all visual, aerial, and acoustic searches would be reported immediately to the OCE. No weapons launches or firing would commence until the OCE declares the safety and exclusion zones free of marine mammals and threatened and endangered species.
    - If a protected species observed within the exclusion zone is diving, firing would be delayed until the animal is re-sighted outside the exclusion zone, or 30 minutes have elapsed. After 30 minutes, if the animal has not been re-sighted it would be assumed to have left the exclusion zone. This is based on a typical dive

time of 30 minutes for traveling listed species of concern. The OCE would determine if the listed species is in danger of being adversely affected by commencement of the exercise.

  - During breaks in the exercise of 30 minutes or more, the exclusion zone would again be surveyed for any protected species. If protected species are sighted within the exclusion zone, the OCE would be notified, and the procedure described above would be followed.
  - Upon sinking of the vessel, a final surveillance of the exclusion zone would be monitored for 2 hours, or until sunset, to verify that no listed species were harmed.

- Aerial surveillance would be conducted using helicopters or other aircraft based on necessity and availability. The Navy has several types of aircraft capable of performing this task; however, not all types are available for every exercise. For each exercise, the available asset best suited for identifying objects on and near the surface of the ocean would be used. These aircraft would be capable of flying at the slow safe speeds necessary to enable viewing of marine vertebrates with unobstructed, or minimally obstructed, downward and outward visibility. The exclusion and safety zone surveys may be cancelled in the event that a mechanical problem, emergency search and rescue, or other similar and unexpected event preempts the use of one of the aircraft onsite for the exercise.
- Every attempt would be made to conduct the exercise in sea states that are ideal for marine mammal sighting, Beaufort Sea State 3 or less. In the event of a 4 or above, survey efforts would be increased within the zones. This would be accomplished through the use of an additional aircraft, if available, and conducting tight search patterns.
- The exercise would not be conducted unless the exclusion zone could be adequately monitored visually.
- In the unlikely event that any listed species are observed to be harmed in the area, a detailed description of the animal would be taken, the location noted, and if possible, photos taken. This information would be provided to NMFS via the Navy’s regional environmental coordinator for purposes of identification.
- An after action report detailing the exercise’s time line, the time the surveys commenced and terminated, amount, and types of all ordnance expended, and the results of survey efforts for each event would be submitted to NMFS.

5.8.2.13 Mitigation Measures Related to Explosive Source Sonobuoys (AN/SSQ-110A)

- Crews will conduct visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search should be conducted below 457 m (500 yd) at a slow speed, if operationally feasible and weather conditions permit. In dual aircraft operations, crews are allowed to conduct coordinated area clearances.
- Crews shall conduct a minimum of 30 minutes of visual and aural monitoring of the search area prior to commanding the first post detonation. This 30-minute observation period may include pattern deployment time.
- For any part of the briefed pattern where a post (source/receiver sonobuoy pair) will be deployed within 914 m (1,000 yd) of observed marine mammal activity, deploy the receiver ONLY and monitor while conducting a visual search. When marine mammals

are no longer detected within 914 m (1,000 yd) of the intended post position, co-locate the explosive source sonobuoy (AN/SSQ-110A) (source) with the receiver.

- When able, crews will conduct continuous visual and aural monitoring of marine mammal activity. This is to include monitoring of own-aircraft sensors from first sensor placement to checking off station and out of RF range of these sensors.
- Aural Detection:
    - o If the presence of marine mammals is detected aurally, then that should cue the aircrew to increase the diligence of their visual surveillance. Subsequently, if no marine mammals are visually detected, then the crew may continue multi-static active search.
- Visual Detection:
    - o If marine mammals are visually detected within 914 m (1,000 yd) of the explosive source sonobuoy (AN/SSQ-110A) intended for use, then that payload shall not be detonated. Aircrews may utilize this post once the marine mammals have not been re-sighted for 10 minutes, or are observed to have moved outside the 914 m (1,000 yd) safety buffer.
    - o Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 914 m (1,000 yd) safety buffer.
- Aircrews shall make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the “Payload 1 Release” command followed by the “Payload 2 Release” command. Aircrews shall refrain from using the “Scuttle” command when two payloads remain at a given post. Aircrews will ensure that a 914 m (1,000 yd) safety buffer, visually clear of marine mammals, is maintained around each post as is done during active search operations.
- Aircrews shall only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary or tertiary method.
- Ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ-110A) that can not be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.
- Mammal monitoring shall continue until out of own-aircraft sensor range.

5.8.3 Conservation Measures

5.8.3.1 SOCAL Marine Species Monitoring Plan

The Navy is developing developed a Marine Species Monitoring Plan (MSMP) that provides recommendations for site-specific monitoring for MMPA and ESA listed species (primarily marine mammals) within the SOCAL Range Complex, including during training exercises. The primary goals of monitoring are to evaluate trends in marine species distribution and abundance in order to assess potential population effects from Navy training activities and determine the effectiveness of the Navy’s mitigation measures. The information gained from the monitoring will also allow the Navy to evaluate the models used to predict effects to marine mammals.

By using a combination of monitoring techniques or tools appropriate for the species of concern, type of Navy activities conducted, sea state conditions, and the size of the Range Complex, the detection, localization, and observation of marine mammals and sea turtles can be maximized. The following available monitoring techniques and tools are described in this monitoring plan for monitoring for range events (several days or weeks) and monitoring of population effects such as abundance and distribution (months or years):

- Visual Observations – Vessel-, Aerial- and Shore-based Surveys (for marine mammals and sea turtles) will provide data on population trends (abundance, distribution, and presence) and response of marine species to Navy training activities. Navy lookouts will also record observations of detected marine mammals from Navy ships during appropriate training and test events.

- Acoustic Monitoring – Passive Acoustic Monitoring possibly using towed hydrophone arrays, Autonomous Acoustic Recording buoys and U.S. Navy Instrument Acoustic Range (for marine mammals only) may provide presence/absence data on cryptic species that are difficult to detect visually (beaked whales and minke whales) that could address long term population trends and response to Navy training exercises.

- Tagging – Tagging marine mammals with instruments to measure their dive depth and duration, determine location and record the received level of natural and anthropogenic sounds.

- Additional Methods – Oceanographic Observations and Other Environmental Factors will be obtained during ship-based surveys and satellite remote sensing data. Oceanographic data is important factor that influences the abundance and distribution of prey items and therefore the distribution and movements of marine mammals.

The monitoring plan will be reviewed annually by Navy biologists to determine the effectiveness of the monitoring elements and to consider any new monitoring tools or techniques that may have become available.

5.8.3.2 Research

The Navy provides a significant amount of funding and support to marine research. The agency provides nearly 10 million dollars annually to universities, research institutions, federal laboratories, private companies, and independent researchers around the world to study marine mammals. The U.S. Navy sponsors seventy percent of all U.S. research concerning the effects of human-generated sound on marine mammals and 50 percent of such research conducted worldwide. Major topics of Navy-supported research include the following:

- Better understanding of marine species distribution and important habitat areas,
- Developing methods to detect and monitor marine species before and during training,
- Understanding the effects of sound on marine mammals, sea turtles, fish, and birds, and
- Developing tools to model and estimate potential effects of sound.

The Navy's Office of Naval Research currently coordinates six programs that examine the marine environment and are devoted solely to studying the effects of noise and/or the implementation of technology tools that will assist the Navy in studying and tracking marine mammals. The six programs are as follows:

- Environmental Consequences of Underwater Sound,
- Non-Auditory Biological Effects of Sound on Marine Mammals,

- Effects of Sound on the Marine Environment,
- Sensors and Models for Marine Environmental Monitoring,
- Effects of Sound on Hearing of Marine Animals, and
- Passive Acoustic Detection, Classification, and Tracking of Marine Mammals.

The Navy has also developed the technical reports referenced within this document, which include the Marine Resource Assessments and the Navy OPAREA Density Estimates (NODE) reports. Furthermore, research cruises by the National Marine Fisheries Service (NMFS) and by academic institutions have received funding from the U.S. Navy.

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and other research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods on instrumented ranges. However, acoustic detection, identification, localization, and tracking of individual animals still requires a significant amount of research effort to be considered a reliable method for marine mammal monitoring. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential mitigation and monitoring tool.

Overall, the Navy will continue to fund ongoing marine mammal research, and is planning to coordinate long term monitoring/studies of marine mammals on various established ranges and operating areas. The Navy will continue to research and contribute to university/external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include mitigation and monitoring programs; data sharing with NMFS and via the literature for research and development efforts; and future research as described previously.

5.8.4 Coordination and Reporting

The Navy will coordinate with the local NMFS Stranding Coordinator for any unusual marine mammal behavior and any stranding, beached live/dead or floating marine mammals that may occur coincident with Navy training activities.

5.8.5 Alternative Mitigation Measures Considered but Eliminated

As described in Chapter 3, Section 3.9 and Appendix F, the vast majority of estimated sound exposures of marine mammals during proposed active sonar activities would not cause injury. Potential acoustic effects on marine mammals would be further reduced by the mitigation measures described above. Therefore, the Navy concludes the proposed action and mitigation measures would achieve the least practical adverse impact on species or stocks of marine mammals.

A determination of “least practicable adverse impacts” includes consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity in consultation with the DoD. Therefore, the following additional mitigation measures were analyzed and eliminated from further consideration:

- Reduction of training. The requirements for training have been developed through many years of iteration to ensure sailors achieve levels of readiness to ensure they are prepared to properly respond to the many contingencies that may occur during an actual mission. These training requirements are designed provide the experience needed to ensure sailors are properly prepared for operational success. There is no extra training built in to the plan, as this would not be an efficient use of the resources needed to support the training (e.g. fuel, time). Therefore, any reduction of training would not allow sailors to achieve satisfactory levels of readiness needed to accomplish their mission.

- Use of ramp-up to attempt to clear the range prior to the conduct of exercises. Ramp-up procedures, (slowly increasing the sound in the water to necessary levels), are not a viable alternative for training exercises because the ramp-up would alert opponents to the participants' presence. This affects the realism of training in that the target submarine would be able to detect the searching unit prior to themselves being detected, enabling them to take evasive measures. This would insert a significant anomaly to the training, affecting its realism and effectiveness. Though ramp-up procedures have been used in testing, the procedure is not effective in training sailors to react to tactical situations, as it provides an unrealistic advantage by alerting the target. Using these procedures would not allow the Navy to conduct realistic training, thus adversely impacting the effectiveness of the military readiness activity.

- Visual monitoring using third-party observers from air or surface platforms, in addition to the existing Navy-trained lookouts.

    - The use of third-party observers would compromise security due to the requirement to provide advance notification of specific times/locations of Navy platforms.

    - Reliance on the availability of third-party personnel would also impact training flexibility, thus adversely affecting training effectiveness.

    - The presence of other aircraft in the vicinity of naval exercises would raise safety concerns for both the commercial observers and naval aircraft.

    - Use of Navy observers is the most effective means to ensure quick and effective implementation of mitigation measures if marine species are spotted. A critical skill set of effective Navy training is communication. Navy lookouts are trained to act swiftly and decisively to ensure that appropriate actions are taken.

    - Use of third-party observers is not necessary because Navy personnel are extensively trained in spotting items on or near the water surface. Navy spotters receive more hours of training, and use their spotting skills more frequently, than many third-party trained personnel.

    - Crew members participating in training activities involving aerial assets have been specifically trained to detect objects in the water. The crew's ability to sight from both surface and aerial platforms provides excellent survey capabilities using the Navy's existing exercise assets.

    - Security clearance issues would have to be overcome to allow non-Navy observers onboard exercise participants.

    - Some training events will span one or more 24-hour periods, with operations underway continuously in that timeframe. It is not feasible to maintain non-Navy surveillance of these operations, given the number of non-Navy observers that would be required onboard.

    - Surface ships having active mid-frequency sonar have limited berthing capacity. As exercise planning includes careful consideration of this limited capacity in the placement of exercise controllers, data collection personnel, and Afloat Training Group personnel on ships involved in the exercise. Inclusion of non-Navy observers onboard these ships would require that in some cases there would be no additional berthing space for essential Navy personnel required to fully evaluate and efficiently use the training opportunity to accomplish the exercise objectives.

- Contiguous ASW events may cover many hundreds of square miles. The number of civilian ships and/or aircraft required to monitor the area of these events would be considerable. It is, thus, not feasible to survey or monitor the large exercise areas in the time required ensuring these areas are devoid of marine mammals. In addition, marine mammals may move into or out of an area, if surveyed before an event, or an animal could move into an area after an exercise took place. Given that there are no adequate controls to account for these or other possibilities and there are no identified research objectives, there is no utility to performing either a before or an after the event survey of an exercise area.
- Survey during an event raises safety issues with multiple, slow civilian aircraft operating in the same airspace as military aircraft engaged in combat training activities. In addition, most of the training events take place far from land, limiting both the time available for civilian aircraft to be in the exercise area and presenting a concern should aircraft mechanical problems arise.
- Scheduling civilian vessels or aircraft to coincide with training events would impact training effectiveness, since exercise event timetables cannot be precisely fixed and are instead based on the free-flow development of tactical situations. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would slow the unceasing progress of the exercise and impact the effectiveness of the military readiness activity.
- Multiple simultaneous training events continue for extended periods. There are not enough qualified third-party personnel to accomplish the monitoring task.

- Reducing or securing power during the following conditions.
  - Low-visibility / night training: ASW can require a significant amount of time to develop the “tactical picture,” or an understanding of the battle space such as area searched or unsearched, identifying false contacts, understanding the water conditions, etc. Reducing or securing power in low-visibility conditions would affect a commander’s ability to develop this tactical picture and would not provide realistic training.
  - Strong surface duct: The complexity of ASW requires the most realistic training possible for the effectiveness and safety of the sailors. Reducing power in strong surface duct conditions would not provide this training realism because the unit would be operating differently than it would in a combat scenario, reducing training effectiveness and the crew’s ability. Additionally, water conditions may change rapidly, resulting in continually changing mitigation requirements, resulting in a focus on mitigation versus training.

- Vessel speed: Establish and implement a set vessel speed.
  - Navy personnel are required to use caution and operate at a slow, safe speed consistent with mission and safety. Ships and submarines need to be able to react to changing tactical situations in training as they would in actual combat. Placing arbitrary speed restrictions would not allow them to properly react to these situations, resulting in decreased training effectiveness and reduction the crew proficiency.
- Increasing power down and shut down zones:
  - The current power down zones of 457 and 914 m (500 and 1,000 yd), as well as the 183 m (200 yd) shut down zone were developed to minimize exposing marine mammals to sound levels that could cause temporary threshold shift (TTS) or permanent threshold shift (PTS), levels that are supported by the scientific community. Implementation of the safety zones discussed above will prevent exposure to sound levels greater than 195 dB re 1μPa for animals sighted. The safety range the Navy has developed is also within a range sailors can realistically maintain situational awareness and achieve visually during most conditions at sea.
  - Although the three action alternatives were developed using marine mammal density data and areas believed to provide habitat features conducive to marine mammals, not all such areas could be avoided. ASW requires large areas of ocean space to provide realistic and meaningful training to the sailors. These areas were considered to the maximum extent practicable while ensuring Navy's ability to properly train its forces in accordance with federal law. Avoiding any area that has the potential for marine mammal populations is impractical and would impact the effectiveness of the military readiness activity.
- Using active sonar with output levels as low as possible consistent with mission requirements and use of active sonar only when necessary.
  - Operators of sonar equipment are always cognizant of the environmental variables affecting sound propagation. In this regard, the sonar equipment power levels are always set consistent with mission requirements.

    Active sonar is only used when required by the mission since it has the potential to alert opposing forces to the sonar platform's presence. Passive sonar and all other sensors are used in concert with active sonar to the maximum extent practicable when available and when required by the mission.

5.9 SEA BIRDS

Avoidance of seabirds and their nesting and roosting habitats provides the greatest degree of protective measure from potential impacts within the SOCAl Range Complex. Currently, the majority of aircraft operations that might affect seabirds are concentrated at the Naval Auxilary Landing Field (NALF) on SCI, and the potential for bird aircraft strikes exists. Pursuant to Navy instruction, measures to evaluate and reduce of eliminate this hazard to aircraft, aircrews, and birds are implemented. Additionally, guidance involving land or water detonations contains instructions to personnel to observe the surrounding area within 600 yds (585 m) for 30 minutes prior to detonation. If birds (or marine mammals or sea turtles) are seen, the operation must be relocated to an unoccupied area or postponed until animals leave the area. Monitoring of seabird populations and colonies by conservation groups and researchers is conducted intermittently within coastal areas and offshore islands with limited support from various military commands.

5.10 TERRESTRIAL BIOLOGICAL RESOURCES

As noted in section 3.11.1.3, the Navy implements measures to avoid, minimize, or compensate for its effects on biological resources including listed species on SCI. Key management and monitoring activities include completion and implementation of the SCI Wildland Fire Management Plan; continued monitoring and management activities for all endangered species but with particular attention to San Clemente loggerhead shrike, San Clemente sage sparrow, island fox, and six federally-listed plant species; invasive species monitoring and control efforts; continued operation of the on-island nursery and restoration efforts being conducted by nursery staff; vegetation condition and trend assessment; and continued implementation of the SCI Integrated Natural Resources Management Plan (INRMP). The Navy proposes to continue these measures. Further, as noted in section 3.11.4, the Navy proposes to implement additional measures to mitigate the environmental effects of its activities. The following is a comprehensive list of current and proposed mitigation measures intended to reduce effects of military activities on biological resources of SCI:

5.10.1 General Measures

- **G-M-1.** Continue to control invasive exotic plant species on an island-wide scale, with an emphasis on the AVMC, the IOA, TARs, and other operations insertion areas such as West Cove, Wilson Cove and the airfield. A pretreatment survey to identify areas needing treatment, one treatment cycle, and a retreatment cycle (when necessary) will be planned each year to minimize the distribution of invasive species. The focus of the invasive exotic plant control program will continue to be the control of highly invasive exotic plants that have the potential to adversely impact habitat for federally listed species in known locations, and the early detection and eradication of new occurrences of such species. Where feasible, include future construction sites in a treatment and retreatment cycle prior to construction.

- **G-M-2.** Continue feral cat and rat control efforts and monitoring level of feral cat and rat population (would benefit all endangered and threatened wildlife on SCI as well as the island fox). To reduce human-induced increases in the feral cat and rat populations, the Navy will ensure that personnel do not feed cats and that all trash, food waste, and training refuse are disposed of properly in animal proof containers.

- **G-M-3.** Continue implementation of INRMP per funding availability, with review and revision per Navy directives addressing management of natural resources.

- **G-M-4.** Continue to review and coordinate the dissemination of environmental conservation measures to island users. Conservation measures will be distributed to island military and civilian staff in accordance with commander's guidelines, and with Fleet operations.

- **G-M-5.** Conduct any necessary Explosive Ordnance Disposal (EOD) ordnance detonations in or near endangered or threatened species habitat in a manner that minimizes the potential for wildfire without compromising personnel safety.

- **G-M-6.** Coordinate range access to achieve optimal flexibility between training operations and NRO activities, according to range use instructions and with priority given to military training.

- **G-M-7.** Locate SHOBA heavy ordnance targets with regard to proximity to sensitive resources, including San Clemente loggerhead shrike, sensitive plants (e.g., away from Horse Beach Canyon), and coastal salt marsh, to the extent feasible while meeting operational needs.

- **G-M-8.** Conduct monitoring and control activities for non-native predators outside the impact area boundaries. Monitoring and control activities would include China Point Road between Impact Areas I and II. Monitoring and control activities may be intensified as needed to prevent elevated predation on listed species outside the Impact Area boundaries attributable to predator populations within the Impact Area boundaries. Access to conduct control efforts would not be limited within SHOBA outside the Impact Area I and II boundaries. (See also related measure **G-M-2)**.

- **G-M-9.** Conduct monitoring and control activities for invasive non-native plant species outside of the impact area boundaries. Monitoring and control activities would include the China Point Road between Impact Areas I and II. Monitoring and control activities may be intensified as needed to prevent spread of invasive species and effects on listed species outside the Impact Area boundaries attributable to invasive species populations within the Impact Area boundaries. Access to conduct control efforts would not be limited within SHOBA outside the Impact Area I and II boundaries. (See also related measure G-M-1).

5.10.2 AVMC, AVMR, AVMA, AFPs, AMPs, IOA, and Amphibious Landing Sites

- **AVMC-M-1.** Complete survey for federally listed and sensitive plant species within the AVMC (including AVMAs, AFP-1, AFP-6, AMPs) and IOA. This survey was initiated in 2005 and was completed in 2007.

- **AVMC-M-2.** Conduct periodic monitoring of the AVMC (AVMAs, AMPs, AFPs, AVMR) and IOA as part of vegetation/habitat and sensitive species survey updates for the INRMP.

- **AVMC-M-3.** Develop an erosion control plan. Finalize AVMA, AMP, and AFP areas based on field review with soil erosion experts and military personnel, such that operational areas minimize inclusion of steep slopes and drainage heads. Develop, apply and maintain BMPs for erosion/sedimentation where appropriate, and provide for regular monitoring and control of invasive species.

- **AVMC-M-4.** Military units will be briefed on maneuver area boundaries prior to conducting operations in these areas.

- **AVMC-M-5.** Tracked vehicle travel or maneuvering will not be conducted outside the boundaries of the AVMC (including AFPs, AMPs, AVMAs, AVMR).

- **AVMC-M-6.** Develop and implement a project to monitor for erosion, dust generation, and deposition of dust in adjacent habitats.

- **AVMC-M-7.** Prior to coming to SCI, military and non-military personnel will be asked to conduct a brief check for visible plant material, dirt, or mud on equipment and shoes. Any visible plant material, dirt or mud should be removed before leaving for SCI. Wash tactical ground vehicles for invasive species prior to embarkation for SCI. Additional washing is not required for amphibious vehicles after 15 minutes of self-propelled travel through salt water prior to coming ashore on SCI.

- **AVMC-M-8.** Continue to enforce the existing 35 mph speed limit on Ridge Road for shore installation and administrative traffic. Post signs, continue public awareness programs; mow roadside vegetation; and monitor roadways for kills of protected or conservation agreement species including San Clemente loggerhead shrike, San Clemente sage sparrow, and island fox.

- **AVMC-M-9.** Tracked and wheeled vehicles will continue to use the existing route for ingress and egress to/from the beach at West Cove.
- **AVMC-M-10.** For Horse Beach Cove Amphibious Landing and Embarkation Area at TAR 21, vehicles will use an ingress/egress route that avoids impact on wetlands and minimizes impacts on coastal dune scrub. This involves driving amphibious vehicles westward on the unvegetated beach and egressing from beach west of the mouth of Horse Beach Canyon.

5.10.3 Training Areas and Ranges (TARs)

- **TAR-M-1.** Develop and implement a five-year monitoring plan with annual surveys for Threatened and Endangered plant species when they are known to occur within or adjacent to TARs outside of Impact Areas I and II.

5.10.4 Additional Species-Specific Measures

San Clemente sage sparrow

- **SCSS-M-1.** Continue surveys and population analysis for the San Clemente sage sparrow including the populations within TARs 4, 10, and 17. This survey effort includes monitoring transects and breeding plots along the west shore and marine terraces between February through June of each year.
- **SCSS-M-2.** Develop a sage sparrow management plan that includes objectives and management actions for the conservation of the sage sparrow on San Clemente Island. The goal of the management plan would be to provide for the long-term survival of the species on SCI in a manner that supports delisting from protection under the ESA while enabling military training requirements on San Clemente Island to be met.

San Clemente Loggerhead Shrike

- **SCLS-M-1.** ontinue the currently successful program of habitat restoration, predator management, monitoring, captive breeding, and re-introduction to benefit the San Clemente loggerhead shrike until such time that recovery objectives are identified and achieved.
- **SCLS-M-2.** Evaluate nest success data for SCLS in sites nearest AFP-6, including those in Eagle and Cave Canyons, and compare it to other sites in and out of SHOBA with the objective of determining whether or not success rates are typical for the species**.**

Island Night Lizard

- **INL-M-1.** Continue population monitoring at 3-year intervals and annual habitat evaluations while the delisting petition is being evaluated by USFWS.

California brown pelican

- **CBP-M-1.** Ensure that California brown pelicans are not in proximity to over-blast pressure prior to underwater demolition activities.

Western Snowy Plover

- **WSP-M-1.** Continue annual breeding and non-breeding season surveys for the western snowy plover at West Cove and Northwest Harbor.

Island Fox

- **IF-M-1.** Continue educational work with on-Island civilian and military personnel to prevent feeding, handling of foxes.
- **IF-M-2.** Continue feral cat control and education and enforcement of prohibitions concerning on-Island civilian and military personnel feeding, keeping, or otherwise encouraging the persistence of cats on SCI.
- **IF-M-3.** Continue posting signs, mowing road verges, and education to help minimize the potential for vehicular collisions with foxes.

Santa Cruz Island Rock-Cress

- **RC-M-1**. Investigate feasibility of establishing additional colonies in suitable habitat farther away from the IOA and AFP--1 using the on-island nursery to propagate from local seed.

5.11 CULTURAL RESOURCES

Section 3.12.1 details protective measures implemented with regard to cultural resources on SCI. (submerged cultural resources in ocean areas are unaffected by Navy activities.) As noted, the Navy has developed a draft Programmatic Agreement (PA) pursuant to 36 (C.F.R.) § 800.14 (the regulation implementing the National Historic Preservation Act). NHPA Section 106 compliance on SCI will be governed by a PA. The Draft PA stipulates qualifications of personnel, development of an Integrated Cultural Resources Management Plan (ICRMP), determination of an Area of Potential Effects, evaluation of resources to ensure that authorizations for ground-disturbing activities include appropriate measures to protect archaeological resources, emergency procedures, and annual reporting.

The PA identifies Impact Areas I and II in the southern portion of SCI as areas exempt from compliance with Section 106 due to their degree of disturbance and the safety risk to personnel that would be required to survey these areas. The PA defines dispersed pedestrian troop movements as having no potential for affecting cultural resources.

To ensure that cultural resources are managed in a planned and coordinated manner, the Navy is preparing an ICRMP for SCI. There are 18 elements of the ICRMP, as noted in Section 3.12.1.2. Several of these elements already have been addressed in the current Cultural Resources Management Plan for SCI, and some are being addressed in this EIS/ OEIS. All required elements will be addressed in the ICRMP, which will provide for overall management of cultural resources.

Avoidance of adverse effect is the preferred treatment for cultural resources. There are several existing cultural resource measures for site avoidance in place as standard operating procedures at SCI. These measures include:

- All proposed actions except those on existing ranges are reviewed by the NRO for potential effects on cultural resources;
- Ongoing mitigation focuses on treating adverse effects;
- Vehicles are required to stay on established roads or within the AVMC;

- Unauthorized collection of archaeological material is not allowed;
- No digging is permitted;
- Archaeological sites in areas of high use are posted with archaeological site protection signs; and

The Navy uses environmental planning, and project design and redesign to avoid or minimize impacts on resources. When avoidance is not feasible, however, eligible resources must receive appropriate mitigation. For archaeological sites considered important for their potential to provide information, this usually involves data recovery. Mitigating impacts on built resources typically involves Historic American Building Survey/Historic American Engineering Record documentation. The character of treatment is determined through consultation with the California State Historic Preservation Office (SHPO) and Advisory Council on Historic Preservation on adverse effect under 36 C.F.R. § 800.

5.12 TRAFFIC

The Navy strives to ensure that it retains access to ocean training areas and special use airspace (SUA) as necessary to accomplish its mission, while facilitating joint military-civilian use of such areas to the extent practicable and consistent with safety. These goals of military access, joint use, and safety are promoted through various coordination and outreach measures, including:

- Publication of NOTAM advising of the status and nature of activities being conducted in W-291 and other components of SUA in the EIS Study Area.
- Return of SUA to civilian Federal Aviation Administration (FAA) control when not in use for military activities. To accommodate the joint use of SUA, a Letter of Agreement is in place between Los Angeles Air Traffic Control Center (ARTCC) and Fleet Area Control and Surveillance Facility (FACSFAC) San Diego (Navy). The LOA defines the conditions and procedures to ensure safe and efficient joint use of waning areas.
- Publication of NOTMAR and other outreach. The Navy provides information about potentially hazardous activities planned for the SOCAL OPAREA, for publication by the U.S. Coast Guard in NOTMAR. Most such activities occur in the vicinity of SCI. To ensure the broadest dissemination of information about hazards to commercial and recreational vessels, the Navy provides detailed schedules of its activities planned near SCI on a dedicated website.

5.13 SOCIOECONOMICS

Given the nature and location of Navy activities addressed in this EIS/OEIS, mitigation and protective measures are unnecessary with respect to socioeconomic considerations.

5.14 ENVIRONMENTAL JUSTICE AND PROTECTION OF CHILDREN

Given the nature and location of Navy activities addressed in this EIS/OEIS, mitigation and protective measures are unnecessary with respect to socioeconomic considerations.

5.15 PUBLIC SAFETY

Navy activities in the SOCAL Range Complex comply with numerous established safety procedures to ensure the safety of participants and the public. FACSFAC and Navy range managers have published safety procedures for activities on the offshore and nearshore areas. These guidelines are directive for range users. They provide, among other measures, that:

- Commanders are responsible for ensuring that impact areas and targets are clear prior to commencing activities that are hazardous.

- Aircraft or vessels expending ordnance shall not commence firing without permission of the scheduling authority for their specific range area.
- Firing units and targets must remain in their assigned areas, and units must fire in accordance with current safety instructions.
- Except for SCI, ships are authorized to fire their weapons only in offshore areas and at specific distances from land, depending on the caliber and range of the weapons fired. The larger the caliber, the farther offshore that the firing must take place.
- The use of pyrotechnic or illumination devices and marine markers such as smoke or dye markers will be allowed only in the assigned areas, to avoid the launch of Search and Rescue forces when not required. Aircraft carrying ordnance to or from ranges shall avoid populated areas to the maximum extent possible.
- Aircrews operating in W-291 are aware that non-participating aircraft are not precluded from entering the area and may not comply with a NOTAM or radio warning that hazardous activities are scheduled or occurring. Aircrews are required to maintain a continuous lookout for non-participating aircraft while operating under visual flight rules in W-291.

In addition to the FACSFAC and SCORE procedures, the Navy has instituted the following SOPs for use of the SOCAL Range Complex:

5.15.1.1 Aviation Safety

Aircraft in W-291 fly under visual flight rules (VFR) and under visual meteorological conditions. This means that the commanders of military aircraft are responsible for the safe conduct of their flight. Prior to releasing any weapons or ordnance, the impact area must be clear of non-participating vessels, people, or aircraft. The OCE is ultimately responsible for the safe conduct of range training. A qualified Safety Officer is assigned to each training event or exercises and can terminate activities if unsafe conditions exist. Aircraft entering the SCI Air Traffic Area are required to be in radio contact with military air traffic control.

5.15.1.2 Submarine Safety

Vertical separation of at least 100 ft (30.5 m) is required between the top of a submarine's sail and the depth of a surface ship's keel. If a submarine (or submarine simulated target, the MK-30) is at periscope depth, at least a 1,500-yard (yd) (1,372-m) horizontal separation from other vessels must be maintained.

5.15.1.3 Surface Ship Safety

During training events, surface ships maintain radio contact with range control. Prior to launching a weapon, ships are required to obtain a "Green Range," which indicates that all safety criteria have been satisfied, and that the weapons and target recovery conditions and recovery helicopters and boats are ready to be employed.

5.15.1.4 Missile Exercise Safety

Safety is the top priority and paramount concern during missile exercises. These exercises can be surface-to-surface, subsurface-to-surface, surface-to-air, or air-to-air. A Missile Exercise (MISSILEX) Letter of Instruction is prepared prior to any missile firing exercise. This instruction establishes precise ground rules for the safe and successful execution of the exercise. Any MISSILEX participant who observes an unsafe situation can communicate a "Red Range" order over any voice communication systems. Range control is in radio contact with participants at all times during a MISSILEX.

6 Other Considerations Required by NEPA

This Page Intentionally Left Blank

TABLE OF CONTENTS

LIST OF FIGURES

There are no figures in this section.

LIST OF TABLES

This page intentionally left blank.

6 OTHER CONSIDERATIONS REQUIRED BY NEPA

6.1 CONSISTENCY WITH OTHER FEDERAL, STATE, AND LOCAL PLANS, POLICIES, AND REGULATIONS

Based on an evaluation with respect to consistency with statutory obligations, the Department of the Navy's (DoN) alternatives including the Proposed Action for the Southern California Range Complex Draft Environmental Impact Statement (EIS) / Overseas Environmental Impact Statement (OEIS) (hereafter referred to as "EIS/OEIS") does not conflict with the objectives or requirements of Federal, State, regional, or local plans, policies, or legal requirements. Table 6-1 provides a summary of environmental compliance requirements that may apply.

Table 6-1: Summary of Environmental Compliance for the Proposed Action

Plans, Policies, and Controls	Responsible Agency	Status of Compliance
National Environmental Policy Act (NEPA) of 1969 (42 U.S.C §§ 4321 *et seq.*) Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 C.F.R. §§ 1500-1508) DoN Procedures for Implementing NEPA (32 C.F.R. § 775)	DoN	This EIS has been prepared in accordance with NEPA, CEQ regulations and Navy NEPA procedures. Public participation and review is being conducted in compliance with the NEPA.
Executive Order 12114, 32 CFR 187, Environmental Effects Abroad of Major Federal Actions	DoN	This OEIS has been prepared in accordance with EO 12114 as implemented by 32 CFR 187, which requires environmental consideration for actions that may affect the environment outside of U.S. Territorial Waters on the high seas.
Clean Air Act (CAA) (42 USC §§ 7401 *et seq.*) CAA General Conformity Rule (40 C.F.R. § 93[B]) State Implementation Plan (SIP)	U.S. Environmental Protection Agency (USEPA) South Coast Air Quality Management District San Diego Air Pollution Control District	The Proposed Action would not conflict with attainment and maintenance goals established in SIPs. A CAA conformity determination will not be required because emissions attributable to the alternatives including the Proposed Action would be below *de minimis* thresholds.
Federal Water Pollution Control Act (Clean Water Act [CWA)]) (33 U.S.C. §§ 1344 *et seq.*)	USEPA	No permits are required under the CWA Sections 401, 402, or 404 (b) (1).
Rivers and Harbors Act (33 U.S.C.§§ 401 et seq.)	U.S. Army Corps of Engineers	No permit is required under the Rivers and Harbors Act.

Plans, Policies, and Controls	Responsible Agency	Status of Compliance
Coastal Zone Management Act (CZMA) (16 C.F.R. §§ 1451 *et seq*.)	California Coastal Commission	See Section 6.1.1, below, for discussion of Navy activities and compliance with the CZMA.
Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §§ 1801-1802)	National Marine Fisheries Service (NMFS)	The Proposed Action would not adversely affect Essential Fish Habitat (EFH) and would not decrease the available area or quality of EFH.
Endangered Species Act (ESA) (16 U.S.C. §§ 1531 et seq.)	DoN U.S. Fish and Wildlife Service (USFWS) NMFS	The EIS/OEIS analyzes potential effects to species listed under the ESA. In accordance with ESA requirements, the Navy will complete consultation under Section 7 of the ESA with NMFS and USFWS on the potential that implementation of the Proposed Action may affect listed species. With regard to NMFS jurisdiction, upon concluding Section 7 consultation, the Navy will adhere to any Biological Opinion (BO). In addition, the Navy will apply for a Letter of Authorization (see discussion below re: Marine Mammal Protection Act), which is expected to impose terms and conditions that, when implemented, would make ESA Section 9 prohibitions inapplicable to covered Navy activities. With regard to USFWS jurisdiction over species present in SCI, the Navy will initiate Section 7 consultation and conduct its activities in accordance with any applicable BOs.
Marine Mammal Protection Act (MMPA) (16 U.S.C. §§ 1431 *et seq*.)	NMFS	The MMPA governs activities with the potential to harm, disturb, or otherwise "harass" marine mammals. As a result of acoustic effects associated with mid-frequency active sonar use and underwater detonations of explosives, implementation of the alternatives including the Proposed Action may result in potential Level A (harm) or Level B (disturbance) harassment to marine mammals. Therefore, the Navy will engage NMFS in the regulatory process to determine whether incidental "takes" of marine mammals are likely, and seek a Letter of Authorization (LOA) from NMFS to permit takes as appropriate.

Plans, Policies, and Controls	Responsible Agency	Status of Compliance
The National Marine Sanctuaries Act (16 U.S.C. §§ 1431 et. seq.)	National Oceanic and Atmospheric Administration	Channel Islands National Marine Sanctuary (CINMS) lies within the study area addressed in this EIS/OEIS. Per CINMS regulations (15 CFR §922.71(a)), national defense activities in existence at the time of designation are not subject to CINMS regulatory prohibitions, provided they are "consistent with the [CINMS] regulations to the maximum extent practicable." CINMS regulations also require that the exemption of additional activities having significant impact shall be determined after consultation with the Director of the National Marine Sanctuary Program (NMSP). The Navy does not propose new activities in the CINMS, nor activities that are different from those currently conducted in the CINMS. Therefore, proposed activities are consistent with those activities currently conducted in the CINMS, are consistent with those described in the designation document, and are not being changed or modified in a way that would require consultation. Implementation of the alternatives including the Proposed Action would have no effect on sanctuary resources in the off-shore environment of southern California. Review of agency actions under Section 304 of the National Marine Sanctuaries Act is not required.
The Sikes Act of 1960 (16 U.S.C. §§ 670a-670o, as amended by the Sikes Act Improvement Act of 1997, Pub. L. No. 105-85)	DoD	The alternatives including the Proposed Action would be implemented in accordance with the management and conservation criteria developed in the Sikes Act Integrated Natural Resources Management Plans (INRMP) for SCI.
National Historic Preservation Act (NHPA) (16 U.S.C. §§ 470 *et seq.*)	DoN	The alternatives including the Proposed Action would be implemented in consultation with and under programmatic agreement with the State Historic Preservation Office, and pursuant to the criteria developed in the Integrated Cultural Resources Management Plans (ICRMP) for SCI.
EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	DoN	The Proposed Action would not result in any disproportionately high adverse human health or environmental effects on minority or low-income populations.
EO 13045, Protection of Children from Environmental Health Risks and Safety Risks	DoN	The Proposed Action would not result in environmental health and safety risks to children.

Plans, Policies, and Controls	Responsible Agency	Status of Compliance
EO 13112, Invasive Species	DoN	EO 13112 requires agencies to identify actions that may affect the status of invasive species and take measures to avoid introduction and spread of these species. To the extent invasive species management relates to ESA compliance on SCI, the BO is expected to ensure compliance with EO 13112. This EIS/OEIS also otherwise satisfies the requirement of EO 13112.
EO 13089, Coral Reef Protection	DoN	EO 13089 preserves and protects the biodiversity, health, heritage, social and economic value of U.S. coral reef ecosystems and the marine environments. All Navy actions that may affect U.S. coral reef ecosystems shall: (a) identify their actions that may affect U.S. coral reef ecosystems; (b) utilize their programs and authorities to protect and enhance the conditions of such ecosystems; and (c) to the extent permitted by law, ensure that any actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems. Navy SOPs ensure all precautions are made to comply with required statutes. No resources that are governed by this EO exist within the SOCAL Range Complex, therefore, mitigation of effects will not be necessary for the protection of resources under EO 13089.
EO 11990, Protection of Wetlands	DoN	Implementation of the alternatives including the Proposed Action would not have a significant impact on wetlands.
EO 12962, Recreational Fisheries	DoN	EO 12962 requires federal agencies to fulfill certain duties with regard to promoting the health and access of the public to recreational fishing areas. The alternatives including the Proposed Action comply with EO 12962.
California Coastal National Monument Designation (Presidential Proclamation, January 11, 2000)	Bureau of Land Management (BLM) and California Department of Fish and Game (CDFG)	The proclamation designates all non-major U.S. owned lands (rocks, islands, etc.) along the coast of California from mean high tide out to a distance of 12 nautical miles (22 kilometers) as national monuments. The SOCAL Range Complex includes resources designated as part of the California Coastal National Monument area. The Navy has agreed with BLM on the terms of a memorandum of understanding (MOU) dated Nov. 5, 2007 regarding Navy activities in the vicinity of monument resources. Implementation of the alternatives including the Proposed Action would be consistent with the MOU and would not affect monument resources.

Plans, Policies, and Controls	Responsible Agency	Status of Compliance
California Marine Life Protection Act (MLPA) and Marine Managed Areas Improvement Act (California Fish and Game Code §§ 2850-2863)	CDFG	MLPA requires CDFG to confer with the Navy regarding issues related to Navy activities as such may engage Marine Managed Areas.
Migratory Bird Treaty Act (16 U.S.C. §§ 703-712)	USFWS	Implementation of the alternatives including the Proposed Action would not have a significant impact on any population of migratory birds; would comply with the MBTA; and would not require a permit under the MBTA.

6.1.1 Coastal Zone Management Act Compliance

The CZMA of 1972 (16 United States Code [U.S.C.] Section [§] 1451) encourages coastal states to be proactive in managing coastal zone uses and resources. CZMA established a voluntary coastal planning program; participating states submit a Coastal Management Plan (CMP) to National Oceanographic and Atmospheric Administration (NOAA) for approval. Under CZMA, federal actions are required to be consistent, to the maximum extent practicable, with the enforceable policies of approved CMPs.

CZMA defines the coastal zone (16 U.S.C. § 1453) as extending, "to the outer limit of State title and ownership under the Submerged Lands Act" (i.e., 3 nautical miles [nm] from the shoreline). The coastal zone extends inland only to the extent necessary to control the shoreline. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of, or which is held in trust by, the federal government (16 U.S.C. § 1453). Accordingly, federal military lands such as SCI are not within the coastal zone.

The State of California has an approved CMP. The *California Coastal Act* (CCA) of 1976 (California Public Resources Code, Division 20) implements California's CZMA program. The CCA includes policies to protect and expand public access to shorelines, and to protect, enhance, and restore environmentally sensitive habitats, including intertidal and nearshore waters, wetlands, bays and estuaries, riparian habitat, certain woods and grasslands, streams, lakes, and habitat for rare and endangered plants and animals. The California Coastal Commission (CCC) administers the State's CMP.

The CZMA federal consistency determination process includes a review of the Proposed Action to determine whether it has reasonably foreseeable effects on coastal zone resources or uses, an in-depth examination of any such effects, and a determination on whether those effects are consistent to the maximum extent practicable with the State's enforceable policies. Under the CZMA, the CCC must provide an opportunity for public comment and involvement in the federal coastal consistency determination process.

In conjunction with the EIS process, and before issuing a Record of Decision (ROD), the Navy will complete the federal consistency review process, which will be initiated through submission of its Consistency Determination to the CCC. Its preliminary determination, based in large part on the environmental impact analyses presented in this EIS/OEIS, is that the Navy is consistent to the maximum extent practicable with the State's enforceable CZMA policies. In particular, the Navy has determined that its Proposed Action is consistent with: CCA Article 2 (Public Access), Section 30210 (Access, recreational opportunities, posting); Article 3 (Recreation), Section 30220 (Protection of water-oriented activities); Article 4 (Maritime Environment), Sections 30230 (Marine resources, maintenance), 30231 (Biological productivity, wastewater), and 30234.5 (Fishing; economic, commercial, and recreational importance); and Article 5 (Land Resources), Section 30240 (Environmentally sensitive habitat areas). The Navy has determined that other policies embodied in the articles and sections of the CCA are not applicable to the Proposed Action.

The EIS/OEIS addresses those coastal resources and uses which would be affected by the Proposed Action, although the impact analyses do not specifically distinguish effects within the coastal zone from those effects outside of it. Public access and recreation are discussed in Sections 3.4 (Water Resources) and 3.16 (Public Health and Safety). Marine resources and biological productivity are discussed in Sections 3.6 (Marine Plants and Invertebrates), 3.7 (Fish), 3.8 (Sea Turtles), 3.9 (Marine Mammals), and 3.10 (Sea Birds). Fishing and commercial and recreational economics is discussed in Sections 3.7 (Fish) and 3.14 (Socioeconomics). Cultural resources are discussed in Section 3.12, Cultural Resources.

6.2 RELATIONSHIP BETWEEN SHORT-TERM USE OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

NEPA requires an analysis of the relationship between a project's short-term impacts on the environment and the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This means that choosing one option may reduce future flexibility in pursuing other options, or that committing a resource to a certain use may often eliminate the possibility for other uses of that resource.

The Proposed Action would result in both short- and long-term environmental effects. However, the Proposed Action would not be expected to result in any impacts that would reduce environmental productivity, permanently narrow the range of beneficial uses of the environment, or pose long-term risks to health, safety or the general welfare of the public. The Navy is committed to sustainable range management, including co-use of the SOCAL Range Complex with the general public and commercial interests to the extent practicable consistent with accomplishment of the Navy mission and in compliance with applicable law. This commitment to co-use will enhance the long-term productivity of the range areas surrounding SOCAL Range Complex.

6.3 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

NEPA requires that environmental analysis include identification of "any irreversible and irretrievable commitments of resources which would be involved in the Proposed Action should it be implemented." [NEPA Sec. 102 (2)(C)(v), 42 USC § 4332**].** Irreversible and irretrievable resource commitments are related to the use of non-renewable resources and the effects that the uses of these resources have on future generations. Irreversible effects primarily result from the use or destruction of a specific resource (*e.g.*, energy or minerals) that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action (*e.g.*, the disturbance of a cultural site). Construction of the SWTR and the shallow water minefield would cause short-term and temporary impacts during construction. Once SWTR is put in place, anchoring points will be carefully chosen by the Navy in order to mitigate any possible effects the laying of SWTR cable might have on marine resources.

For the alternatives including the Proposed Action, most resource commitments are neither irreversible nor irretrievable. Most impacts are short-term and temporary, or, if long lasting are negligible. Culturally significant resources known to occur in the area proposed for training activities are carefully managed under a comprehensive cultural resources program which the Navy is currently advancing through a programmatic agreement. This will insure the future management of these resources. No habitat associated with threatened or endangered species would be lost as result of implementation of the Proposed Action. Since there would be no building or facility construction, the consumption of materials typically associated with such construction (*e.g.*, concrete, metal, sand, fuel) would not occur. Energy typically associated with construction activities would not be expended and irreversibly lost.

Implementation of the Proposed Action would require fuels used by aircraft, ships, and ground-based vehicles. Since fixed- and rotary-wing flight and ship activities could increase relative, total fuel use would increase. Fuel use by ground-based vehicles involved in training activities would also increase. Therefore, total fuel consumption would increase and this nonrenewable resource would be considered irreversibly lost.

6.4 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL OF ALTERNATIVES AND MITIGATION MEASURES

Increased training and testing operations on the SOCAL Range Complex would result in an increase in energy demand over the No Action Alternative. This would result in an increase in fossil fuel consumption, mainly from aircraft, vessels, ground equipment, and power supply. Although the required electricity demands of increased intensity of land-use would be met by the existing electrical generation infrastructure at the SOCAL Range Complex, the alternatives would result in a net cumulative negative impact on the energy supply.

Energy requirements would be subject to any established energy conservation practices at each facility. No additional power generation capacity other than the potential use of generators would be required for any of the operations. The use of energy sources has been minimized wherever possible without compromising safety, training, or testing operations. No additional conservation measures related to direct energy consumption by the proposed operations are identified.

6.5 NATURAL OR DEPLETABLE RESOURCE REQUIREMENTS AND CONSERVATION POTENTIAL OF VARIOUS ALTERNATIVES AND MITIGATION MEASURES.

Resources that will be permanently and continually consumed by project implementation include water, electricity, natural gas, and fossil fuels; however, the amount and rate of consumption of these resources would not result in significant environmental impacts or the unnecessary, inefficient, or wasteful use of resources. Nuclear powered vessels would be a benefit as it decreases use of fossil fuels.

In addition, construction activities related to increased training and testing operations on the SOCAL Range Complex would result in the irretrievable commitment of nonrenewable energy resources, primarily in the form of fossil fuels (including fuel oil), natural gas, and gasoline construction equipment. With respect to operational activities, compliance with all applicable building codes, as well as project mitigation measures, would ensure that all natural resources are conserved or recycled to the maximum extent feasible. It is also possible that new technologies or systems will emerge, or will become more cost effective or user-friendly, that will further reduce the site’s reliance upon nonrenewable natural resources; however, even with implementation of conservation measures, consumption of natural resources would generally increase with implementation of the alternatives.

Pollution prevention is an important component of mitigation of the alternative’s adverse impacts. To the extent practicable, pollution prevention considerations are included.

By virtue of inclusion of proposed increases in SOCAL Range Complex operations in the SIP, air emissions inventory, the emissions of NO_x and ROG associated with the Proposed Action and alternatives are in conformity with the SIP and have demonstrated that they will not cause or contribute to a violation of the ozone standard [SOCAL, 2007 (Chapter 3.2 Air Quality)]. Therefore, because the Proposed Action will not adversely affect the ability of the South Coast

Air Basin to attain and maintain the NAAQS, the proposed project is presumed to conform with the SIP.

Aircraft operations at NALF SCI are the single largest airborne noise source. Noise levels in excess of 90-dBA can occur at the BUD/S Camp [(SOCAL, 2007 (Chapter 3.5 Acoustic Environment)]. Mitigations (structural attenuation features) are in place.

Sustainable range management practices are in place that protect and conserve natural and cultural resources; and preservation of access to training areas for current and future training requirements, while addressing potential encroachments that threaten to impact range capabilities.

7 List of Preparers

This Page Intentionally Left Blank

7 LIST OF PREPARERS

GOVERNMENT PREPARERS

Alexander Stone (U.S. Navy Fleet Environmental Division)
EIS Project Manager
B.S. Environmental Studies, George Washington University

Chip Johnson (U.S. Navy Pacific Fleet)
Marine Species Advisor and Staff Marine Biologist
B.S. Biology, University of North Carolina at Wilmington
M.A. Marine Science, Virginia Institute of Marine Science, College of William and Mary

Dean Leach, CDR, JAGC (U.S. Navy Pacific Fleet)
U.S. Navy Judge Advocate, U.S. Pacific Fleet
J.D., 1988
LLM (Environmental), 2001

Arthur Popper, PhD
Interim Associate Dean, College of Chemical and Life Sciences, Department of Biology
University of Maryland, College Park, MD

CONTRACTOR PREPARERS

Matthew Bartlett (Parsons Infrastructure and Technology), Cultural Resources, Public Health/Safety
B.S. Environmental Policy & Planning, Virginia Polytechnic Institute and State University
Years of Experience: 3.5

Blair Brownyard (Man Tech SRS Technologies, Inc.), Environmental Analyst
B.A. History, California State University, San Marcos
J.D. Touro Law Center
Years of Experience: 6

Bruce Campbell (Parsons Infrastructure and Technology), Lead Analyst, Geology/Soils, Noise
B.S. Environmental Biology, University of California, Santa Barbara
M.S. Environmental Management, University of San Francisco
Years of Experience: 26

Brian Fenlon (ManTech SRS Technologies), Military Operations Specialist
B.A. Mathematics, Providence College
Years of experience: 20

Lawrence Honma (Merkel & Associates, Inc.), Marine Biology and Fish
B.S. Wildlife and Fisheries Biology, University of California, Davis M.S. Marine Sciences, Moss Landng Marine Laboratory, California State University, San Francisco
Years of Experience: 18

Krystal Kermott (ManTech SRS), Deputy Project Manager
B.S. Biological Sciences, University of California at Santa Barbara
Years of Experience: 7

Derek Lerma (Tierra Data Inc.), Senior Marine Biologist, USCG 100 Ton Captain, Dive Master
B.S. Biological Oceanography, Humboldt State University
Years of Experience: 20

Thomas W. Mulroy (SAIC), Terrestrial Biological Assessment Leader
Ph.D. Ecology and Evolutionary Biology, University of California at Irvine,
M. A. Biology, University of Arizona; B.A. Zoology, Pomona College.
Years of Experience: 30

Paul Nyenhuis (ManTech SRS), Senior Systems Analyst
B.S. Computer Science, National University
Years of Experience: 17

Karyn Palma (ManTech SRS), Resource Analyst
B.A. Environmental Studies, University of California, Santa Barbara
Years of Experience: 15

Antonio Perez (ManTech SRS), Lead Geospatial Analyst
Geospatial Intelligence Diploma, National Geospatial Intelligence College
Years of Experience: 15

Angela Schnapp (Parsons Infrastructure and Technology), Hazardous Materials / Wastes, Water Quality
B.S., Nuclear Engineering, University of Illinois at Urbana-Champaign, Urbana, Illinois
M.S., Environmental Engineering, University of Illinois at Urbana-Champaign, Urbana, Illinois
Years of Experience: 13

Valorie L. Thompson (Scientific Resources Associated), Air Quality
B.S. Chemistry, Eastern Michigan University
M.S. Chemical Engineering, Purdue University
Ph.D. Chemical Engineering, Purdue University
Years of Experience: 21

Philip Thorson (ManTech SRS), Senior Research Biologist/Marine Mammal Biologist
Ph.D. Biology, University of California at Santa Cruz
Years of Experience: 27

Brian Tucker (ManTech SRS), Project Manager
B.A. University of Notre Dame
J.D. Loyola Law School, Los Angeles
Years of Experience: 21

Karen Waller (ManTech SRS), Vice President/Quality Assurance
B.S. Public and Environmental Affairs, Indiana University
Years of Experience: 20

Brian D. Wauer (ManTech SRS), Director, Range and Environmental Services
B.S. 1983, Administrative Management, University of Arkansas
B.S. 1984, Industrial Management, University of Arkansas
Years of Experience: 22

8 References

This Page Intentionally Left Blank

8 REFERENCES

CHAPTER 1 AND 2

No references in this section

CHAPTER 3

GEOLOGY AND SOILS

Olmstead FH. 1958. Geologic Reconnaissance of San Clemente Island California. Geologic Survey Bulletin 1071-B. Prepared in cooperation with the U.S. Department of the Navy, United States Government Printing Office, Washington, D.C.

Soil Conservation Service. 1982. Soil survey of Channel Islands area, San Clemente Island part, interim report. U.S. Department of Agriculture SCS in cooperation with the Regents of the University of California and the Department of the Navy.

U.S. Department of the Navy [DoN]. 2001. EA on small arms, demolition ranges and training areas for Naval Special Warfare Group One at San Clemente Island, California.

U.S. Department of the Navy. 2002. San Clemente Island integrated natural resources management plan: Final. San Diego, California. Prepared by Tierra Data Systems, Escondido, CA. May.

U.S. Department of the Navy. 2006. San Clemente Island watershed erosion and sediment yield assessment.

U.S. Department of the Navy. 2007. Projected increases in sheet and rill erosion due to military operations Proposed on San Clemente Island. March.

Yatsko A. 1989. Reassessing archaeological site density at San Clemente Island. In Proceedings of the Society for California Archaeology 2:187-204. San Diego, CA.

AIR QUALITY

Aircraft Environmental Support Office. 1990. Summary Tables of Gaseous and Particulate Emissions from Aircraft Engines. AESO Report 6-90. June.

Aircraft Environmental Support Office. 1998a. Aircraft Emission Estimates: AH-1W Landing and Takeoff Cycle and In-Frame, Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9824. October.

Aircraft Environmental Support Office. 1998b. Aircraft Emission Estimates: HH/UH-1N Landing and Takeoff Cycle and In-Frame, Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9904. November.

Aircraft Environmental Support Office. 1999a. Aircraft Emission Estimates: P-3 Landing and Takeoff Cycle and In-Frame, Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9911. January.

Aircraft Environmental Support Office. 1999b. Aircraft Emission Estimates: A-6 Landing and Takeoff Cycle and In-Frame, Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9917. January.

Aircraft Environmental Support Office. 1999c. Aircraft Emission Estimates: C-2 Landing and Takeoff Cycle and In-Frame, Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9919. February.

Aircraft Environmental Support Office. 1999d. Aircraft Emission Estimates: E-2 Landing and Takeoff Cycle and In-Frame, Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9920. February.

Aircraft Environmental Support Office. 1999e. Aircraft Emission Estimates: C-9 and DC-9 Landing and Takeoff Cycle and In-Frame, Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9926. February.

Aircraft Environmental Support Office. 1999f. Aircraft Emission Estimates: H-3 Landing and Takeoff Cycle and In-Frame, Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9927. February.

Aircraft Environmental Support Office. 1999g. Aircraft Emission Estimates: H-60 Landing and Takeoff Cycle and In-Frame, Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9929. February.

Aircraft Environmental Support Office. 1999h. Aircraft Emission Estimates: H-3 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9934. March.

Aircraft Environmental Support Office. 1999i. Aircraft Emission Estimates: C-2 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9936. March.

Aircraft Environmental Support Office. 1999j. Aircraft Emission Estimates: AV-8B Landing and Takeoff Cycle and Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9913. May.

Aircraft Environmental Support Office. 1999k. Aircraft Emission Estimates: A-6 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9941. May.

Aircraft Environmental Support Office. 1999l. Aircraft Emission Estimates: C-9 and DC-9 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9942. May.

Aircraft Environmental Support Office. 1999m. Aircraft Emission Estimates: E-2 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9943. May.

Aircraft Environmental Support Office. 1999n. Aircraft Emission Estimates: F-14 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9945. May.

Aircraft Environmental Support Office. 1999o. Aircraft Emission Estimates: P-3 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9948. May.

Aircraft Environmental Support Office. 1999p. Aircraft Emission Estimates: H-60 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9953. June.

Aircraft Environmental Support Office. 1999q. Aircraft Emission Estimates: S-3 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9954. June.

Aircraft Environmental Support Office. 2000a. Aircraft Emission Estimates: F/A-18 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9933A. March.

Aircraft Environmental Support Office. 2000b. Aircraft Emission Estimates: F/A-18 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9933A. March.

Aircraft Environmental Support Office. 2000c. Aircraft Emission Estimates: F/A-18 Landing and Takeoff Cycle and In-Frame, Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9815, Revision C. February.

Aircraft Environmental Support Office. 2000d. Aircraft Emission Estimates: H-53 Landing and Takeoff Cycle and In-Frame, Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9822, Revision C. February.

Aircraft Environmental Support Office. 2000e. Aircraft Emission Estimates: S-3 Landing and Takeoff Cycle and In-Frame, Maintenance Testing Using JP-5. DRAFT. AESO Memorandum Report No. 9915, Revision A. March.

California Air Resources Board [CARB]. 1997. Southern California Ozone Study.

California Air Resources Board. 2000. 1996 Estimated Annual Average Emissions. South Coast Air Basin. www.arb.ca.gov.

California Air Resources Board. 2000. 1996 Estimated Annual Average Emissions. San Diego Air Basin. www.arb.ca.gov.

California Air Resources Board. 2006. California Almanac of Emissions and Air Quality – 2006 Edition.

California Air Resources Board. 2007a. Current Air Quality Standards. www.arb.ca.gov/research/aaqs/aaqs2.pdf.

California Air Resources Board. 2007b. EMFAC 2007 Model.

California Air Resources Board. 2007c. Speciation Profiles, http://www.arb.ca.gov/ei/speciate/speciate.htm.

Federal Aviation Administration. 2005. EDMS, Version 4.3. July 18.

JJMA. 2001. Emission Factors for Navy Ships. Personal Communication. May.

South Coast Air Quality Management District. 1995. Final Supplemental Environmental Assessment for Proposes Amended Regulation XX–Regional Clean Air Incentives Market (RECLAIM) Program for Oxides of Nitrogen (NO_x) and Oxides of Sulfur (SO_x). August.

South Coast Air Quality Management District. 1997. Final Subsequent Environmental Assessment for Rule 1110.2–Emissions from Gaseous and Liquid-Fueled Engines. SCAQMD No. 970909DWS. October 30.

South Coast Air Quality Management District. 2002. Letter to Martha Gandy from Elaine Chang, Deputy Executive Officer, Planning, Rule Development, and Area Sources. March 13.

South Coast Air Quality Management District. 2005. AQMD 2004-2005 Annual Emissions Report, NALF San Clemente Island. September 22.

South Coast Air Quality Management District. 2007.

U.S. Department of the Navy [DoN]. 1996. Ordnance Data for Toxic Hazards Associated with Pyrotechnic Items, NAVSEA SW050-AC-ORD-010, NAVAIR 11-15-8.

U.S. Environmental Protection Agency [USEPA]. 1992. Procedures for Emission Inventory Preparation Volume IV: Mobile Sources.

U.S. Environmental Protection Agency. 2005a. Ambient Air Quality Standards. www.epa.gov/air/oaqps/greenbk/index.html.

U.S. Environmental Protection Agency. 2006. Compilation of Air Pollutant Emission Factors, Fifth Edition, Chapter 15, Ordnance Detonation.

HAZARDOUS MATERIALS AND WASTES

Brinkley SR, Wilson EB. 1943. Calculation of detonation pressures for several explosives. OSRD 1231.

Cook DS, Spillman E. 2000. Military training ranges as a source of environmental contamination. Federal Facilities Environmental Journal. Summer 27-37, 2000.

Ek H, Dave G, Nilsson E, Sturve J, Birgersson G. 2006. Fate and effects of 2,4,6-trinitrotoluene (TNT) from dumped ammunition in a field study with fish and invertebrates. Archives of Environmental Contamination and Chemistry 51:244-252.

Janes. 2005. Jane's ammunition handbook: 5-inch 54-calibre naval gun ammunition.

Janes. 2006. Jane's air-launched weapons: Mk 80 series general purpose bombs (Mk 81, 82, 83, 84 and BLU-110/111/117).

John H. 1941. British report RC-166 and British report RC-212.

John H. 1943. British report RC-383.

Lotufo GR, Ludy MJ. 2005. Comparative toxicokinetics of explosive compounds in sheepshead minnows. Archives of Environmental Contamination and Toxicology 49:206-214.

Rand Corporation. 2005. Unexploded ordnance cleanup costs: Implications of alternative protocols.

Renner RH, Short JM. 1980. Chemical products of underwater explosions. Naval Surface Weapons Center, Dahlgren, VA. NSWC/WOL. TR 78-87, February.

Rosen G, Lotufo GR. 2005. Toxicity and fate of two munitions constituents in spiked sediment exposures with the marine amphipod *Eohaustorius estuarius*. Environmental Toxicology and Chemistry 24(11): 2887-2897.

Rosen G, Lotufo GR. 2007a. Toxicity of explosive compounds to the marine mussel *Mytilus galloprovincialis*, in aqueous exposures. Ecotoxicology and Environmental Safety, "Highlighted Article."

Rosen G, Lotufo GR. 2007b. Bioaccumulation of explosive compounds in the marine mussel *Mytilus galloprovincialis*. Ecotoxicology and Environmental Safety, "Highlighted Article."

U.S. Army Corps of Engineers [USACE]. 2001a. Sampling for Explosives Residues at Fort Greely, Alaska. November.

U.S. Army Corps of Engineers. 2001b. Characterization of Explosives Contamination at Military Firing Ranges.

U.S. Army Corps of Engineers. 2003. Estimates for explosives residue from the detonation of Army munitions. September.

U.S. Army Corps of Engineers. 2004. Field-portable x-ray fluorescence (FP-XRF) determinations of metals in post-blast ordnance residues. March.

U.S. Army Corps of Engineers. 2007. Explosives residues resulting from the detonation of common military munitions, 2002-2006. February.

U.S. Department of the Navy [DoN]. 1996. Joint standoff weapon (JSOW) baseline, BLU-108, and unitary test and evaluation program at San Clemente Island environmental assessment. U.S. Navy Natural Resources Office North Island Naval Air Station, San Diego and JSOW Project Office China Lake, California. KEA Environmental, Inc., San Diego for Southwest Division Naval Facilities Engineering Command (SWDIV). On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, California.

U.S. Department of the Navy. 1998. Tomahawk flight test operations on the west coast of the United States final environmental impact assessment for Naval Air Warfare Center Weapons Division. Naval Facilities Engineering Command, Southwest Division, San Diego. Tetra Tech, San Francisco and KEA Environmental, Inc., San Diego for Southwest Division Naval Facilities Engineering Command (SWDIV). On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, California.

U.S. Department of the Navy, Naval Facilities Engineering Command Southwest, (2002), Environmental Assessment on Norwegian Anti-ship Missile Flight Test.

U.S. Department of the Navy. 2007. Southern California (SOCAL) Operating Areas Operations Data Book. December

U.S. Environmental Protection Agency [USEPA]. 2004. Preliminary remediation goals. October.

U.S. Environmental Protection Agency. 2006. Method 8330, Appendix A: Collecting and processing of representative samples for energetic residues in solid matrices from military training ranges.

WATER RESOURCES

Allen LG, Bouvier LS, Jensen RE. 1992. Abundance, diversity, and seasonality of cryptic fishes and their contribution to a temperate reef fish assemblage off Santa Catalina Island, California. Bulletin of the Southern California Academy of Sciences 91:55-69.

Bureau of Land Management [BLM]. 1978. Intertidal study of the Southern California Bight—Volume 3. Department of the Interior Contract AA550-CT6-40.

California Cooperative Oceanic Fisheries Investigations [CALCOFI]. 1982. Atlas No. 30. Cooperative Agencies: California Department of Fish and Game; National Oceanic and Atmospheric Administration, National Marine Fisheries Service; University of California Scripps Institute of Oceanography.

California Department of Health Services. 2005. Perchlorate in drinking water: California MCL status. http://www.dhs.ca.gov/ps/ddwem/chemicals/perchl/perchlorate MCL.htm. Updated 17 Oct 2005.

California Division of Mines and Geology. 1986. Geologic map of the mid-southern California continental margin-map 2A (Geology). California Department of Conservation, Division of Mines and Geology.

Coastal Resources Management [CRM]. 1998. San Clemente Island marine resources inventory report—Wilson Cove outfall study, June and August 1997 Surveys. Report by Coastal Resources Management, Corona del Mar, CA for Southwestnavfacengcom, South Bay Area Focus Team, Contract N68711-97-M-8426, San Diego, CA.

Cross JN, Allen LG. 1993. Fishes. In M. D. Dailey, D. J. Reish, and J. W. Anderson, eds. Ecology of the Southern California Bight, a Synthesis and Interpretation. University of California Press, Berkeley, CA. pp 459-540.

Curl HC, O'Donnell K. 1977. Chemical and physical properties of refined petroleum products. NOAA Technical Memorandum ERL MESA-17.

Dailey MD, Reish DJ, Anderson JW. 1993. Ecology of the Southern California Bight, a synthesis and interpretation. University of California Press, Berkeley and Los Angeles, CA.

Engle JM. 1994. Perspectives on the structure and dynamics of nearshore marine assemblages of the California Channel Islands. In The Fourth California Islands Symposium: Update on the Status of Resources. W. L. Halvorson and G. J. Maender, eds. Santa Barbara Musuem of Natural History, Santa Barbara, CA. pp 13-26.

Grovhoug JG. 1992. Evaluation of sediment contamination in Pearl Harbor. Naval Command, Control and Ocean Surveillance Center Technical Report TR-1502. San Diego, CA. 70 pp.

Hoffman DJ, Rattner BA, Burton Jr GA, Cairns Jr J. 1995. Handbook of ecotoxicology. CRC Press, Inc. Boca Raton, Florida. 755 pp.

Johnston RK, Wild WJ, Richter KE, Lapota D, Stang PM, Flor TH. 1989. Navy aquatic hazardous waste sites: The Problem and Possible Solutions. Naval Ocean Systems Center Technical Report TR-1308. San Diego, CA. 50 pp.

Leatherwood S, Stewart BS, Folkens PA. 1987. Cetaceans of the Channel Islands National Marine Sanctuary. U.S. National Oceanic and Atmospheric Administration, Channel Islands National Marine Sanctuary and U.S. National Marine Fisheries Service, Santa Barbara and La Jolla, CA. 69 pp.

Lund SP, Gorsline DS, Henyey TL. 1992. Rock magnetic characteristics of surficial marine sediments from the California continental borderland. Earth and Planetary Science Letters 108:93-107.

Meighan CW. 2000. Overview of the archaeology of SCI, California. Pacific Coast Archaeological Society Quarterly 36(1):1-17.

Monterey Bay Area Research Institute. 2002. www.mbari.org/chemsensor/pteo.htm.

National Centers for Coastal Ocean Science (NCCOS). 2005. A biogeographic assessment of the Channel Islands National Marine Sanctuary: A review of boundary expansion concepts for NOAA's National Marine Sanctuary program. Prepared by NOAA National Centers for Coastal Ocean Science Biogeography Team in cooperation with the National Marine Sanctuary Program. Silver Springs, MD. NOAA Technical Memorandum NOS NCCOS 21. 215 pp.

National Oceanographic and Atmospheric Administration. 1999. Sediment Quality Guidelines Developed for the National Status and Trends Program.

National Park Service [NPS]. 1985. Channel Islands National Park general management plan. Prepared and published for Channel Islands National Park, Lakewood, CA. Jan.

National Research Council. 1985. Oil in the sea: Inputs, fates, and effects. National Academy Press.

Regional Water Quality Review Board. 1994. Basin plan for the coastal watersheds of Los Angeles and Ventura Counties. California Regional Water Quality Control Board. Los Angeles, CA.

Science Applications International Corporation [SAIC] and MEC. 1995. Monitoring assessment of long-term changes in biological communities in the Santa Maria Basins: Phase III, final report.

Shineldecker CL. 1992. Handbook of environmental contaminants: A guide for site assessment. Lewis Publishers, Inc. Chelsea, Michigan. 367 pp.

Southern California Coastal Water Research Project. 2003. Southern California Bight 1998, regional monitoring program, executive summary.

State Water Resources Control Board [SWRCB]. 2001. Ocean waters of California water quality control plan.

State Water Resources Control Board. 2005. Ocean plan; water quality control plan, ocean waters of California.

State Water Resources Control Board and Cal-EPA. 1997. Functional equivalent document, amendment of the water quality control plan for ocean waters of California: California ocean plan.

Tait RV. 1980. Elements of marine ecology. Third Edition. University Press, Cambridge.

U.S. Air Force. 1997. Environmental effects of self-protection chaff and flares. U.S. Air Force, Headquarters Air Combat Command, Langley Air Force Base, VA. var. p. NTIS PB98-110620.

U.S. Department of the Navy [DoN]. 1954. Feasibility study at San Clemente Island. Prepared by Porter, Urquhart and Beavin–Consulting Engineers.

U.S. Department of the Navy. 1993a. Naval Auxiliary Landing Filed San Clemente Island compatibility study: Land use, operations and natural resource compatibility report. KTU&A, Contract Number N68711-91-C-0035 for Southwest Division Naval Facilities Engineering Command (SWDIV). On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, California.

U.S. Department of the Navy. 1993b. Report on continuing action: standard range sonobuoy quality assurance program, San Clemente Island, California. Program Executive Office, Antisubmarine Warfare.

U.S. Department of the Navy. 1996a. EA for Joint standoff weapon (JSOW) baseline, BLU-108, and unitary test and evaluation program at San Clemente Island environmental assessment. U.S. Navy Natural Resources Office North Island Naval Air Station, San Diego and JSOW Project Office China Lake, California. KEA Environmental, Inc., San Diego for Southwest Division Naval Facilities Engineering Command (SWDIV). On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, California.

U.S. Department of the Navy. 1996b. Draft Environmental Assessment of the Use of Selected Navy Test Sites for Development Tests and Fleet Training Exercises of the MK-46 and MK-50 Torpedoes. (U) (CONFIDENTIAL). Program Executive Office Undersea Warfare, Program Manager for Undersea Weapons.

U.S. Department of the Navy. 1996c. Environmental Assessment of the Use of Selected Navy Test Sites for Development Tests and Fleet Training Exercises of the MK-48 Torpedoes. (U) (CONFIDENTIAL). Program Executive Office Undersea Warfare, Program Manager for Undersea Weapons.

U.S. Department of the Navy. 1997. Biological assessment: Establishment of an island night lizard management area on San Clemente Island. Prepared by R. Church, J. Larson, L. Murphy, and A. Yatsko, Natural Resources Office, Staff Civil Engineer, Naval Air Station, North Island, San Diego, CA.

U.S. Department of the Navy. 1998. Tomahawk flight test operations on the west coast of the United States final environmental impact assessment for Naval Air Warfare Center Weapons Division. Naval Facilities Engineering Command, Southwest Division, San Diego. Tetra Tech, San Francisco and KEA Environmental, Inc., San Diego for Southwest Division Naval Facilities Engineering Command (SWDIV). On file, Navy

Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, California.

U.S. Department of the Navy. 1999. Southern California offshore range users manual. FACSFACDINST 3550.1. Naval Air Station North Island, San Diego, CA.

U.S. Department of the Navy. 2000. San Diego Bay integrated natural resources management plan. U.S. Department of the Navy, Southwest Division, San Diego.

U.S. Department of the Navy, Naval Facilities Engineering Command Southwest, (2002), Environmental Assessment on Norwegian Anti-ship Missile Flight Test.

U.S. Department of the Navy. 2005. Final environmental assessment, San Clemente Island wastewater treatment plant outfall project.

U.S. Department of the Navy. 2006. Final environmental assessment, San Clemente Island wastewater treatment plant increase in maximum allowable discharge volume.

U.S. Department of the Navy. 2007. OPNAVINST 5090.1C. October

U.S. Environmental Protection Agency [USEPA]. 1986. National ambient water quality criteria.

ACOUSTIC ENVIRONMENT

Burgess and Greene 1998

ISE, 1999. Larson Davis Model 700 ANSI Type 2 Integrating Sound Level Meters measurements taken on 13 and 14 January 1999.

U.S. Department of the Navy [DoN]. 2002. Final EIS/OEIS, Point Mugu Sea Range. March.

U.S. Department of the Navy. 2005. Final environmental assessment for replacement of EA-6B aircraft with EA-18G aircraft at Naval Air Station Whidbey Island, Washington. January.

Wyle. 2008. Aircraft Noise Study for the Introduction of the P-8A Multi-Mission Maritime Aircraft into the Fleet.

MARINE PLANTS AND INVERTEBRATES

Abbott IA, Hollenberg GJ. 1976. Marine algae of California. Stanford, California: Stanford University Press.

Adams AJ, Locascio JV, Robbins BD. 2004. Microhabitat use by a post-settlement stage estuarine fish: Evidence from relative abundance and predation among habitats. Journal of Experimental Marine Biology and Ecology 299:17-33.

Au WWL, Banks K. 1998. "The acoustics of the snapping shrimp *Synalpheus parneomeris* in Kaneohe Bay." Journal of the Acoustical Society of America 103:41-47.

Bernal PA, McGowan JA. 1981. Advection and upwelling in the California current. In Coastal Upwelling. F.A. Richards, ed. Amer. Geophys. Union. Washington, D.C. pp. 381-399.

Blecha JB, Steinbeck JR, Sommerville DC. 1992. Aspects of the biology of the black abalone (*Haliotis cracherodii*) near Diablo Canyon, central California. In: Abalone of the World: Biology, Fisheries and Culture. Proceedings of the First International Symposium on Abalone (Ed. By S.A. Sheperd, M.J. Tegner and S.A. Guzman del Proo). Blackwell Scientific Publications, Inc. Cambridge. pp 225-237.

Brinton E. 1981. Euphausid distributions in the California Current during the warm winter-spring of 1977-78, in the context of a 1949-1966 time series. California Cooperative Oceanic Fisheries Investigations Reports 22: 135-154.

Brinton E. 1976. Population biology of *Euphausia pacifica* off southern California. Fishery Bulletin, U.S. 74: 733-762.

Budelmann BU. 1992a. "Hearing by Crustacea." In Evolutionary Biology of Hearing, eds. D.B. Webster, R.R. Fay, and A.N. Popper, 131-139. New York: Springer Verlag.

Budelmann BU. 1992b. "Hearing in nonarthropod invertebrates." In Evolutionary Biology of Hearing, eds. D.B. Webster, R.R. Fay, and A.N. Popper, 141-155. New York: Springer Verlag.

Bureau of Land Management [BLM]. 1977. Southern California baseline study, intertidal, year two final report volume III, report 1.4: Kelp survey of the Southern California Bight.

Bureau of Land Management. 1978. Intertidal study of the Southern California Bight volume 3. Department of the Interior Contract AA550-CT6-40.

Bushing W. 1995. Indentifying regions of giant kelp (*Macrocystis pyrifera*) around Santa Catalina Island for designation as marine reserves. In Proc. 15th ESRI User Conference. May 21-26, 1995, Palm Spring, CA. http://www.catalinas.net/seer/research/respaper.htm. 21 Dec 1998.

Bythell JC. 1986. A guide to the identification of the living corals (Scleractinia) of southern California. Occasional Papers of the San Diego Society of Natural History. 16:1-40.

Cairns SD. 1994. Scleractinia of the temperate North Pacific. Washington, D.C.: Smithsonian Institution Press.

Cairns, S.D. 1999. Species richness of recent Scleractinia. Atoll Research Bulletin. 459:1-46.

California Department of Fish and Game [CDFG]. 2002. Descriptions and evaluations of existing California marine protected areas June 1, 2002 (updated June 2003). Sacramento: California Department of Fish and Game.

California Department of Fish and Game. 2003. California marine protected areas database. Accessed 22 Jun 2004. http://www.geog.ucsb.edu/~jeff/projects/mpa/.

California Department of Fish and Game. 2005. Abalone recovery and management plan. www.dfg.ca.gov/mrd/armp/index.html.

California Exotic Pest Plant Council [CalEPPC]. 1999. Exotic pest plants of greatest ecological concern in California. Accessed 31 Aug 2005._http://ucce.ucdavis.edu/files/filelibrary/5319/4898.pdf.

Channel Islands National Park [CINP]. 2005. 2004 Annual report and final report: Naval Auxiliary Landing Field San Clemente Island, kelp forest monitoring. Prepared for SWDIV NAVFACENGCOM, Contract #N68711-01-LT-01038.

Chess JR, Hobson ES. 1997. Benthic invertebrates of four southern California marine habitats prior to onset of ocean warming in 1976, with lists of fish predators. NOAA Technical Memorandum NMFS-SWFSC-243. La Jolla, California: Southwest Fisheries Science Center.

Coastal Resources Management [CRM]. 1998. San Clemente Island marine resources inventory report–Wilson Cove outfall study, June and August 1997 surveys. Report by Coastal Resources Management, Corona del Mar, CA for Southwestnavfacengcom, South Bay Area Focus Team, Contract N68711-97-M-8426, San Diego, CA.

Dailey MD, Anderson JW, Reish DJ, Gorsline DS. 1993. The Southern California Bight: background and setting. In M.D. Dailey, D.J. Reish, and J.W. Anderson, eds. Ecology of the Southern California Bight. Berkeley: University of California Press. pp 1-18.

Davis GE, Haaker PL, Richards DV. 1996. Status and trends of white abalone at the California Channel Islands. Transactions of the American Fisheries Society 125:42-48.

Davis GE, Haaker PL, Richards DV. 1998. The perilous condition of white abalone, *Haliotis sorenseni*, Bartsch, 1940. Journal of Shellfish Research 17(3):871-875.

Dayton PK. 1985. Ecology of kelp communities. Annual Review of Ecology and Systematics 16:215-245.

Dayton PK, Tegner MJ, Parnell PE, Edwards PB. 1992. Temporal and spatial patterns of disturbance and recovery in a kelp forest community. Ecological Monographs 62(3):421-445.

Den Hartog C. 1970. The Seagrasses of the World. Amsterdam, North-Holland Publishers.

Department of Fisheries and Oceans (DFO). 2004. "Potential impacts of seismic energy on snow crabs." Habitat Status Report 2004/003. Fisheries and Oceans Canada, Gulf Region.

Deysher LE, Dean TA, Grove RS, Jahn A. 2002. Design considerations for an artificial reef to grow giant kelp (*Macrocystis pyrifera*) in Southern California. ICES Journal of Marine Science 59:S201-S207.

Douros WJ. 1985. Density, growth, reproduction and recruitment in an intertidal abalone: effects of intraspecific competition and prehistoric predation. Msc thesis, University of California, Santa Barbara.

Dugan JE, Hubbard DM, Engle JM, Martin DL, Richards DM, Davis GE, Lafferty KD, Ambrose RF. 2000. Macrofauna communities of exposed sandy beaches on the southern California mainland and Channel Islands. Fifth California Islands Symposium, OCS Study, MMS 99-0038. pp 339-346.

Edwards M, Foster M. 1996. Monterey Bay National Marine Sanctuary site characterization. Kelp Forest & Rocky Subtidal Habitats. Accessed 20 Jun 2005. http://bonita.mbnms.nos.noaa.gov/sitechar/main.html.

Edwards MS, Hernández-Carmona G. 2005. Delayed recovery of giant kelp near its southern range limit in the North Pacific following El Niño. Marine Biology 147:273-279.

Engle, J. M., 1994. Perspectives on the structure and dynamics of nearshore marine assemblages of the California Channel Islands. In W. L. Halvorson and G. J. Maender (eds.), The Fourth California Islands Symposium: Update on the Status of Resources. Santa Barbara Museum of Natural History (Santa Barbara, CA). pp. 13-26.

Engle JM, Adams SL. 2003. Rocky intertidal resource dynamics in San Diego County: Cardiff, La Jolla, and Point Loma, sixth year report (2002/2003). Prepared by Marine Science Institute, University of California, Santa Barbara for AMEC Earth and Environmental, Inc. and U.S. Navy.

Engle JM, Miller KA. 2005. Distribution and Morphology of Eelgrass (*Zostera marina*) at eh California Channel Islands. Proceeding of the Sixth California Islands Symposium. D.K. Garcelon and C.A. Schwemmm (eds.). National Park Service Technical Publication CHIS-05-01, Institute for Wildlife Studies, Arcata, California.

Estrada M, Blasco D. 1979. Two phases of the phytoplankton community in the Baja California upwelling. Limnology and Oceanography 24:1065-1080.

Etnoyer P, Morgan L. 2003. Occurrences of habitat-forming deep sea corals in the northeast Pacific Ocean: A report to NOAA's office of habitat conservation. Redmond, Washington: Marine Conservation Biology Institute.

Etnoyer P, Morgan LE. 2005. Habitat-forming deep-sea corals in the Northeast Pacific Ocean. In A. Freiwald, and J.M. Roberts, eds. Cold-water corals and ecosystems. Berlin Heidelberg: Springer-Verlag. pp 331-343.

Fiedler PC, Reilly SB, Hewitt RP, Demer D, Philbrick VA, Smith S, Armstrong W, Croll DA, Tershy BR, Mate BR. 1998. Blue whale habitat and prey in the California Channel Islands. Deep-Sea Research II 45:1781-1801.

Foster MS, Schiel DR. 1985. The ecology of giant kelp forests in California: A community profile. U.S. Fish and Wildlife Service Biological Report 85(7.2). Slidell, Louisiana: U.S. Fish and Wildlife Service.

Friedman CS, Andree KB, Beauchamp KA, Moore JD, Robbins TT, Shields JD, Hedrick RP. 2000. *Candidatus Xenohaliotis californiensis*, a newly described pathogen of abalone, *Haliotis* spp., along the west coast of North America. International Journal of Systematic Evolution and Microbiology 50: 487-855.

Graham MH. 1997. Factors determining the upper limit of giant kelp, *Macrocystis pyrifera* Agardh, along the Monterey Peninsula, central California, USA. Journal of Experimental Marine Biology and Ecology 218:127-149.

Green EP, Short FT. 2003. World atlas of seagrasses. Prepared by the UNEP World Conservation Monitoring Centre. University of California Press, Berkeley, USA.

Grossman C, Great Escape Charters [GEC]. 1998. Deep offshore reefs Southern California deep reef and wreck diving on the Great Escape live aboard dive boat. Accessed 21 March 2005. http://www.diveboat.com/deep_reef_and_wreck_diving.shtml.

Guerra A, Gonzalez AF, Rocha F, Gracia Ecobiomar J. 2004. “Calamares gigantes varados. Victimas de exploraciones acústicas.” Investigación y Ciencia July:35-37.

Haaker PL, Henderson KC, Parker DO. 1986. California abalone. Marine Resources Leaflet No. 11. State of California Department of Fish and Game, Marine Resources Division, Long Beach, CA.

Haaker PL, Richards DV, Friedman CS, Davis GE, Parker DO, Togstad HA. 1992. Mass mortality and withering syndrome in black abalone, *Haliotis cracherodii* in California. In Abalone of the World: Biology, Fisheries, and Culture. Proceedings in the First International Symposium on Abalone (ED. By S.A. Sheperd, M.J. Tegner and S.A. Guzman del Proo). Blackwell Scientific Publications, Inc. Cambridge. Pp 214-224.

Haaker PL, Karpov K, Rogers-Bennett L, Taniguchi I, Friedman CS, Tegner MJ. Abalone. 2001. In W.S. Leet, C.M. Dewees, R. Klingbeil, and E.J. Larson, eds. California’s living marine resources: A status report. California Department of Fish and Game SG01-11. pp 89-97.

Hardy JT. 1993. Phytoplankton. In M.D. Dailey, D.J. Reish, and J.W. Anderson, eds. Ecology of the Southern California Bight. Berkeley: University of California Press. pp 233-265.

Heberholz J, Schmitz BA. 2001. “Signaling via water currents in behavioral interactions of snapping shrimp (*Alpheus heterochaelis*).” Biological Bulletin 201:6-16.

Hellberg ME, Taylor MS. 2002. Genetic analysis of sexual reproduction in the dendrophylliid coral Balanophyllia elegans. Marine Biology 141:629-637.

Hernández-Carmona G, Robledo D, Serviere-Zaragoza E. 2001. Effect of nutrient availability on Macrocystis pyrifera recruitment and survival near its southern limit off Baja California. Botanica Marina. 44:221-229.

Hobday AJ, Tegner MJ. 2000. Status review of white abalone (*Haliotis sorenseni*) throughout its range in California and Mexico. NOAA Technical Memorandum NOAATM-NMFS-SWR-035. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. National Marine Fisheries Service—Southwest Region Office.

Hobday AJ, Tegner MJ, Haaker PL. 2001. Over-exploitation of a broadcast spawning marine invertebrate: Decline of the white abalone. Reviews in Fish Biology and Fisheries 10:493-514.

Howorth PC. 1978. The abalone book. Naturegraph Publishers. Happycamp, California.

Kantrud HA. 1991. Wigiongrass (*Ruppia maritima L*.): A literature review. U.S. Fish and Wildlife Service, Fish and Wildlife Research 10. Jamestown, ND, Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/literatr/ruppia/ruppia.htm (Version 16JUL97).

Karpov KA, Haaker PL, Taniguchi IK, Rogers-Bennett L. 2000. Serial depletion and the collapse of the California abalone fishery. In: A. Campbell, editor. Workshop on rebuilding abalone stocks in British Columbia. Canadian Spec. Publ., Fish. and Aquat. Sci. pp. 11–24.

Kushner DJ, Lerma D, Shaffer J, Hajduczek B. 1999. Kelp forest monitoring annual report 1999. National Park Service Channel Islands National Park Technical Report CHIS-01-05. Ventura, California: Channel Islands National Park.

Lafferty KD, Behrens MD, Davis GE, Haaker PL, Kusher DJ, Richards DV, Taniguchi IK, Tegner MJ. 2004. Habitat of endangered white abalone, *Haliotis sorenseni*. Biol. Cons. 116:191-19

Lafferty KD, Kuris AM. 1993. Mass mortality of abalone *Haliotis cracherodii* on the California Channel Islands: tests of epidemiological hypotheses. Mar. Ecol. Prog. Ser. 96: 239-248.

Lagardère J-P. 1982. “Effects of noise on growth and reproduction of *Crangon crangon* in rearing tanks.” Marine Biology 71:177-185.

Lagardère J-P, Régnault MR. 1980. “Influence du niveau sonore de bruit ambient sur la métabolisme de *Crangon crangon* (Decapoda: Natantia) en élevage.” Marine Biology 57:157-164.

Latha G, Senthilvadivu S, Venkatesan R, Rajendran R. 2005. “Sound of shallow and deep water lobsters: Measurements, analysis, and characterization (L).” Journal of the Acoustical Society of America 117:2720-2723.

Leet WS, Dewees CM, Klingbeil R, Larson EJ. 2001. California's living marine resources: status report. California Department of Fish and Game.

Lissner A. 1988. Biological reconnaissance of selected benthic habitats within three California OCS planning areas: Final report on review of recovery and recolonization of hard substrate communities of the outer continental shelf. OCS Study MMS 88-0034. San Diego, California: Minerals Management Service, Pacific OCS Region.

Littler MM. 1980. Overview of the rocky intertidal systems of Southern California. In D.M. Power, ed. The California islands: Proceedings of a multidisciplinary symposium. Santa Barbara, California: Santa Barbara Museum of Natural History. pp 265-306.

Long ER, Morgan LG. 1991. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, National Oceanic and Amospheric Administration, Seattle, WA, 175 pp.

Long ER, MacDonald DD, Smith SL, Calder FD. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ Manage 19: 81-97.

McArdle DA. 1997. California marine protected areas. La Jolla, California, California Sea Grant College System, University of California.

McCauley RD, Fewtrell J, Duncan AJ, Jenner C, Jenner M-N, Penrose JD, Prince RIT, Adhitya A, Murdoch J, McCabe C. 2000. “Marine Seismic Surveys: Analysis and Propagation of Air Gun Signals; and Effects of Air-Gun Exposure on Humpback Whales, Sea Turtles, Fishes and Squid.” Report R99-15 prepared by Centre for Marine Science and Technology, Curtin University of Technology, Western Australia for Australian Petroleum Production and Exploration Association.

McConnaughey BH, McConnaughey E. 1985. Pacific coast. New York, New York: Alfred A. Knopf.

Miner CM, Altstatt JM, Raimondi PT, Minchinton TE. 2006. Recruitment failure and shifts in community structure following mass mortality limit recovery prospects of black abalone. Marine Ecology Progress Series 327:107–117.

Minerals Management Service [MMS]. 2001. Delineation drilling activities in federal waters offshore Santa Barbara, California. Draft Environmental Impact Statement. OCS Study MMS-2001-046. Camarillo, California: Minerals Management Service.

Morris RH, Abbott DP, Haderlie EC. 1980. Intertidal invertebrates of California. Standford University Press, Stanford.

Murray SN, Bray RN. 1993. Benthic macrophytes. Ecology of the Southern California Bight. M. D. Dailey, D. J. Reish and J. W. Anderson. Berkeley, University of California Press: 304-368.

Murray SN, Littler MM. 1981. Biogeographical analysis of intertidal macrophyte floras of southern California. Journal of Biogeography 8:339-351.

Murray SN, Littler MM, Abbott IA. 1980. Biogeography of California marine algae with emphasis on the southern California islands. In D. M. Power, ed. The California Islands: Proceedings of a Multi-disciplinary Symposium. Santa Barbara Museum of Natural History, Santa Barbara, California. Pp 325-339.

National Research Council. 1985. Oil in the sea: Inputs, fates, and effects. National Academy Press.

NAWCWPNS Point Mugu, 1994. Environmental assessment for the joint standoff weapon (JSOW) baseline test program. Prepared by the Naval Air Warfare Center, Weapons Division by Pacific Northwest Laboratory. September. Point Mugu, CA.

NAWCWPNS Point Mugu. 1998. Environmental assessment (EA) for the Tomahawk flight test operations on the west coast of the United States. San Diego, CA. June.

National Estuarine Research Reserve System [NERRS]. 2004a. National estuarine research reserve system. Accessed 3 Jun 2004. http://nerrs.noaa.gov/.

National Estuarine Research Reserve System. 2004b. Tijuana River Reserve, California. Accessed 3 Jun 2004. ttp://www.nerrs.noaa.gov/TijuanaRiver/welcome.html.

National Marine Fisheries Service [NMFS]. 2001. Endangered and threatened species: Endangered status for white abalone. Federal Register 66(103):29046-29055.

National Marine Fisheries Service. 2006. White Abalone Recovery Plan (*Haliotis sorenseni*), Draft. National Marine Fisheries Service, Long Beach, CA.

National Oceanic and Atmospheric Administration [NOAA]. 2001. Seagrasses of the United States of America (including U.S. Territories in the Caribbean), NOAA Coastal Services Center.

National Oceanic and Atmospheric Administration. 2002. NGDC coastal relief model, Volume 06, version 4.1: Southern California coast [Online]. Available by National Geophysical Data Center. CD.

National Oceanic and Atmospheric Administration. 2003. Channel Islands. Accessed 4 Jun 2004. http://sanctuaries.noaa.gov/oms/omschannel/omschannel.html.

National Oceanic and Atmospheric Administration. 2004a. Inventory of sites-Status of the inventory. Accessed 4 Jun 2004. http://mpa.gov/inventory/status.html.

National Oceanic and Atmospheric Administration. 2004b. Welcome. Accessed 4 Jun 2004. http://www.sanctuaries.nos.noaa.gov/welcome.html.

National Oceanic and Atmospheric Administration. 2004c. Channel Islands National Marine Sanctuary. Accessed 4 Jun 2004. http://channelislands.noaa.gov/drop_down/reg.html.

National Oceanic and Atmospheric Administration. 2004d. Marine managed areas inventory data download. Accessed 22 Feb 2005. http://www3.mpa.gov/exploreinv/download.aspx.

National Ocean Service [NOS]. 1980. Environmental sensitivity index maps, San Clemente Island; Maps SC 49, 50 and 51. National Ocean Service, NOAA, Silver Spring, MD. http://mapindex.nos.noaa.gov. 1 Jan 1999.

National Park Service [NPS]. 2004a. Cabrillo National Monument. Accessed 4 Jun 2004. http://www.nps.gov/cabr/.

National Park Service. 2004b. Channel Islands National Park. Accessed 3 Jun 2004. http://www.nps.gov/chis/homepage.htm.

National Park Service. 2004c. National Park Service Boundaries. Accessed 16 Jun 2004. http://www.nps.gov/gis/national_data.htm .

Nybakken JW. 1988. Marine Biology: An ecological approach. Second Edition. Harper and Row, Publishers. New York. 514pp.

Pacific Fishery Management Council [PFMC]. 1998. The coastal pelagic species fishery management plan draft amendment eight. pp A78-A90.

Packard A, Karlsen HE, Sand O. 1990. “Low frequency hearing in cephalopods.” Journal of Comparative Physioilogy A, 166:501-505.

Parry GD, Gason A. 2006. “The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia.” Fisheries Research 79:272-284.

Phillips RC, Meñez EG. 1988. Seagrasses. Smithsonian contributions to the Marine Sciences 34:1-104.

Popper AN, Salmon M, Horch KW. 2001. “Acoustic detection and communication by decapod crustaceans.” Journal of Comparative Physiology A 187:83-89.

Ramirez-Garcia P, Terrados J, Ramos F, Lot A, Ocana D, Duarte CM. 2002. Distribution and nutrient limitation of surfgrass, *Phyllospadix scouleri* and *Phyllospadix torreyi*, along the Pacific coast of Baja California (Mexico). Aquatic Botany 74:121-131.

Richards DV, Davis GE. 1993. Early warnings of modern population collapse in black abalone *Haliotis cracherodii*, Leach, 1814 at the California Channel Islands. Journal of Shellfish Research 12(2): 189-194.

Richards D, Avery W, Kushner D. 1990. Kelp forest monitoring Channel Islands National Park. Ventura, CA: Channel Islands National Park.

Roberts S, Hirshfield M. 2004. Deep-sea corals: out of sight, but no longer out of mind. Frontiers in Ecology and the Environment 2:123-130.

Rodriguez AR. 2003. Consumption of drift kelp by intertidal populations of the sea urchin Tetrapygus niger on the central Chilean coast: Possible consequences at different ecological levels. Marine Ecology Progress Series 251:141-151.

Rodriguez S, Santiago ART, Shenker G. 2001. A public-access GIS-based model of potential species habitat distribution for the Santa Barbara Channel and the Channel Islands National Marine Sanctuary, Donald Bren School of Environmental Science and Management: 130 pp.

Rogers A. 1999. The biology of *Lophelia pertusa* (Linnaeus 1758) and other deep-water reef-forming corals and impacts from human activities. International Review of Hydrobiology 84(4):315-410.

Rogers-Bennett L, Haaker PL, Huff TO, Dayton PK. 2002. Estimating baseline abundances of abalone in California for restoration. CalCOFI Rep. 43:97–111.

Roper CFE, Sweeney MJ, Nauen CE. 1984. FAO Species Catalogue. Vol. 3, Cephalopods of the world, and species of interest to fisheries. FAO Fisheries Synopsis 3: 1-277.

Sandwell DT, Smith WHF, Smith SM, Small C. 2004. Global topography: Measured and estimated seafloor topography. Accessed 21 Feb 2005. http://topex.ucsd.edu/marine_topo/ martopo.html.

Science Applications International Corporation [SAIC] and MEC. 1995. Monitoring assessment of long-term changes in biological communities in the Santa Maria Basins: Phase III, final report.

Smith D. 1977. A guide to marine coastal plankton and marine invertebrate larvae. Kendall/Hunt Publishing Co, Dubuque, IO.

Sousa WP. 1984. The role of disturbance in natural communities. Annual Review of Ecology and Systematics 15:353–391.

Sousa WP. 2001. Natural disturbance and the dynamics of marine benthic communities. In: Bertness, M.D., Gaines, S.D., Hay, M.E. (Eds.), Marine Community Ecology. Sinauer Associates, Sunderland, MA. pp 85– 130.

Spalding MD, Ravilious C, Green EP. 2001. World atlas of coral reefs. Berkeley, California: University of California Press.

Steneck RS, Graham MH, Bourque BJ, Corbett D, Erlandson JM, Estes JA, Tegner MJ. 2002. Kelp forest ecosystems: Biodiversity, stability, resilience, and future. Environmental Conservation 29(4):436-459.

Tegner MJ, Dayton PK, Edwards PB, Riser KL. 1996. Is there evidence for long-term climatic change in southern California kelp forests? CalCOFI Reports 37:111-126.

TerraLogic GIS, Copps S. 2004. Pacific coast groundfish essential fish habitat project. Consolidated GIS data, Vol. 1: Physical and Biological Habitat. Stanwood, Washington: TerraLogic GIS.

Thayer GW, Bjorndal KA, Ogden JC, Williams SL, Zieman JC. 1984. Role of larger herbivores in seagrass communities. Estuaries 7(4A):351-376.

Thompson B, Dixon J, Schroeter S, Reish DJ. 1993. Benthic invertebrates. In M.D. Dailey, D.J. Reish, and J.W. Anderson, eds. Ecology of the Southern California Bight. Berkeley: University of California Press. pp 369-458.

U.S. Department of the Navy [DoN]. 1993. Naval Auxiliary Landing Filed San Clemente Island Compatibility Study: Land use, operations and natural resource compatibility report. KTU&A, Contract Number N68711-91-C-0035 for Southwest Division Naval Facilities Engineering Command (SWDIV). On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, California.

U.S. Department of the Navy. 1995. Final environmental impact statement for the development of facilities in San Diego/Coronado to support the homeporting of one NIMITZ class aircraft carrier. Prepared by Ogden Environmental and Energy Services, San Diego, CA. October.

U.S. Department of the Navy. 1999. Environmental assessment for the plasma sound source (PSS) ocean test. San Diego, Space and Naval Warfare Systems Command.

U.S. Department of the Navy. 2000. San Diego Bay integrated natural resources management plan. U.S. Department of the Navy, Southwest Division, San Diego.

U.S. Department of the Navy. 2002. San Clemente Island integrated natural resources management plan draft final, October 2001. Prepared for the U.S. Department of the Navy, Southwest Division (USDON, SWDIV), San Diego, CA by Tierra Data Systems, Escondido, CA.

U.S. Department of the Navy. 2004b. San Diego Bay 2004 eelgrass survey. San Diego: Naval Facilities Engineering Command, Southwest Division.

U.S. Department of the Navy. 2007. Naval Auxiliary Landing Field, San Clemente Island area of special biological significance biological survey report. Naval Facilities Engineering Command, Southwest Division Contract #N68711-03-D-7001, Delivery Order No. 18 and 25. February.

U.S. Fish and Wildlife Service [USFWS]. 2005. U.S. Fish and Wildlife Service: FWS geospatial data sources. Accessed 7 Apr 2005. http://www.fws.gov/data/datafws.htm .

U.S. Geological Survey [USGS]. 2004. Channel Island National Marine Sanctuary GIS. Accessed 16 Jun 2004. ttp://coastalmap.marine.usgs.gov/regional/contusa/westcoast/socal/cinms/.

Veron J. 2000. Corals of the world. Volume 1. Townsville, Australia: Australian Institute of Marine Science.

Walder RR, Foster MS. 2000. Recovery of rocky intertidal assemblages following the wreck and salvage of the F/V Trinity. Final Report: Years 1 and 2. June.

Walsh JJ, Whitledge TE, Kelley JC, Huntsman SA, Pillsbury RD. 1977. Further transition states of the Baja California upwelling ecosystem. Limnology and Oceanography 22:264-280.

Waterproof Charts, Inc. 2003. Southern California and Baja fish/dive waterproof chart #88F. Punta Gorda, Florida: Waterproof Charts, Inc.

Wilson M., Hanlon RT, Tyack PL, Madsen PT. 2007. "Intense ultrasonic clicks from echolocating toothed whales do not elicit anti-predator responses or debilitate the squid *Loligo pealeii*." Biology Letters 3:225-227.

Young RE. 1972. The systematics and areal distribution of pelagic cephalopods from the seas off Southern California. Smithson. Contr. Zool. 97: 1-159.

Zimmerman RC. 2003. A biooptical model of irraciance distribution and photosynthesis in seagrass canopies. Limnology and Oceanography 48(1, part 2):568-585.

FISH

Abbott R, Bing-Sawyer E, Blizard R. 2002. "Assessment of pile driving impacts on the Sacramento blackfish (Orthodon microlepidotus)." Draft report prepared for Caltrans District 4, Oakland, California.

Abbott R, Reyff J, Marty G. 2005. "Monitoring the effects of conventional pile driving on three species of fish." Final report prepared by Strategic Environmental Consulting, Inc. for Manson Construction Company, Richmond, California.

Allen LG. 1985. A habitat analysis of the nearshore marine fishes from southern California. Bulletin of the Southern California Academy of Sciences 84:133-155.

Allen MJ, Herbinson KT. 1991. Beam-trawl survey of bay and nearshore fishes of the soft-bottom habitat of southern California in 1989. Calif. Coop. Oceanic Fish. Invest. Rep. 32:112–127.

Allen LG, Bouvier LS, Jensen RE. 1992. Abundance, diversity, and seasonality of cryptic fishes and their contribution to a temperate reef fish assemblage off Santa Catalina Island, California. Bulletin of the Southern California Academy of Sciences 91:55-69.

Amoser S, Ladich F. 2003. Diversity in noise-induced temporary hearing loss Journal of the Acoustical Society of America 113 (4(1)):2170-2179.

Amoser S, Ladich F. 2005. Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? The Journal of Experimental Biology 208: 3533-3542.

Aplin JA. 1947. "The effect of explosives on marine life." California Fish and Game 33:23-30.

Astrup J. 1999. Ultrasound detection in fish—a parallel to the sonar-mediated detection of bats by ultrasound-sensitive insects? Comparative Biochemistry and Physiology Part A 124: 19-72.

Astrup J, Møhl B. 1993. Detection of intense ultrasound by the cod *Gadus morhua*. Journal of Experimental Biology 182:71–80.

Atema J, Fay RR, Popper AN, Tavolga WN, eds. 1988. Sensory Biology of Aquatic Animals. New York: Springer Verlag.

Atema J, Kingsford MJ, Gerlach G. 2002. "Larval reef fish could use odour for detection, retention and orientation to reefs." Marine Ecology Progress Series 241:151-160.

Au WWL, Banks K. 1998. "The acoustics of the snapping shrimp *Synalpheus parneomeris* in Kaneohe Bay." Journal of the Acoustical Society of America 103:41-47.

Banner A, Hyatt M. 1973. “Effects of noise on eggs and larvae of two estuarine fishes.” Transactions of the American Fisheries Society 102(1):134-136.

Bennett DH, Falter CM, Chipps SR, Niemela K, Kinney J. 1994. “Effects of underwater sound stimulating the intermediate scale measurement system on fish and zooplankton of Lake Pend Oreille, Idaho.” Research Report prepared by College of Forestry, Wildlife and Range Sciences, University of Idaho for Office of Naval Research, Arlington Virginia, Contract N00014-92-J-4106.

Blunt CE (ed). 1980. Atlas of California coastal marine resources. State of California, Resources Agency and Department of Fish and Game, Sacramento, CA. 134 pp.

Bodkin JL. 1988. Effects of kelp forest removal on associated fish assemblages in central California. Journal of Experimental Marine Biology and Ecology 117:227-238.

Bodkin JL, VanBlaricon GR, Jameson RJ. 1987. Mortalities of kelp-forest fishes associated with large oceanic waves off central California, 1982-1983. Environmental Biology of Fishes 18:73-76.

Booman C, Dalen H, Heivestad H, Levsen A, van der Meeren T, Toklum K. 1996. “Effekter av luftkanonskyting pa egg, larver og ynell.” Havforskningsinstituttet, Issn 0071-5638.

Brown DW. 1974. Hydrography and midwater fishes of three contiguous areas off Santa Barbara, California. Natural History Museum of Los Angeles County, Contributions in Science 261:1-30.

Buerkle U. 1968. “Relation of pure tone thresholds to background noise level in the Atlantic cod (*Gadus morhua*).” Journal of the Fisheries Research Board of Canada, 25: 1155 1160.

Buerkle U. 1969. “Auditory masking and the critical band in Atlantic cod (*Gadus morhua*).” Journal of the Fisheries Research Board of Canada. 26:1113 1119.

Bushing W. 1995. Indentifying regions of giant kelp (*Macrocystis pyrifera*) around Santa Catalina Island for designation as marine reserves. In Proc. 15th ESRI User Conference. May 21-26, 1995, Palm Spring, CA. http://www.catalinas.net/seer/research/respaper.htm. 21 Dec 1998.

California Department of Fish and Game [CDFG]. 1970. Plants and animals recorded from San Clemente Island, 1965-1969. California Department of Fish and Game, Unpublished Manuscript. 8 pp.

California Department of Fish and Game. 2007. Robertson J. Digital Database of Commercial Landings for CDFG Statistical Areas in California for the Years 2002 to 2005. Personal communication via e-mail, California Department of Fish and Game, Long Beach, CA.

Caltrans. 2001. “Pile Installation Demonstration Project, Fisheries Impact Assessment.” PIDP EA 012081, Caltrans Contract 04A0148. San Francisco - Oakland Bay Bridge East Span Seismic Safety Project.

Caltrans. 2004. “Fisheries and Hydroacoustic Monitoring Program Compliance Report for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project.” Prepared by Strategic Environmental Consulting, Inc. and Illingworth & Rodkin, Inc. June.

Casper BM, Mann DA. 2006. Evoked potential audiograms of the nurse shark (*Ginglymostoma cirratum*) and the yellow stingray (*Urobatis jamaicensis*). Environmental Biology of Fishes 76:101–108.

Casper BM, Lobel PS, Yan HY. 2003. The hearing sensitivity of the little skate, *Raja erinacea*: A comparison of two methods. Environmental Biology of Fishes 68: 371-379.

Cato DH. 1978. Marine biological choruses observed in tropical waters near Australia. Journal of the Acoustical Society of America 64:736–743.

Chapman CJ. 1973. “Field studies of hearing in teleost fish.” Helgoländer wissenschaftliche Meeresuntersuchungen 24:371-390.

Chapman CJ, Hawkins AD. 1969. The importance of sound in fish behaviour in relation to capture by trawls. In: A. Ben-Tuvia and W. Dickson (eds.), Proceedings of the FAO conference on fish behaviour in relation to fishing techniques and tactics, 19-27 Oct. 1967. FAO Fisheries Report No. 62, Vol. 3, Rome. Pp 717-729.

Chapman CJ, Hawkins AD. 1973. “A field study of hearing in the cod, *Gadus morhua*.” Journal of Comparative Physiology 85:147 167.

Chapman CJ, Sand O. 1974. “Field studies of hearing in two species of flatfish *Pleuronectes platessa* (L.) and *Limanda limanda* (L.) (family Pleuronectidae).” Comparative Biochemistry and Physiology 47(A):371-385.

Coastal Resources Management [CRM]. 1998. San Clemente Island marine resources inventory report–Wilson Cove outfall study, June and August 1997 surveys. Report by Coastal Resources Management, Corona del Mar, CA for Southwestnavfacengcom, South Bay Area Focus Team, Contract N68711-97-M-8426, San Diego, CA.

Coker CM, Hollis EH. 1950. “Fish mortality caused by a series of heavy explosions in Chesapeake Bay.” Journal of Wildlife Management 14:435-445.

Collin SP, Marshall NJ eds. 2003. Sensory Processing in Aquatic Environments. New York: Springer-Verlag.

Coombs S, Montgomery JC. 1999. “The enigmatic lateral line system.” In Comparative Hearing: Fish and Amphibians, eds. R.R. Fay, and A.N. Popper, 319-362. New York: Springer-Verlag.

Coombs S, Popper AN. 1979. Hearing differences among Hawaiian squirrelfish (family Holicentridae) related to differences in the peripheral auditory system. Journal of Comparative Physiology A 132:203-207.

Corwin JT. 1981. “Audition in elasmobranchs.” In Hearing and Sound Communication in Fishes, eds. W.N. Tavolga, A.N. Popper, and R.R. Fay, 81 105. New York: Springer Verlag.

Corwin JT. 1989. “Functional anatomy of the auditory system in sharks and rays.” Journal of Experimental Zoology, Supplement 2:62-74.

Cowen RK, Bodkin JL. 1993. Annual and spatial variation of the kelp forest fish assemblage at San Nicolas Island, California. In F.G. Hochberg, (ed.), Third California Islands Symposium: Recent Advances in Research on the California Islands. Santa Barbara Museum of Natural History, Santa Barbara, CA. pp 463-474.

Cross JN, Allen LG. 1993. Fishes. In M. D. Dailey, D. J. Reish, and J. W. Anderson, eds. Ecology of the Southern California Bight, A Synthesis and Interpretation. University of California Press, Berkeley, CA. pp 459-540.

Culik BM, Koschinski S, Tregenza N, Ellis GM. 2001. Reactions of harbour porpoises (*Phocoena phocoena*) and herring (*Clupea harengus*) to acoustic alarms. Marine Ecology Progress Series 211: 255–260.

Dahlgren. 2000. Noise blast test results aboard USS Cole. Report from Dahlgren Division, Naval Surface Warfare Center, to Commander-in Chief, U.S. Atlantic Fleet (N3).

Dalen J, Knutsen GM. 1986. Scaring effects in fish and harmful effects on eggs, larvae and fry by offshore seismic exploration. In: Merklinger, H.M. (Ed.), Progress in Underwater Acoustics. Plenum Press, New York, pp 93–102.

Dalen J, Raknes A 1985. Scaring effects on fish from three-dimensional seismic surveys. Report No. FO 8504. Institute of Marine Research. Bergen, Norway.

DeMartini EE, Roberts DA. 1990. Effects of giant kelp (*Macrocystis*) on the density and abundance of fishes in a cobble-bottom kelp forest. Bulletin of Marine Science 46:287-300.

Dijkgraaf S. 1952. “Uber die Schallwahrnehmung bei Meeresfischen.” Zeitschrift verglishende Phyiologie 34:104-122.

Dunning DJ, Ross QE, Geoghegan P, Reichle JJ, Menezes JK, Watson JK. 1992. Alewives avoid high-frequency sound. North American Journal of Fisheries Management. 12:407-416.

Dwyer WP, Fredenberg W, Erdahl DA. 1993. “Influence of electroshock and mechanical shock on survival of trout eggs.” North American Journal of Fisheries Management 13:839-843.

Ebeling AW, Larson RJ, Alevison WS, Bray RN. 1979. Annual variability of reel fish assemblages in kelp forests off Santa Barbara, California. Fisheries Bulletin (U.S.) 78:361-377.

Egner SA, Mann DA. 2005. Auditory sensitivity of sergeant major damselfish *Abudefduf saxatilis* from post-settlement juvenile to adult. Marine Ecology Progress Series 285: 213–222.

Engås A, Løkkeborg S. 2002. Effects of seismic shooting and vessel-generated noise on fish behaviour and catch rates. Bioacoustics, 12: 313-315.

Engas A, Lokkeborg S, Ona E, Soldal A. 1996. Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*). Can. J. Fish. Aquat. Sci. 53: 2238-2249.

Enger PS. 1967. “Hearing in herring.” Comparative Biochemistry and Physiology 22:527 538.

Enger PS. 1981. “Frequency discrimination in teleosts-central or peripheral?” In Hearing and Sound Communication in Fishes, eds. W.N. Tavolga, A.N. Popper, and R.R. Fay, 243-255. New York: Springer-Verlag.

Engle JM. 1993. Distribution patterns of rocky subtidal fishes around the California Islands. In F.G. Hochberg, (ed.) Third California Islands Symposium: Recent Advances in Research on the California Islands. Santa Barbara Museum of Natural History, Santa Barbara, CA. pp 475-484.

Fay RR. 1988. Hearing in vertebrates, A psychophysics databook. Hill-Fay Associates, Winnetka, IL.

Fay R, Popper AN. 2000. Evolution of hearing in vertebrates: the inner ears and processing. Hearing Research. 149: 1-10.

Fay RR. 2005. “Sound source localization by fishes.” In Sound Source Localization, eds. A.N. Popper and R.R. Fay, 36-66. New York: Springer Science + Business Media, LLC.

Fay RR, Megela-Simmons A. 1999. “The sense of hearing in fishes and amphibians.” In Comparative Hearing: Fish and Amphibians, eds. R.R. Fay and A.N. Popper, 269-318. New York: Springer-Verlag.

Fish JF, Offutt GC.1972. “Hearing thresholds from toadfish, *Opsanu tau*, measured in the laboratory and field.” Journal of the Acoustical Society of America 51:1318-1321.

Fletcher R. 1999. Sports Fishing Association of California. Personal communication 4 January 1999, San Diego, CA.

Froese R, Pauly D. 2004. FishBase. Accessed 20 Apr 2005. http://www.fishbase.org.

Gannon DP, Barros NB, Nowacek DP, Read AJ, Waples DM, Wells RS. 2005. Prey detection by bottlenose dolphins (*Tursiops truncatus*): an experimental test of the passive listening hypothesis. Animal Behaviour 69:709–720.

Gaspin JB. 1975. “Experimental investigations of the effects of underwater explosions on swimbladder fish, I: 1973 Chesapeake Bay tests.” Navel Surface Weapons Center Technical Report NSWC/WOL/TR 75-58, White Oak Laboratory, Silver Spring, Maryland.

Gausland I. 2003. “Seismic survey impact on fish and fisheries.” Report prepared by Stavanger for Norwegian Oil Industry Association, March.

Gearin PJ, Gosho ME, Lakke JL, Cooke L, Delong RL, Hughes KM. 2000. Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, *Phoceoena phocoena*, in the state of Washington. Journal of Cetacean Research and Management 2(1):1-9.

Goertner JF, Wiley ML, Young GA, McDonald WW. 1994. Effects of underwater explosions on fish without swimbladders. Naval Surface Warfare Center, Dahlgren Division, White Oak Detachment, Silver Spring, MD. NSWC TR 88-114.

Govoni JJ, Settle LR, West MA. 2003. “Trauma to juvenile pinfish and spot inflicted by submarine detonations.” Journal of Aquatic Animal Health 15:111-119.

Gregory J, Clabburn P. 2003. Avoidance behaviour of *Alosa fallax fallax* to pulsed ultrasound and its potential as a technique for monitoring clupeid spawning migration in a shallow river. Aquatic Living Resources 16: 313–316.

Guth J. 1999. California lobster and trap fishermen's association. Personal communication, Oceanside, CA, 11 Jan 1999.

Halmay P. 1999. Sea urchin harvester's association of California. Personal communication, Bodega Bay, CA, 8 Jan 1999.

Halvorsen MB, Wysocki LE, Popper AN. 2006. “Effects of high-intensity sonar on fish.” Journal of the Acoustical Society of America 119:3283.

Hastings MC, Popper AN, Finneran JJ, Lanford PJ. 1996. “Effects of low-frequency underwater sound on hair cells of the inner ear and lateral line of the teleost fish *Astronotus ocellatus*.” Journal of the Acoustical Society of America 99(3):1759-1766.

Hastings MC, Popper AN. 2005. Effects of sound on fish. Jones & Stokes under California Department of Transportation Contract No. 43A0139, Task Order 1.

Hawkins AD, Johnstone ADF. 1978. The hearing of the Atlantic salmon, *Salmo salar*. Journal of Fish Biology 13: 655-673.

Helgren R. 1999. Helgren sport fishing. Personal communication. 11 Jan 1999, Oceanside, CA.

Higgs DM. 2005. Auditory cues as ecological signals for marine fishes. Marine Ecology Progress Series 287: 278-281

Higgs DM, Plachta DTT, Rollo A, Singheiser M, Hastings MC, Popper AN. 2004. Development of ultrasound detection in American shad (*Alosa sapidissima*). J Exp Biol 207:155- 163.

Holbrook SJ, Carr MH, Schmidt RJ, Coyer JA. 1990. Effect of giant kelp on local abundance of reef fishes: The importance of ontogenetic resource requirements. Bulletin of Marine Science 47:104-114.

Horn MH. 1980. Diversity and ecological roles of non-commercial fishes in California marine habitats. California Cooperative Oceanic Fisheries Investigations Reports 21:37-47.

Horn MH, Allen LG. 1978. A distributional analysis of California coastal marine fishes. Journal of Biogeography 5:23-42.

Horn MH, Allen LG, Lea RN. 2006. Biogeography. In: Allen LG, Pondella DJ II, Horn MH editors. The Ecology of Marine Fishes: California and Adjacent Waters. Berkeley (CA): University of California Press. pp 3-25.

IRI/LDEO. 1998. Monthly mean sea surface temperature anomalies. International Research Institute for Climatic Prediction, Columbia University, Lamont Doherty Earth Observatory and Scripps Institute of Oceanography. http://ingrid.lgdo.columbia.edu/SOURCES/.indices/ensomonitor.html. 21 Dec 1998.

IRI/LDEO. 2006. Monthly mean sea surface temperature anomalies. International Research Institute for Climatic Prediction, Columbia University, Lamont Doherty Earth Observatory and Scripps Institute of Oceanography. http://ingrid.lgdo.columbia.edu/SOURCES/.indices/ensomonitor.html.

Iversen RTB. 1967. Response of the yellowfin tuna (*Thunnus albacares*) to underwater sound. In W.N. Tavolga (ed), Marine Bio-Acoustics II. Pergamon Press, New York. pp 105-121.

Iversen RTB. 1969. Auditory thresholds of the scombrid fish *Euthynnus affinis*, with comments on the use of sound in tuna fishing. Proceedings of the FAO Conference on Fish Behaviour in Relation to Fishing Techniques and Tactics, October 1967. FAO Fisheries Reports No. 62 Vol. 3. FRm/R62.3.

Jackaloni V. 1999. Commercial fisherman. Personal Communication, 11 Jan 1999, San Diego, CA.

Jensen JOT, Alderdice DF. 1983. "Changes in mechanical shock sensitivity of coho salmon (*Oncorhyncuus kisutch*) eggs during incubation." Aquaculture 32:303-312.

Jensen JOT, Alderdice DF. 1989. "Comparison of mechanical shock sensitivity of eggs of five Pacific salmon (Oncorhyncus) species and steelhead trout (*Salmo gairdneri*)." Aquaculture 78:163-181.

Jerkø H, Turunen-Rise I, Enger PS, Sand O. 1989. "Hearing in the eel (*Anguilla anguilla*)." Journal of Comparative Physiology 165:455-459.

Jørgensen R, Handegard NO, Gjøsæter H, Slotte A. 2004. Possible vessel avoidance behaviour of capelin in a feeding area and on a spawning ground. Fisheries Research 69: 251-261.

Jørgensen R, Olsen KK, Falk-Petersen IB, Kanapthippilai P. 2005. Investigations of potential effects of low frequency sonar signals on survival, development and behaviour of fish larvae and juveniles. The Norwegian College of Fishery Science, University of Tromsø, N-9037 Tromsø Norway.

Kalmijn AJ. 1988. "Hydrodynamic and acoustic field detection." In Sensory Biology of Aquatic Animals, eds. A. Atema, R.R. Fay, A.N. Popper, and W.N. Tavolga, 83-130. New York: Springer-Verlag.

Kalmijn AJ. 1989. "Functional evolution of lateral line and inner ear sensory systems." In: The mechanosensory lateral line - Neurobiology and evolution, eds. S. Coombs, P. Görner, and M. Münz, 187-215. Berlin: Springer Verlag.

Karlsen HE. 1992. "Infrasound sensitivity in the plaice (*Pleuronectes plattessa*)." Journal of Experimental Biology, 171:173-187.

Keevin TM, Hempen GL, Schaeffer DJ. 1997. "Use of a bubble curtain to reduce fish mortality during explosive demolition of Locks and Dam 26, Mississippi River." In Proceedings of the Twenty-third Annual Conference on Explosives and Blasting Technique, Las Vegas, Nevada, International Society of Explosive Engineers, Cleveland, Ohio, 197-206.

Kenyon TN. 1996. "Ontogenetic changes in the auditory sensitivity of damselfishes (Pomacentridae)." Journal of Comparative Physiology A 179:553-561.

Kenyon TN. 1996. Ontogenetic changes in the auditory sensitivity of damselfishes (pomacentridae). Journal of Comparative Physiology 179: 553-561.

Knudsen FR, Enger PS, Sand O. 1992. Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, Salmo salar. Journal of Fish Biology. 40: 523–534.

Knudsen FR, Enger PS, Sand O.1994. Avoidance responses tolow frequency sound in downstream migrating Atlantic salmon smolt, *Salmo salar*. Journal of Fish Biology. 45: 227-233.

Kobylinsky G. 1998. Digital database of commercial landings for CDFG statistical areas within and near the San Clemente sea ranges complex for the years 1993 to 1997. Personal communication via e-mail, California Department of Fish and Game, Long Beach, CA.

Koski WR, Lawson JW, Thomson DH, Richardson WJ. 1998. Point Mugu sea range technical report. Rep. by LGL Limited, King City, ON and Ogden Environmental Energy Services, Santa Barbara, CA for U.S. Navy Naval Air Warfare Center, Weapons Division, Point Mugu, CA and Southwest Division Naval Facilities Engineering Command, San Diego, CA. 281 pp.

Kostyuchenko LP. 1973. "Effects of elastic waves generated in marine seismic prospecting on fish eggs in the Black Sea." Hydrobiologia 9:45-46.

Kushner DJ, Rich P. 2004. Naval Auxiliary Landing Field, San Clemente Island kelp forest monitoring 2004 annual report and final report. Contract # N68711-01-LT-01038. Rep. prepared for SWDIV NAVFACENGCOM. 37 p. + Appendices.

Kvadsheim PH, Sevaldsen EM. 2005. The potential impact of 1-8 kHz active sonar on stocks of juvenile fish during sonar exercises. FFI/Report-2005/01027.

Ladich F, Bass AH. 2003. Underwater sound generation and acoustic reception in fishes with some notes on frogs. In Collin, S.P. and N.J. Marshall (eds), Sensory Processing in Aquatic Environments. Springer-Verlag, New York. pp 173-193.

Ladich F, Popper AN. 2004. Parallel evolution in fish hearing organs. In Manley, G.A., A.N. Popper, and R.R. Fay (eds), Evolution of the Vertebrate Auditory System. Springer Handbook of Auditory Research. Springer-Verlag, New York. pp 95-127.

Ladich F,Wysocki LE. 2003. How does tripus extirpation affect auditory sensitivity in goldfish? Hearing Research 182: 119-129.

Larson RJ, DeMartini EE. 1984. Abundance and vertical distribution of fishes in a cobble bottom kelp forest of San Onofre, California. Fisheries Bulletin (U.S.) 82:37-53.

Lenarz WH, VenTresca DA, Graham WM, Schwing FB, Chavez F. 1995. Explorations of El Niño events and associated biological population dynamics off central California. Calif. Coop. Oceanic Fish. Invest. Rep. 36:106–119.

Lombarte A., Popper AN. 1994. "Quantitative analyses of postembryonic hair cell addition in the otolithic endorgans of the inner ear of the European hake, *Merluccius merluccius* (Gadiformes, Teleostei)." Journal of Comparative Neurology 345:419-428.

Lombarte A, Yan HY, Popper AN, Chang JC, Platt C. 1993. "Damage and regeneration of hair cell ciliary bundles in a fish ear following treatment with gentamicin." Hearing Research, 66:166-174.

Love MS, Stephens JS, Morris PA, Singer MM, Sandhu M, Sciarrotta TC. 1986. Inshore soft substrata fishes in the southern California Bight: An overview. California Cooperative Fisheries Investigations Report 27:84-106.

Lovell JM, Findlay MM, Moate RM, Pilgrim DA. 2005. The polarization of inner ear ciliary bundles from a scorpaeniform fish. Journal of Fish Biology 66: 836–846.

Løvik A, Hovem JM. 1979. An experimental investigation of swimbladder resonance in fishes. The Journal of the Acoustical Society of America 66: 850-854.

Luczkovich JJ, Daniel HJ, Hutchinson M, Jenkins T, Johnson SE, Pullinger RC, Sprague MW. 2000. Sounds of sex and death in the sea: bottlenose dolphin whistles suppress mating choruses of silver perch. Bioacoustics 10:323–334.

MacCall AD. 1996. Patterns of Low-Frequency Variability in Fish Populations of the California Current. California Cooperative Fisheries Investigations Report 37:100-110.

Mann DA, Lobel PS. 1997. Propagation of damselfish (Pomacentridae) courtship sounds. J. Acoust. Soc. Amer. 101:3783–3791.

Mann DA, Lu Z, Popper AN. 1997. "A clupeid fish can detect ultrasound." Nature 389:341.

Mann DA, Popper AN, Wilson B. 2005. Pacific herring hearing does not include ultrasound. Biology Letters 1: 158-161.

Mann DA, Lu Z, Hastings MC, Popper AN. 1998. Detection of ultrasonic tones and simulated echolocation clicks by a teleost fish, the American shad (*Alosa sapidissima*). Journal of the Acoustical Society of America 104:562-568.

Mann DA, Higgs DM, Tavolga WN, Souza MJ, Popper AN. 2001. Ultrasound detection by clupeiform fishes. The Journal of the Acoustical Society of America 109: 3048-3054.

McCartney BS, Stubbs AR. 1971. Measurements of the acoustic target strengths of fish in dorsal aspect, including swimbladder resonance. Journal of Sound and Vibration 15(3): 397-404.

McCauley RD, Cato DH. 2000. Patterns of fish calling in a nearshore environment in the Great Barrier Reef. Philosophical Transaction of the Royal Society of London B 355:1289–1293.

McCauley RD, Fewtrell J, Duncan AJ, Jenner C, Jenner MN, Penrose JD, Prince RIT, Adhitya A, Murdoch J, McCabe C. 2000. "Marine Seismic Surveys: Analysis and Propagation of Air Gun Signals; and Effects of Air-Gun Exposure on Humpback Whales, Sea Turtles, Fishes and Squid." Report R99-15 prepared by Centre for Marine Science and Technology, Curtin University of Technology, Western Australia for Australian Petroleum Production and Exploration Association.

McCauley RD, Fewtrell J, Popper AN. 2003. High intensity anthropogenic sound damages fish ears. Journal of the Acoustical Society of America 113 (1): 638-642.

McEwan D, Jackson TA. 1996. Steelhead restoration and management plan for California. Sacremento: California Department of Fish and Game.

McLennan MW. 1997. A simple model for water impact peak pressure and pulse width. Technical Memorandum, Greeneridge Sciences Inc., Santa Barbara, CA. 4 p.

Mearns AJ, Allen MJ, Moore MD, Sherwood MJ. 1980. Distribution, abundance, andrecruitment of softbottom rockfishes (Scorpaenidae: Sebastes) on the southern California mainland shelf. California Cooperative Oceanic Fisheries Investigations Reports 21:180-190.

Myrberg Jr AA. 1980. Fish bioacoustics: its relevance to the ‘not so silent world.’ Environmental Biology of Fish 5(4): 297-304.

Myrberg AA. 2001. The acoustical biology of elasmobranches. Environ. Biol. Fishes 60: 31–45.

Myrberg Jr AA, Banner A, Richard JD. 1969. “Shark attraction using a video-acoustic system.” Marine Biology 2:264.

Myrberg Jr AA, Gordon CR, Klimley AP. 1976. “Attraction of free ranging sharks by low frequency sound, with comments on its biological significance.” In Sound Reception in Fish, eds. A. Schuijf and A.D. Hawkins, 205-228. Amsterdam: Elsevier.

Myrberg Jr AA, Ha SJ, Walewski S, Banbury JC. 1972. “Effectiveness of acoustic signals in attracting epipelagic sharks to an underwater sound source.” Bulletin of Marine Science 22:926-949.

Myrberg Jr AA, Spires JY. 1980. “Hearing in damselfishes: an analysis of signal detection among closely related species.” Journal of Comparative Physiology 140:135-144.

National Marine Fisheries Service [NMFS]. 1997. Endangered and threatened species: Listing of several evolutionary significant units (ESUs) of West Coast steelhead. Federal Register 62(159):43937-43954.

National Marine Fisheries Service. 2002. Endangered and threatened species: Range extension for endangered steelhead in southern California. Federal Register 67(84):21586-21598.

National Research Council (NRC). 1994. Low-Frequency Sound and Marine Mammals: Current Knowledge and Research Needs. Washington, DC: National Academy Press.

National Research Council (NRC). 2003. Ocean Noise and Marine Mammals. Washington, DC: National Academy Press.

Naval Research Laboratory. 1999. Environmental effects of RF chaff. A Select Panel Report to the Undersecretary of Defense for Environmental Security. Final Report. Accession Number : ADA379848.

Nedwell JR, Turnpenny A, Langworthy J, Edwards B. 2003. “Measurements of underwater noise during piling at the Red Funnel Terminal, Southampton, and observations of its effect on caged fish.” Report 558 R 0207 prepared by Subacoustech Ltd., Hants, UK.

Nedwell JR, Edwards B, Turnpenny AWH, Gordon J. 2004. “Fish and marine mammal audiograms: A summary of available information.” Report 534 R 0214 prepared by Subacoustech Ltd., Hamphire, UK. http://www.subacoustech.com/information/downloads/reports/534R0214.pdf

Nelson DR, Johnson RH. 1972. "Acoustic attraction of Pacific reef sharks: effect of pulse intermittency and variability." Comparative Biochemistry and Physiology Part A 42:85-95.

Nelson JS. 1994. Fishes of the world, third edition. John Wiley & Sons, Inc., New York. Pages 12 and 125-127.

Nestler JM. 2002. Simulating movement patterns of blueback herring in a stratified southern impoundment. Transactions of the American Fisheries Society. 131: 55-69.

Nestler JM, Plaskey GR, Pickens J, Menezes J, Schilt C. 1992. Reponses of blueback herring to high-frequency sound and implications for reducing entertainment at hydropower dams. North American Journal of Fisheries Management 12:667-693.

NSWC/Anteon Corp., Inc., 2005. Very shallow water explosion tests at Naval Amphibious Base, Coronado, CA and San Clemente Island, CA: Conditions, results, and model predictions.

Offutt GC. 1971. "Response of the tautog (*Tautoga onitis,* teleost) to acoustic stimuli measured by classically conditioning the heart rate." Conditional Reflex 6(4):205-214.

Oxman DS., Barnett-Johnson R, Smith ME, Coffin AB, Miller DD, Josephson R, Popper AN. 2007. "The effect of vaterite deposition on otolith morphology, sound reception and inner ear sensory epithelia in hatchery-reared chinook salmon (*Oncorhynchus tshawytscha*)." Canadian Journal of Fisheries and Aquatic Sciences 64:1469-1478.

Pacific Fishery Management Council [PFMC]. 2005. Description and identification of essential Fish Habitat for the Coastal Species Fishery Management Plan. Coastal Species Fishery Management Plan. Pacific Fisheries Management Council. http://www.pcouncil.org/cps/cpsfmp.html.

Pacific Fishery Management Council. 2006. Pacific Coast Groundfish Fishery Management Plan as Amended through Amendment 19. National Oceanic and Atmospheric Administration. 167p. http://www.pcouncil.org/groundfish/gffmp.html.

Pearson WH, Skalski JR, Malme CI. 1987. "Effects of sounds from a geophysical survey device on fishing success." Report prepared by Battelle/Marine Research Laboratory for the Marine Minerals Service, United States Department of the Interior under Contract Number 14-12-0001-30273. June.

Pearson WH, JR Skalski, CI Malme. 1992. Effects of sounds from a geophysical survey device on behaviour of captive rockfish (*Sebastes* spp.). Canadian Journal of Fisheries and Aquatic Science 49(7):1343-1356.

Pickering AD. 1981. Stress and Fishes. New York: Academic Press.

Plachata DTT, Popper AN. 2003. Evasive responses of American shad (*Alosa sapidissima*) to ultrasonic stimuli. Acoustics Research Letters Online 4: 25-30.

Plachta DTT, Song J, Halvorsen MB, Popper AN. 2004. "Neuronal encoding of ultrasonic sound by a fish." Journal of Neurophysiology 91:2590-2597.

Popper AN. 1976. "Ultrastructure of the auditory regions in the inner ear of the lake whitefish." Science 192:1020 1023.

Popper AN. 1977. "A scanning electron microscopic study of the sacculus and lagena in the ears of fifteen species of teleost fishes." Journal of Morphology 153:397 418.

Popper AN.1980. Scanning electron microscopic study of the sacculus and lagena in several deep-sea fishes. The American Journal of Anatomy157:115-136.

Popper AN. 1981. Comparative scanning electron microscopic investigations of the sensory epithelia in the teleost sacculus and lagena. Journal of Comparative Neurology 200: 357-374.

Popper AN. 2003. Effects of anthropogenic sounds on fishes. Fisheries, 28(10):24-31.

Popper AN, Carlson TJ. 1998. Application of sound and other stimuli to control fish behavior. Transactions of the American Fisheries Society 127: 673-707.

Popper AN, Fay RR, Platt C, Sand O. 2003. "Sound detection mechanisms and capabilities of teleost fishes." In Sensory Processing in Aquatic Environments, eds. S.P. Collin and N.J. Marshall, 3-38. New York: Springer-Verlag.

Popper AN, Halvorsen MB, Kane E, Miller DD, Smith ME, Stein P, Wysocki LE. 2007. "The effects of high-intensity, low-frequency active sonar on rainbow trout." Journal of the Acoustical Society of America 122:623-635.

Popper AN, Hoxter B. 1984. "Growth of a fish ear: 1. Quantitative analysis of sensory hair cell and ganglion cell proliferation." Hearing Research 15:133 142.

Popper AN, Hoxter B. 1987. "Sensory and nonsensory ciliated cells in the ear of the sea lamprey, Petromyzon marinus." Brain, Behavior and Evolution 30:43-61.

Popper AN, Plachta DTT, Mann DA, Higgs D. 2004. "Response of clupeid fish to ultrasound: a review." ICES Journal of Marine Science 61:1057-1061.

Popper AN, Salmon M, Horch KW. 2001. "Acoustic detection and communication by decapod crustaceans." Journal of Comparative Physiology A 187:83-89.

Popper AN, Schilt CR. 2008. "Hearing and acoustic behavior (basic and applied)." In Fish Bioacoustics, eds. J.F. Webb, R.R. Fay, and A.N. Popper. New York: Springer Science + Business Media, LLC.

Popper AN, Smith ME, Cott PA, Hanna BW, MacGillivray AO, Austin ME, Mann DA. 2005. Effects of exposure to seismic airgun use on hearing of three fish species. J. Acoust. Soc. Am., 117:3958-3971.

Popper AN, Tavolga WN.1981. Structure and function of the ear in the marine catfish, *Arius felis*. Journal of Comparative Physiology 144: 27-34.

Popper AN, Plachta DTT, Mann DA, Higgs D. 2004. Response of clupeid fish to ultrasound: a review. ICES Journal of Marine Science, 61: 1057-1061.

Popper AN, Halvorsen MB, Kane E, Miller DD, Smith ME, Stein P, Wysocki LE. 2007. The effects of high-intensity, low-frequency active sonar on rainbow trout. J. Acoust. Soc. Am., 122:623-635Rainwater, C. L. 1975. An ecological study of midwater fishes in Santa Catalina basin, off southern California, using cluster analysis. Ph.D. Thesis, University of Southern California.

Rainwater CL 1975. An ecological study of mid-water fishes in Santa Catalina Basin, off southern California, using cluster analysis. Dissertation, Univ. South. Calif., Los Angeles : 159 pp.

Ramcharitar J, Popper AN. 2004. Masked auditory thresholds in sciaenid fishes: A comparative study. Journal of the Acoustical Society of America 116 (3): 1687–1691.

Ramcharitar J, Higgs DM, Popper AN. 2001. Sciaenid inner ears: A study in diversity. Brain, Behavior and Evolution 58: 152-162.

Ramcharitar JU, Deng X, Ketten D, Popper AN. 2004. Form and function in the unique inner ear of a teleost fish: The silver perch (*Bairdiella chrysoura*). Journal of Comparative Neurology 475:531–539.

Ramcharitar JU, Higgs DM, Popper AN. 2006a. Audition in sciaenid fishes with different swim bladder-inner ear configurations. Journal of the Acoustical Society of America 119 (1): 439-443.

Ramcharitar J, Gannon D, Popper A. 2006b. Bioacoustics of fishes of the Family Sciaenidae (croakers and drums). Transactions of the American Fisheries Society 135:1409–1431.

Remage-Healey L, Nowacek DP, Bass AH. 2006. Dolphin foraging sounds suppress calling and elevate stress hormone levels in a prey species, the Gulf toadfish. The Journal of Experimental Biology 209: 4444-4451.

Richardson WJ, Greene CR Jr., Malme CI, Thomson DH. 1995. Marine Mammals and Noise. New York: Academic Press.

Rogers PH, M. Cox. 1988. "Underwater sound as a biological stimulus." In Sensory Biology of Aquatic Animals, eds. A. Atema, R.R. Fay, A.N. Popper, and W.N. Tavolga, 131-149. New York: Springer-Verlag.

Ross QE, Dunning DJ, Menezes JK, Kenna Jr MJ, Tiller G. 1996. Reducing impingement of alewives with high-frequency sound at a power plant intake on Lake Ontario. North American Journal of Fisheries Management 16: 548-559.

Sand O, Karlsen HE. 1986. "Detection of infrasound by the Atlantic cod." Journal of Experimental Biology 125:197-204.

Sand O, Karlsen HE. 2000. "Detection of infrasound and linear acceleration in fish." Philosophical Transactions of the Royal Society of London B 355:1295-1298.

Sand O, Enger PS, Karlsen HE, Knudsen FR, Kvernstuen T. 2000. "Avoidance responses to infrasound in downstream migrating European silver eels, *Anguilla anguilla*." Environmental Biology of Fishes 47:327-336.

Scholik AR, Yan HY. 2001. Effects of underwater noise on auditory sensitivity of a cyprinid fish. Hearing Research 152: 17-24.

Scholik AR, Yan HY. 2002. Effects of boat engine noise on the auditory sensitivity of the fathead minnow, *Pimephales promelas*. Environmental Biology of Fishes 63: 203–209.

Schwarz AL, GL Greer. 1984. Responses of Pacific herring, *Clupea harengus pallasi*, to some underwater sounds. Canadian Journal of Fisheries and Aquatic Science 41:1183-1192.

Sevaldsen EM, Kvadsheim PH. 2004. Active sonar and the marine environment. In Porter, M.B., M. Siderius, and W.A. Kuperman (editors), High Frequency Ocean Acoustics. Conference Proceedings 728, American Institute of Physics 0-7354-0210-8/04. pp 272-279.

Sisneros JA 2007. "Saccular potentials of the vocal plainfin midshipman fish, *Porichthys notatus*." Journal of Comparative Physiology A 193:413-424.

Sisneros JA, Bass AH. 2003. Seasonal placticity of peripheral auditory frequency sensitivity. The Journal of Neuroscience 23(3): 1049-1058.

Skalksi JR, Pearson WH, Malme CI. 1992. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (Sebastes spp.). Canadian Journal of Fisheries and Aquatic Science 49:1357-1365.

Slotte A, Hansen K, Dalen J, Ona E. 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. Fisheries Research 67: 143-150.

Smith ME, Kane AS, Popper AN. 2004a. Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water? The Journal of Experimental Biology 207: 3591-3602.

Smith ME, Kane AS, Popper AN. 2004b. Noise-induced stress response and hearing loss in goldfish (*Carassius auratus*). The Journal of Experimental Biology 207: 427-435.

Smith ME, Coffin AB, Miller DL, Popper AN. 2006. "Anatomical and functional recovery of the goldfish (*Carassius auratus*) ear following noise exposure." Journal of Experimental Biology 209:4193-4202.

Song J, Mathieu A, Soper RF, Popper AN. 2006. Structure of the inner ear of bluefin tuna *Thunnus thynnus*. Journal of Fish Biology 68: 1767–1781.

Sonny D, Knudsen RR, Enger PS, Kvernstuen T, Sand O. 2006. "Reactions of cyprinids to infrasound in a lake and at the cooling water inlet of a nuclear power plant." Journal of Fish Biology 69:735-748.

Sverdrup A, Kjellsby E, Krueger PG, Floysand R, Knudsen FR, Enger PS, Serck-Hanssen G, Helle KB. 1994. "Effects of experimental seismic shock on vasoactivity of arteries, integrity of the vascular endothelium and on primary stress hormones of the Atlantic salmon." Journal of Fish Biology 45:973-995.

Tavolga WN 1974a. "Sensory parameters in communication among coral reef fishes." The Mount Sinai Journal of Medicine 41(2):324-340.

Tavolga WN 1974b. "Signal/noise ratio and the critical band in fishes." Journal of the Acoustical Society of America 55:1323-1333.

Tavolga WN, Wodinsky J. 1963. "Auditory capacities in fishes: pure tone thresholds in nine species of marine teleosts." Bulletin of the American Museum of Natural History 126:177 240.

Turnpenny AWH, Thatcher KP, Nedwell JR. 1994. "The effects on fish and other marine animals of high-level underwater sound." Report FRR 127/94 prepared by Fawley Aquatic Research Laboratories, Ltd., Southampton, UK.

U.S. Air Force. 1997. Environmental effects of self-protection chaff and flares. U.S. Air Force, Headquarters Air Combat Command, Langley Air Force Base, VA. var. p. NTIS PB98-110620.

U.S. Department of the Navy [DoN]. 1998. Final environmental impact statement: Shock testing the SEAWOLF submarine. Department of the Navy, Southern Division, Naval Facilities Engineering Command, North Charleston, SC.

U.S. Department of the Navy. 2005. Marine Resource Assessment for the Southern California Operating Area- Final September 2005. Prepared for Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, HI. Prepared by GeoMarine Inc., Plano, TX. 574 pp

U.S. Department of the Navy. 2007. Whales and sonar. http://www.whalesandsonar. navy.mil.

Wardle CS, Carter TJ, Urquhart GG, Johnstone ADF, Ziolkowski AM, Hampson G, Mackie D. 2001. "Effects of seismic air guns on marine fish." Continental Shelf Research 21:1005-1027.

Webb JF, Montgomery J, Mogdans J. 2008. “Bioacoustics and the lateral line of fishes.” In Fish Bioacoustics, eds. J.F. Webb, R.R. Fay, and A.N. Popper. New York: Springer Science + Business Media, LLC.

Wilson B, Dill LM. 2002. “Pacific herring respond to simulated odontocete echolocation sounds.” Canadian Journal of Aquatic Science 59: 542-553.

Winn HE. 1967. “Vocal facilitation and biological significance of toadfish sounds.” In Marine Bio Acoustics, II, ed. W.N. Tavolga, 283 303. Oxford: Pergamon Press.

Wodinsky J, Tavolga WN. 1964. Sound detection in teleost fishes. p. 269-280 In: W.N. Tavolga (ed), Marine Bio-Acoustics. Pergamon Press, Oxford.

Wright KJ, Higgs DM, Belanger AJ, Leis JM. 2005. Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces:Pomacentridae). Marine Biology 147: 1425-1434.

Wright KJ, Higgs DM, Belanger AJ, Leis JM. 2005. Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces:Pomacentridae). Erratum. Marine Biology (2007) 150: 1049-1050.

Wright KJ, Higgs DM, Belanger AJ, Leis JM. 2007. “Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces: Pomacentridae). Erratum.” Marine Biology 150:1049-1050.

Wysocki LE, Ladich F. 2005. Hearing in fishes under noise conditions. Journal of the Association for Research in Otoryngology 6(1): 28-36.

Wysocki LE, Ladich F, Dittami J. 2006. “Ship noise and cortisol secretion in European freshwater fishes.” Biological Conservation 128:501-508.

Wysocki LE, Davidson JW III, Smith ME, Frankel AS, Ellison WT, Mazik PM, Popper AN, Bebak J. 2007. “Effects of aquaculture production noise on hearing, growth, and disease resistance of rainbow trout *Oncorhynchus mykiss*.” Aquaculture 272:687-697.

Yelverton JT. 1981. Underwater explosion damage risk criteria for fish, birds, and mammals. Paper presented at the 102nd Meeting of the Acoustical Society of America, 30 November–4 December, Miami Beach, FL.

Yelverton JT, DR Richmond, ER Fletcher, RK Jones. 1973. Safe distances from underwater explosions for mammals and birds. Report by Lovelace Foundation for Medical Education and Research, Albuquerque, NM, for Defense Nuclear Agency, Washington, DC. Report No. 3114T. 72 p.

Yelverton JT, Richmond DR, Hicks W, Saunders K, Fletcher ER. 1975. “The relationship between fish size and their response to underwater blast.” Report DNA 3677T prepared by Lovelace Foundation for Medical Education and Research for Director, Defense Nuclear Agency, Washington, DC.

Young GA. 1991. Concise methods for predicting the effects of underwater explosions on marine life. Naval Surface Warfare Center, Dahlgren, Virginia. 13 p.

Zelick R, Mann D, Popper AN. 1999. “Acoustic communication in fishes and frogs.” In Comparative Hearing: Fish and Amphibians, eds. R.R. Fay and A.N. Popper, 363-411. New York: Springer-Verlag.

SEA TURTLES

Arenas P, Hall M. 1992. The association of sea turtles and other pelagic fauna with floating objects in the eastern tropical Pacific Ocean. In M. Salmon and J. Wyneken, eds. Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-302. pp 7-10.

Balazs GH. 1995. Status of sea turtles in the Central Pacific Ocean. In K.A. Bjorndal, ed. Biology and conservation of sea turtles. Rev. ed. Washington, D.C.: Smithsonian Institution Press.pp 243-252.

Balazs, G.H. 1980. Synopsis of Biological Data on the Green Turtle in the Hawaiian Islands, NOAA Technical Memorandum NMFS-SWFC-7.

Bane G. 1992. First report of a loggerhead sea turtle from Alaska. Marine Turtle Newsletter. 58:1-2.

Bartol SM, Musick JA, Lenhardt ML. 1999. Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). Copeia. 1999:836-840.

Berkson H. 1967. Physiological adjustments to deep diving in the Pacific green turtle (*Chelonia myda sagassizii*). Comparative Biochemistry and Physiology. 21:507-524.

Brill RW, Balazs GS, Holland KN, Chang RKC, Sullivan S, George J. 1995. Daily movements, habitat use, and submergence intervals of normal and tumor-bearing juvenile green turtles (*Chelonia mydas* L.) within a foraging area in the Hawaiian Islands. Journal of Experimental Marine Biology and Ecology. 185:203-218.

Brueggeman JJ (ed). 1991. Oregon and Washington marine mammal and seabird surveys. OCS Study MMS 91-000 (contract 14-12-0001-30426). Pacific OCS Region, Minerals Mgmt. Serv., Los Angeles. U.S. Dept. Interior.

Byles RA. 1988. Behavior and ecology of sea turtles from Chesapeake Bay, Virginia. PhD dissertation, College of William and Mary.

Caribbean Conservation Corporation [CCC]. 2003. Sea turtles: An introduction. http://www. cccturtle.org/overview.htm.

Carr A. 1952. Handbook of turtles: the turtles of the United States, Canada and Baja California. Comstock Publishing Associates, Ithac, New York.

Carr A. 1987. New perspectives on the pelagic stage of sea turtle development. Conservation Biology. 1:103-121.

Carr A. 1995. Notes on the behavioral ecology of sea turtles. In K.A. Bjorndal, ed. Biology and conservation of sea turtles. Rev. ed. Washington, D.C.: Smithsonian Institution Press. pp 19-26.

Cliffton K, Cornejo DO, Felger RS. 1982. Sea turtles of the Pacific coast of Mexico. Pages 199-209 in K.A. Bjorndal ed., Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C. 583 pp.

Cornelius SE. 1982 Status of sea turtles along the Pacific coast of middle America. Pages 211-219 in K.A. Bjorndal ed., Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C. 583 pp.

Cornelius SE. 1995. Status of sea turtles along the Pacific coast of Middle America. Pages 211-219 in K.A. Bjorndal, ed. Biology and conservation of sea turtles, revised edition. Washington, D.C.: Smithsonian Institution Press.

Davenport J, Balazs GH. 1991. Fiery bodies—are pyrosomas an important component of the diet of leatherback turtles? British Herpetological Society Bulletin. 37:33-38.

Dohl TD, Bonnell ML, Guess RC, Briggs KT. 1983. Marine mammals and seabirds of central and northern California, 1980-1983: synthesis of findings. Prepared for the U.S. Department of the Interior, Minerals Management Service, Pacific OCS Region, Los Angeles, California. 248 pp.

Dutton PH, McDonald DL. 1990a. Status of sea turtles in San Diego Bay, 1989-1990. Final report. Sea World Research Institute Technical Report #90-225.

Dutton PH, McDonald DL. 1990b. Sea turtles present in San Diego Bay. In T.H. Richardson, J.I. Richardson, and M. Donnelly, eds. Proceedings of the Tenth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFC-278. pp 139-141.

Eckert KL. 1987. Environmental unpredictability and leatherback sea turtle (*Dermochelys coriacea*) nest loss. Herpetologica. 43:315-323.

Eckert KL. 1993. The biology and population status of marine turtles in the North Pacific Ocean. NOAA Technical Memorandum NMFS-SWFSC-186:1-156.

Eckert KL. 1995. Anthropogenic threats to sea turtles. In K.A. Bjorndal, ed. Biology and conservation of sea turtles, Rev. ed. Washington, D.C.: Smithsonian Institution Press. pp 611-612.

Eckert KL, Eckert SA. 1988. Pre-reproductive movements of leatherback sea turtles (*Dermochelys coriacea*) nesting in the Caribbean. Copeia. 1988:400-406.

Eckert KL, Luginbuhl C. 1988. Death of a giant. Marine Turtle Newsletter. 43:2-3.

Eckert SA. 2002. Distribution of juvenile leatherback sea turtle *Dermochelys coriacea* sightings. Marine Ecology Progress Series. 230:289-293.

Eckert SA, Nellis DW, Eckert KL, Kooyman GL. 1986. Diving patterns of two leatherback sea turtles (*Dermochelys coriacea*) during internesting intervals at Sandy Point, St. Croix, U.S. Virgin Islands. Herpetologica. 42:381-388.

Eckert SA, Liew HC, Eckert KL, Chan EH. 1996. Shallow water diving by leatherback turtles in the South China Sea. Chelonian Conservation and Biology. 2:237-243.

Ernst CH, Lovich JE, Barbour RW. 1994. Turtles of the United States and Canada. Washington, D.C.: Smithsonian Institution Press.

Fritts TH. 1981. Pelagic feeding habits of turtles in the eastern Pacific. Marine Turtle Newsletter. 17:1.

Fritts TH, Reynolds RP. 1981. Pilot study of the marine mammals, birds and turtles in OCS areas of the Gulf of Mexico. U.S. Fish and Wildlife Service Office of Biological Services FWS/OBS-81/36. 139pp.

Fritts TH, Stinson ML, Márquez-M R. 1982. Status of sea turtle nesting in southern Baja California, Mexico. Bulletin of the Southern California Academy of Sciences. 81:51-60.

Gooding RM, Magnuson JJ. 1967. Ecological significance of a drifting object to pelagic fishes. Pacific Science. 21:486-497.

Goertner JF. 1982. Prediction of underwater explosion safe ranges for sea mammals. Report NSWC/WOL TR 82-188. Silver Spring, MD: Naval Ordnance Laboratory.

Guess RC. 1981a. A Pacific Loggerhead captured of California's northern Channel Islands. Herpetological Review. 12:15.

Guess RC. 1981b. Occurrence of a Pacific loggerhead turtle, *Caretta caretta gigas* Deraniyagala, in the waters off Santa Cruz, California. California Fish Game Notes. 68:122-123.

Hartog JC, van Nierop MM. 1984. A study on the gut contents of six leathery turtles, *Dermochelys coriacea* (Linneaus) (Reptilia: Testudines: Dermochelyidae) from British waters and from the Netherlands. Zoologische Verhandelingen 209:1-36 J. C. den Hartog, Rijksmuseum van Natuurlijke Historie, Postbus 9517, 2300 RA Leiden, Nederland.

Hasbun CR, Vasquez M. 1999. Sea turtles of El Salvador. Marine Turtle Newsletter. 85:7-9.

Hays GC, Adams CR, Broderick AC, Godley BJ, Lucas DJ, Metcalfe JD, Prior AA. 2000. The diving behaviour of green turtles at Ascension Island. Animal Behaviour. 59:577-586.

Hochscheid S, Godley BJ, Broderick AC, Wilson RP. 1999. Reptilian diving: Highly variable dive patterns in the green turtle *Chelonia mydas*. Marine Ecology Progress Series. 185:101-112.

Hodge RP. 1982. *Caretta caretta gigas* (Pacific loggerhead) USA: Washington. Herpetology Review. 13:24

Hodge RP, Wing BL. 2000. Occurrences of marine turtles in Alaska waters: 1960-1998. Herpetological Review. 31:148-151.

Hubbs CL. 1977. First record of mating of ridley turtles in California, with notes on commensals, characters, and systematics. California Fish and Game. 63:263-267.

Jessop TS, Knapp R, Limpus CJ, Whittier JM. 2002. Dynamic endocrine responses to stress: evidence for energetic constraints and status dependence of breeding in male green turtles. General Comparative Endocrinology. 126:59–67.

Kalb H, Owens D. 1994. Differences between solitary and arribada nesting olive ridley females during the internesting period. In, K.A. Bjorndal, A.B. Bolten, D.A. Johnson, and P.J. Eliazar eds. Proceedings of the Fourteenth Annual Symposium on Sea Turtle biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351. 323 pp.

Ketten DR. 1998. Marine mammal auditory systems: A summary of audiometric and anatomical data and its implications for underwater acoustic impacts," NOAA-TM-NMFSSWFSC-256, Department of Commerce.

Klima EF, Gitschlag GR, Renaud ML. 1988. Impacts of explosive removal of offshore petroleum platforms on sea turtles and dolphins. Marine Fisheries Review. 50:33-42.

Kopitsky K, Pitman RL, Plotkin P. 2000. Investigations on at-sea mating and reproductive status of olive ridleys, *Lepidochelys olivacea*, captured in the eastern tropical Pacific. Pp. 160-162. In: Kalb, H.J. and Wibbels, T. (compilers). Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum, NMFS-SEFSC-443.

Lenhardt ML. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (*Caretta caretta*). Pages 238-241 in K.A. Bjorndal, A.B. Bolten, D.A. Johnson, and P.J. Eliazar, eds. Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351.

Lenhardt ML, Bellmund S, Byles RA, Harkins SW, Musick JA. 1983. Marine turtle reception of bone-conducted sound. Journal of Auditory Research. 23:119-123.

López-Castro MC, Nichols WJ, Orantes M. 2000. Olive ridley nesting in Baja California Sur, Mexico: Preliminary observations. In H. Kalb and T. Wibbels, eds. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-443. pp 273-4.

Lutcavage ME, Lutz PL. 1997. Diving physiology. In P.L. Lutz and J.A. Musick, eds. The biology of sea turtles. Boca Raton, Florida: CRC Press. pp 277-296.

Lux J, Reina R, Stokes L. 2003: Nesting activity of leatherback turtles **(***Dermochelys coriacea*) in relation to tidal and lunar cycles at Playa Grande, Costa Rica. In *Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation Miami FL*. Edited by: Seminoff JA. NOAA Technical Memorandum NMFS-SEFSC-503,215-216.

Márquez-M R. 1990. Sea turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date. Rome: Food and Agriculture Organization of the United Nations.

McEwen BS, Lashley EA. 2002. The end of stress as we know it. Washington, DC:Joseph Henry Press.

Meylan A. 1995. Sea turtle migration—evidence from tag returns. In K.A. Bjorndal, ed. Biology and conservation of sea turtles, Rev. ed. Washington, D.C.: Smithsonian Institution Press. pp 91-100.

Miller JD. 1997. Reproduction in sea turtles. Pages 51-81 in P.L. Lutz and J.A. Musick, eds. The biology of sea turtles. Boca Raton, Florida: CRC Press.

Morreale SJ, Standora EA, Spotila JR, Paladino FV. 1996. Migration corridor for sea turtles. Nature. 384:319-320.Mortimer, J.A. 1995. Feeding ecology of sea turtles. Pages 103-109 in K.A. Bjorndal, ed. Biology and conservation of sea turtles, Rev. ed. Washington, D.C.: Smithsonian Institution Press.

Musick JA, Limpus CJ. 1997. Habitat utilization and migration of juvenile sea turtles. In P.L. Lutz and J.A. Musick, eds. The biology of sea turtles. Boca Raton, Florida: CRC Press. pp 137-163.

National Marine Fisheries Service [NMFS]. 2002. Annual report to Congress on the status of U.S. fisheries 2001. Silver Spring, Maryland: National Marine Fisheries Service. 142 pp.

National Marine Fisheries Service and U.S. Fish and Wildlife Service [USFWS]. 1998a. Recovery plan for U.S. Pacific populations of the leatherback turtle (*Dermochelys coriacea*). Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998b. Recovery plan for U.S. Pacific populations of the East Pacific green turtle (*Chelonia mydas*). Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998c. Recovery plan for U.S. Pacific populations of the loggerhead turtle (*Caretta caretta*). Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998d. Recovery plan for U.S. Pacific populations of the olive ridley turtle (*Lepidochelys olivacea*). Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998e. Recovery plan for U.S. Pacific populations of the leatherback turtle (*Dermochelys coriacea*). Silver Spring, Maryland: National Marine Fisheries Service.

National Oceanic and Atmospheric Administration [NOAA]. 2001. Final rule for the shock trial of the WINSTON S. CHURCHILL (DDG-81), Federal Register, Department of Commerce; NMFS, FR 66, No. 87, 22450-67.

National Research Council. 1990. Decline of the sea turtles: Causes and prevention. Washington, D.C.: National Academy Press.

Nichols WJ, Resendiz A, Mayoral-Russeau C. 2000. Biology and conservation of loggerhead turtles (*Caretta caretta*) in Baja California, Mexico. Pages 169-171 in H. Kalb and T. Wibbels, eds. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-443.

Oliver JA. 1946. An aggregation of Pacific sea turtles. Copeia. 2:103

Parker DM, Dutton PH, Kopitsky K, Pitman RL. 2003. Movement and dive behavior determined by satellite telemetry for male and female olive ridley turtles in the Eastern Tropical Pacific. In J.A. Seminoff, ed. Proceedings of the Twenty-second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503. pp 48-9.

Pitman RL. 1990. Pelagic distribution and biology of sea turtles in the Eastern Tropical Pacific. Pages 143-148 in T.H. Richardson, J.I. Richardson, and M. Donnelly, eds. Proceedings of the Tenth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFC-278.

Pitman RL. 1992. Sea turtle associations with flotsam in the Eastern Tropical Pacific. Page 94 in M. Salmon and J. Wyneken, eds. Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-302.

Plotkin PT, Byles RA, Owens DW. 1994. Post-breeding movements of male olive ridley sea turtles *Lepidochelys olivacea* from a nearshore breeding area. In: Bjorndal K.A., Bolton A.B., Johnson D.A., Eliazar P.J. (eds). Proc 14th Annual Symposium Sea Turtle Biol Conserv. NOAA Tech Memo NMFCSEFSC 351:119

Polovina JJ, Howell E, Parker DM, Balazs GH. 2003. Dive-depth distribution of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific: Might deep longline sets catch fewer turtles? Fishery Bulletin. 101:189-193.

Pritchard PCH. 1982. Nesting of the leatherback turtle, *Dermochelys coriacea* in Pacific Mexico, with a new estimate of the world population status. Copeia. 1982:741-747.

Radovich J. 1961. Relationships of some marine organisms of the northeast Pacific Ocean to water temperatures, particularly during 1957 through 1959. California Cooperative Oceanic Fishery Investigation Reports. 7:163-71.

Renaud ML, Carpenter JA. 1994. Movements and submergence patterns of loggerhead turtles (*Caretta caretta*) in the Gulf of Mexico determined through satellite telemetry. Bulletin of Marine Science. 55:1-15.

Ridgway SH, Wever EG, McCormick JG, Palin J, Anderson JH. 1969. Hearing in the giant sea turtle, *Chelonia mydas*. Proceedings of the National Academy of Sciences. 64:884-890.

Sarti-M L, Eckert SA, Garcia-T N, Barragan AR. 1996. Decline of the world's largest nesting assemblage of leatherback turtles. Marine Turtle Newsletter. 74:2-5.

Seminoff JA. 2004. Marine turtle specialist group review: 2004 global status assessment, green turtle (*Chelonia mydas*). The World Conservation Union (IUCN), Species Survival Commission Red List Programme, Marine Turtle Specialist Group.

Seminoff JA, Nichols WJ, Resendiz A, Brooks L. 2003. Occurrence of hawksbill turtles, *Eretmochelys imbricata* (Reptilia: Cheloniidae), near the Baja California Peninsula, Mexico. Pacific Science. 57:9-16.

Snover M. 2005. Population trends and viability analyses for Pacific Marine Turtles. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Pacific Islands Fishery Science Center Internal Report IR-05-008. Honolulu, Hawaii.

Southwood AL, Andrews RD, Lutcavage ME, Paladino FV, West NH, George RH, Jones DR. 1999. Heart rates and diving behavior of leatherback sea turtles in the Eastern Pacific ocean. Journal of Experimental Biology. 202:1115–1125.

Spotila J. 2004. Sea Turtles: A complete guide to their biology, behavior, and conservation. Baltimore, Maryland: The Johns Hopkins University Press and Oakwood Arts.

Spotila JR, O'Connor MP, Paladino FV. 1997. Thermal biology. In P.L. Lutz and J.A. Musick, eds. The biology of sea turtles. Boca Raton, Florida: CRC Press. pp 297-314.

Standora EA, Spotila JR, Keinath JA, Shoop CR. 1984. Body temperatures, diving cycles and movement of a subadult leatherback turtle, *Dermochelys coriacea*. Herpetologica. 40:169–176.

Starbird CH, Baldridge A, Harvey JT. 1993. Seasonal occurrence of leatherback sea turtles (*Dermochelys coriacea*) in the Monterey Bay region, with notes on other sea turtles, 1986-1991. California Fish and Game. 79:54-62.

Stinson ML. 1984. Biology of sea turtles in San Diego Bay, California, and in the northeastern Pacific Ocean. Master's thesis, San Diego State University.

U.S. Department of the Navy [DoN]. 1998. Final environmental impact statement, shock testing the SEAWOLF submarine. U.S. Department of the Navy, Southern Division, Naval Facilities Engineering Command, North Charleston, SC, 637 pp.

U.S. Department of the Navy. 2001. Final environmental impact statement, shock trial of the WINSTON S. CHURCHILL (DDG 81). NAVSEA. 597 pp.

U.S. Department of Navy. 2005. Marine resource assessment for the Southern California operating area. Prepared for the Navy Commander, US Pacific Fleet. 574 pp.

Wever EG. 1978. The reptile ear: Its structure and function. Princeton University Press, Princeton, NJ. 1,024 pp.

Whittow GC, Balazs GH. 1982. Basking behavior of the Hawaiian green turtle (*Chelonia mydas*). Pacific Science. 36:129-139.

Wyneken J. 1997. Sea turtle locomotion: Mechanics, behavior, and energetics. Pages 165-198 in P.L. Lutz and J.A. Musick, eds. The biology of sea turtles. Boca Raton, Florida: CRC Press.

MARINE MAMMALS

Babushina, E.S., G.L. Zaslavsky, and L.I. Yurkevich, 1991. Air and underwater hearing of the northern fur seal audiograms and auditory frequency discrimination. Biofizika. 36:904-907. (In Russian with English abstract).

Baker, C.S., L. Medrano-Gonzalez, J. Calambokidis, A. Perry, F. Pichler, H. Rosenbaum, J.M. Straley, J. Urban-Ramirez, M. Yamaguchi, and O. Von Ziegesar. 1998. Population structure of nuclear and mitochondrial DNA variation among humpback whales in the North Pacific. Molecular Ecology. 7:695-707.

Barlow, J., 1994. Abundance of large whales in California coastal waters: a comparison of ship surveys in 1979/80 and in 1991. Reports of the International Whaling Commission. 44:399-406.

Barlow J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. Fishery Bulletin. 93:1-14.

Barlow J. 1997. Preliminary estimates of cetacean abundance off California, Oregon and Washington based on a 1996 ship survey and comparisons of passing and closing modes. NMFS-SWFSC Admin. Rep. LJ-97-11. Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA.

Barlow, J. 2007. Recalculation of Southern California cetacean density estimates based on NMFS survey data through 2005. Unpublished report prepared by the NMFS-South West Fisheries Science Center for the Comander, Pacific Fleet, Department of the Navy.

Barlow J, Forney KA, Hill PS, Brownell Jr PS, Carretta JV, DeMaster DP, Julian F, Lowry MS, Ragen T, Reeves RR. 1997. U.S. Pacific Marine Mammal Stock Assessments: 1996. NOAA Technical Memorandum NMFS-SWFSC-248. Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA.

Barlow, J. and K.A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. Fisheries Bulletin. 105:509–526.

Bjørge A. 2002. How persistent are marine mammal habitats in an ocean of variability? Pages 63-91 in P.G.H. Evans and J.A. Raga, eds. Marine mammals: Biology and conservation. New York: Kluwer Academic/Plenum Publishers.

Bonnell ML, Dailey MD. 1993. Marine mammals. In M. D. Dailey, D. J. Reish and J.W. Anderson, eds. Ecology of the Southern California Bight: A synthesis and interpretation. Berkeley: University of California Press. pp 604-681.

Bowen WD, Beck CA, Austin DA. 2002. Pinniped ecology. In W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego: Academic Press. pp 911-921.

Calambokidis, J., 1995. Blue whales off California. Whalewatcher, Journal of the American Cetacean Society. 29:3-7.

Calambokidis, J., G.H. Steiger, J.C. Cubbage, K.C. Balcomb, C. Ewald, S. Kruse, R. Wells, and R. Sears, 1990. Sightings and movements of blue whales off central California, 1986–88 from photo-identification of individuals. Reports of the International Whaling Commission, Special Issue 12:343-348.

Calambokidis, J., G.H. Steiger, and J. Barlow, 1993. Estimates of humpback and blue whale abundance along the U.S. west coast using mark-recapture of identified individuals. Abstract in Abstracts of the 10th Biennial Conference on the Biology of Marine Mammals; 1993 November; Galveston, TX. p. 34.

Calambokidis, J., G.H. Steiger, J.R. Evenson, K.R. Flynn, K.C. Balcomb, D.E. Claridge, P. Bloedel, J.M. Straley, C.S. Baker, O. von Ziegesar, M.E. Dahlheim, J.M. Waite, J.D. Darling, G. Ellis, and G.A. Green. 1996. Interchange and isolation of humpback whales off California and other North Pacific feeding grounds. Marine Mammal Science. 12:215-226.

Carretta JV, Lowry MS, Stinchcomb CE, Lynn MS, Cosgrove RE. 2000. Distribution and abundance of marine mammals at San Clemente Island and surrounding offshore waters: Results from aerial and ground surveys in 1998 and 1999. Southwest Fisheries Science Center Administrative Report LJ-00-02. La Jolla, California: National Marine Fisheries Service.

Carretta JV, Forney KA, Muto MM, Barlow J, Baker J, Lowry M. 2004. U.S. Pacific marine mammal stock assessments: 2003. NOAA Technical Memorandum NMFS-SWFSC-358. Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA.

Carretta JV, Forney KA, Muto MM, Barlow J, Baker J, Hanson B, Lowry MS. 2005. U.S. Pacific marine mammal stock assessments: 2005. NOAA Technical Memorandum NMFS-SWFSC-375. Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA.

Carretta JV, Forney KA, Muto MM, Barlow J, Baker J, Hanson B, Lowry MS. 2006. U.S. Pacific marine mammal stock assessments: 2005. NOAA Technical Memorandum NMFS-SWFSC-388. Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA. 317 pp.

Carretta JV, Forney KA, Muto MM, Barlow J, Baker J, Hanson B, Lowry MS. 2007. U.S. Pacific marine mammal stock assessments: 2006. NOAA-TM-NMFS-SWFSC-398. 321 pp.

Charif, R.A., D.K. Mellinger, K.J. Dunsmore, K.M. Fristrup, C.W. Clark. 2002. Estimated source levels of fin whale (Balaenoptera physalus) vocalizations: adjustments for surface interference. Marine Mammal Science. 18(1):81-98.

Clark, C.W. and K.M. Fristrup. 1997. Whales ’95: A combined visual and acoustic survey of blue and fin whales off southern California. Reports of the International Whaling Commission. 47:583-600.

Corkeron PJ, Connor RC. 1999. Why do baleen whales migrate? Marine Mammal Science. 15:1228-1245.

Croll DA, Tershy BR, Hewitt RP, Demer DA, Fiedler PC, Smith SE, Armstrong W, Popp JM, Kiekhefer T, Lopez VR, Urban J, Gendron D. 1998. An integrated approach to the foraging ecology of marine birds and mammals. Deep-Sea Research II. 45:1353-1371.

Department of the Navy. 1997. Environmental Impact Statement for Shock Testing the Seawolf Submarine.

Department of the Navy. 2001a. Environmental Impact Statement for the Shock Trial of the Winston S. Churchill, (DDG-81), Department of the Navy.

Department of the Navy. 2002. Point Mugu environmental impact statement/ overseas environmental impact statement. Naval Air Warfare Center, Weapons Division. 712 pp.

Department of the Navy. 2002a. Marine resource assessment for the Cherry Point Operating Area. Contract Number N62470-95-D-1160. Prepared for the Commander, U.S. Atlantic Fleet, Norfolk, Virginia by Geo-Marine, Inc., Plano, Texas.

DoN. February 2004. Biological Assessment for Virtual At-Sea Training/Integrated Maritime Portable Acoustic Scoring & Simulator (VAST/IMPASS) System. Commander U.S. Fleet Forces Command, Norfolk, VA.

Department of the Navy. 2005. Draft Overseas Environmental Impact Statement/Environmental Impact Statement (OEIS/EIS), Undersea Warfare Training Range. Department of the Navy, Commander, U.S. Atlantic Fleet.

Department of the Navy. 2005a. Marine resources assessment for the Southern California Operating Area. Prepared for the Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, HI, by Geo-Marine, Inc., Plano, TX. Contract # N62470-02-D-9997, CTO 0025.

Department of the Navy. 2006. Undersea Warfare Exercise (USWEX) EA/OEA. Department of the Navy, Commander, Third Fleet.

Dailey MD, Anderson JW, Reish DJ, Gorsline DS. 1993. The Southern California Bight: background and setting. In M.D. Dailey, D.J. Reish, and J.W. Anderson, eds. Ecology of the Southern California Bight. Berkeley: University of California Press. pp 1-18.

Deecke, V. B., J. K. B. Ford, and P. J. B. Slater, 2005. The vocal behaviour of mammal-eating killer whales: Communicating with costly calls. Animal Behaviour 69:395-405.

Dierauf, L.A. and F.M.D. Gulland. 2001. Marine Mammal Unusual Mortality Events. IN: L.A. Dierauf and F.M.D. Gulland, eds. Handbook of Marine Mammal Medicine. CRC Press, Boca Raton. pp. 69-81.

Dietz, R., J. Teilmann, M.-P.H. Jørgensen, and M.V. Jensen. 2002. Satellite tracking of humpback whales in West Greenland. National Environmental Research Institute Technical Report 411:1-38. Copenhagen, Denmark: National Environmental Research Institute.

Dohl TP, Norris KS, Guess RC, Bryant JD, Honig MW. 1981. Summary of marine mammal and seabird surveys of the Southern California Bight area, 1975–1978. Volume III, Part II, Cetacea of the Southern California Bight. Report from the Center for Coastal and Marine Studies, University of California, Santa Cruz, CA, for U.S. Bureau of Land Management, Washington, DC. 414 pp. NTIS PB81-248189.

Dohl, T.P., R.C. Guess, M.L. Duman, and R.C. Helm, 1983. Cetaceans of central and northern California, 1980-1983: status, abundance and distribution. OCS Study MMS 84-0045. Report from the Center for Marine Studies, University of California, Santa Cruz, CA, for U.S. Minerals Management Service, Pacific Region OCS, Los Angeles, CA. 284 pp. NTIS PB85-183861.

Dohl TP, Bonnell ML, Ford RG. 1986. Distribution and abundance of common dolphin, *Delphinus delphis*, in the Southern California Bight: A quantitative assessment based upon aerial transect data. Fishery Bulletin. 84:333-343.

Dolar, M.L.L., W.A. Walker, G.L. Kooyman and W.F. Perrin. 2003. Comparative feeding ecology of spinner dolphins (*Stenella longirostris*) and Fraser's dolphins (*Lagenodelphis hosei*) in the Sulu Sea. Marine Mammal Science. 19:1-19.

Dolphin, W.F. 1987. Ventilation and dive patterns of humpback whales, *Megaptera novaeangliae*, on their Alaskan feeding grounds. Canadian Journal of Zoology. 65:83-90.

Domingo, M., M. Vilafranca, J. Vista, N. Prats, A. Trudgett, and I. Visser. 1992. Pathologic and immunocytochemical studies of morbillivirus infection in striped dolphin *Stenella coeruleoalba.* Veterinary Pathology 29:1-10.

Domjan M. 1998. The principles of learning and behavior, 4th ed. New York: Brooks Cole.

Donovan, G.P. 1991. A review of IWC stock boundaries. Reports of the International Whaling Commission, Special Issue. 13:39-63.

Drouot V, Gannier A, and J.C. Goold. 2004. Diving and feeding behaviour of sperm whale (*Physeter macrocephalus*) in the northwestern Mediterranean Sea. Aquat Mamm 30: 419–426.

Dudok van Heel, W.H. 1966. Navigation in Cetaceans. IN: K.S. Norris, eds. Whales, Dolphins, and Porpoises. University of California Press, Berkeley, CA. pp. 597-606.

Dunn, J.L., J.D. Buck, and T.R. Robeck. 2001. Bacterial diseases of cetaceans and pinnipeds. IN: L.A. Dierauf and F.M.D. Gulland, eds. CRC Handbook of Marine Mammal Medicine. CRC Press, Boca Raton, FL.

D'Vincent C.G., R.M. Nilson, RE. Hanna. (1985) Vocalization and coordinated feeding behavior of the humpback whale in southeast ska. Sci Rep Whales Res Inst Tokyo 36:41–47.

Edds, P.L. 1982. Vocalisations of the blue whale, *Balaenoptera musculus* in the St. Lawrence River. J. Mammal. 63:345-7.

Edds, P.L. 1988. Characteristics of finback *Balaenoptera physalus* vocalizations in the St. Lawrence Estuary. Bioacoustics 1: 131-149.

Edds, P.L. and J.A.F. Macfarlane. 1987. Occurrence and general behavior of balaenopterid cetaceans summering in the St. Lawrence Estuary, Canada. Bioacoustics. 1:131-149.

Edds, P.L.; T.J. MacIntyre, and R. Naveen (1984). "Notes on a sei whale (*Balaenoptera borealis* Lesson) sighted off Maryland". Cetus 5: 4–5.

Edds-Walton, P. L. 1997. Acoustic communication signals of mysticete whales. Bioacoustics 8, 47–60.

Eguchi T, and J.T. Harvey. 2005. Diving behavior of the Pacific harbor seal (*Phoca vitulina richardii*) in Monterey Bay, California. Mar Mamm Sci 21:283–295.

Erbe, C. 2002. Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model. Marine Mammal Science 18:394-418.

Estes, J. A. and R.J. Jameson. 1988. A double-survey estimate for sighting probability of sea otters in California. J. Wildl. Manage. 52:70-76.

Estes, J.A., and J.L. Bodkin. 2002. Otters. In Encyclopedia of Marine Mammals (W.F. Perrin, B. Wursig, and J.G.M. Thewissen, ed.). Academic Press, San Diego, California, p. 842–858.

Estes, J.A., B.B. Hatfield, K. Ralls and J. Ames. 2003. Causes of mortality in California sea otters during periods of population growth and decline. Marine Mammal Science. 19:198-216.

Estes, J.A., M.T. Tinker, T.M. Williams, and D.F. Doak. 1998. "Killer whale predation on sea otters linking oceanic ecosystems." Science 282: 473-476.

Etnoyer, P., D. Canny, B. Mate, and L. Morgan, 2004. Persistent pelagic habitats in the Baja California to Bering Sea (B2B) Ecoregion. Oceanography. 17:90-101.

Etnoyer, P., D. Canny, B. Mate, L. Morgan, J. Ortega-Otiz and W. Nichols. 2006. Sea-surface temperature gradients across blue whale and sea turtle foraging trajectories off the Baja California Peninsula, Mexico. Deep-Sea Research II. 43: 340-358.

Evans, D.L. 2002. Report of the Workshop on Acoustic Resonance as a Source of Tissue Trauma in Cetaceans. Silver Spring, MD.

Evans, D.L. and G. R. England. 2001. Joint interim report - Bahamas Marine Mammal Stranding - event of 15-16 March 2000. U.S. Department of Commerce; Secretary of the Navy, vi + 59 pp.

Evans, D.L. and G.R. England. 2001. Joint Interim Report Bahamas Marine Mammal Stranding Event of 15-16 March 2000. Department of Commerce. 66 pp.

Evans, K., R. Thresher, R.M. Warneke, C.J.A. Bradshaw, M. Pook, D. Thiele and M.A. Hindell. 2005. Periodic variability in cetacean strandings: links to large-scale climate events. Biology Letter. 1:147-150.

Evans, P.G.H, P. Anderwald & M.E. Baines 2003. UK Cetacean Status Review. Report to English Nature & Countryside Council for Wales. Sea Watch Foundation, Oxford, UK.

Evans, W. E. 1971. Orientation Behavior of Delphinids: Radio-telemetric Studies. In: Orientation: Sensory Basis, H. E. Adler (ed.). Annals, New York Acad. Sci., Vol. 188, pp. 142-160.

Evans, W. E., 1994. Common dolphin, white-bellied porpoise *Delphinus delphis* Linnaeus, 1758. Pages 191-224 in S. H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego: Academic Press.

Fahlman, A., A. Olszowka, B. Bostrom, and D.R. Jones. 2006. Deep diving mammals: dive behavior and circulatory adjustments contribute to bends avoidance. Respiratory Physiology and Neurobiology. 153:66-77

Fahner, M., J. Thomas, K. Ramirez, and J. Boehm. 2004. Echolocation in bats and dolphins. In Acoustic Properties of Echolocation Signals by Captive Pacific White-Sided Dolphins (*Lagenorhynchus obliquidens*), edited by J. Thomas, C. Moss, and M. Vater, University of Chicago Press, Chicago.

Fay., R.R. 1988. Hearing in Vertebrates: a Psychophysics Databook. Hill-Fay Associates, Winnetka IL.

Feldkamp, S. D., R. L. DeLong, and G. A. Antonelis, 1991. Effects of El Niño 1983 on the foraging patterns of California sea lions *(Zalophus californianus*) near San Miguel Island, California. Pages 146-155 in Trillmich, F. and K. A. Ono, eds. Pinnipeds and El Niño: Responses to environmental stress. Berlin, Germany: Springer-Verlag.

Feldkamp, S.D., R.L. DeLong, and G.A. Antonelis. 1989. Diving patterns of California sea lions, *Zalophus californianus*. Canadian Journal of Zoology. 67:872-883.

Feller, W. 1968. Introduction to probability theory and its application. Vol. 1. 3rd ed. John Wilay & Sons, NY, NY.

Ferguson MC, Barlow J. 2001. Spatial distribution and density of cetaceans in the eastern tropical Pacific Ocean based on summer/fall research vessel surveys in 1986-1996. Southwest Fisheries Science Center Administrative Report LJ-01-04. La Jolla, California: National Marine Fisheries Service.

Ferguson, M. C., J. Barlow, T. Gerrodette, and P. Fiedler, 2001. Meso-scale patterns in the density and distribution of ziphiid whales in the eastern Pacific Ocean. Pages 5-9 in Summary of the Workshop on the Biology and Conservation of Beaked Whales, Fourteenth Biennial Conference on the Biology of Marine Mammals. 28 November-3 December 2001. Vancouver, British Columbia.

Ferguson, M. C. and J. Barlow. 2003. Addendum: Spatial distribution and density of cetaceans in the eastern tropical Pacific Ocean based on summer/fall research vessel surveys in 1986-96. Administrative Report LJ-01-04 (addendum), Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92037.

Ferguson, M. C., 2005. Cetacean population density in the eastern Pacific Ocean: Analyzing patterns with predictive spatial models. Ph. D. diss., University of California.

Ferguson, M. C., J. Barlow, S. B. Reilly, and T. Gerrodette. 2006. Predicting Cuvier's (*Ziphius cavirostris*) and Mesoplodon beaked whale population density from habitat characteristics in the eastern tropical Pacific Ocean. Journal of Cetacean Research and Management 7(3):287-299.

Fernández, A., J.F. Edwards, F. Rodreguez, A. Espinosa de los Monteros, P. Herreez, P. Castro, J. R. Jaber, V. Marten and M. Arbelo. 2005. Gas and Fat Embolic Syndrome Involving a Mass Stranding of Beaked Whales. Family Ziphiidae) Exposed to Anthropogenic Sonar Signals. Veterinary Pathology. 42:446-457.

Ferrero, R. C. and W. A. Walker, 1995. Growth and reproduction of the common dolphin, *Delphinus delphis* Linnaeus, in the offshore waters of the North Pacific Ocean. Fishery Bulletin 93:483-494.

Ferrero, R.C., Hodder, J. and Cesarone, J. 1994. Recent strandings of rough-toothed dolphins, Steno bredanensis, on the Oregon and Washington coasts. Marine Mammal Science 10(1):114-6.

Fiedler PC. 2002. The annual cycle and biological effects of the Costa Rica Dome. Deep-Sea Research I. 49:321–338

Fiedler, P.C., S.B. Reilly, R.P. Hewitt, D. Demer, V.A. Philbrick, S. Smith, W. Armstrong, D.A. Croll, B.R. Tershy, and B.R. Mate, 1998. Blue whale habitat and prey in the California Channel Islands. Deep-Sea Research II 45:1781-1801.

Field I.C, Hindell M.A, Slip D.J, and K. Michael. 2001. Foraging strategies of southern elephant seals (*Mirounga leonina*) in relation to frontal zones and water masses. Antarct. Sci. 13:371–379.

Finneran, J. J. and D. S. Houser, 2006. Comparison of in-air evoked potential and underwater behavioral hearing thresholds in four bottlenose dolphins (*Tursiops truncatus*). Journal of the Acoustical Society of America. 119(5):3181-3192.

Finneran, J. J., C. E. Schlundt, B. Branstetter, and R. L. Dear. 2007. Assessing temporary threshold shift in a bottlenose dolphin (*Tursiops truncates*) using multiple simultaneous auditory evoked potentials. J. Acoust. Soc. Am. 122:1249–1264.

Finneran, J. J., D. A. Carder, C. E. Schlundt, and S. H. Ridgway, 2005. "Temporary threshold shift (TTS) in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones," J. Acoust. Soc. Am. 118, 2696-2705.

Finneran, J.J., and C.E. Schlundt. 2004. Effects of intense pure tones on the behavior of trained odontocetes. Space and Naval Warfare Systems Center, San Diego, Technical Document. September.

Finneran, J.J., D.A. Carder, and S.H. Ridgway. 2001. Temporary threshold shift (TTS) in bottlenose dolphins *Tursiops truncatus* exposed to tonal signals. Journal of the Acoustical Society of America. 1105:2749(A), 142nd Meeting of the Acoustical Society of America, Fort Lauderdale, FL. December.

Finneran, J.J., D.A. Carder, and S.H. Ridgway. 2003. Temporary threshold shift measurements in bottlenose dolphins *Tursiops truncatus*, belugas *Delphinapterus leucas*, and California sea lions *Zalophus californianus*. Environmental Consequences of Underwater Sound (ECOUS) Symposium, San Antonio, TX, 12-16 May 2003.

Finneran, J.J., R. Dear, D.A. Carder, and S.H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. Journal of the Acoustical Society of America. 111:2929-2940.

Fish, J.F. and C.W. Turl. 1976. Acoustic source levels of four species of small whales. Naval Undersea Center Report, NUC-TP 547.

Fitch, J.E. and R.L. Brownell. 1968. Fish otoliths in cetacean stomachs and their importance on interpreting food habits. J. Fish. Res. Board Can., 25:2561–2574.

Forcada, J. 2002. Distribution. Pages 327-333 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego: Academic Press.

Forcada J. 2002. Distribution. I W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego: Academic Press. pp 327-333.

Ford, J.K.B. 2002. Killer whale *Orcinus orca*. Pages 669-676 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego: Academic Press.

Forney K.A., J. Barlow, M.M. Muto, M. Lowry, J. Baker, G. Cameron, J. Mobley, C. Stinchcomb, and J.V. Carretta. 2000. U.S. Pacific marine mammal stock assessments: 2000. NOAA/TM/NMFS/SWFSC/300.

Forney, K. A. 1994. Recent information on the status of odontocetes in Californian waters. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-202, 87 p.

Forney, K. A. 2000. Environmental models of cetacean abundance: reducing uncertainty in population trends. Conserv. Biol. 14(5):1271-1286.

Forney, K. A., and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-1992. Marine Mammal Science 14(3):460–489.

Forney, K. A., J. Barlow, and J. V. Carretta. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. Fish. Bull. 93:1526.

Forney, K.A. 1997. Patterns of variability and environmental models of relative abundance for California cetaceans. Ph.D. Thesis, University of California, San Diego.

Forney, K.A. 2007. Preliminary estimates of cetacean abundance along the U.S. west coast and within four national marine sanctuaries during 2005. NOAA Technical Memorandum NMFS. NOAA-TM-NMFS-SWFSC-406.

Forney, K.A., D.J. St. Aubin and S.J. Chivers. 2002. Chase encirclement stress studies on dolphins involved in eastern tropical pacific ocean purse-seine operations during 2001. NMFS-SWFSC. Administrative Report LJ-02-32. 27 pp.

Frantzis, A. 1998. Does acoustic testing strand whales? Nature. 392:29.

Frazer, L. N. and E. Mercado, 2000. A Model for humpback whale sonar, IEEE. J. Ocean Eng., 25, 160–182.

Freitas, L. 2004. The stranding of three Cuvier’s beaked whales *Ziphius caviostri*s in Madeira archipelago- May 2000. European Cetacean Society Newsletter 42(Special Issue):28-32.

Fromm, D. 2004a. Acoustic Modeling Results of the Haro Strait For 5 May 2003. Naval Research Laboratory Report, Office of Naval Research, 30 January 2004.

Fromm, D. 2004b. EEEL Analysis of U.S.S. SHOUP Transmissions in the Haro Strait on 5 May 2003. Naval Research Laboratory briefing of 2 September 2004.

Gallo, R.J.P. and A.L.C. Figueroa. 1996. Size and weight of Guadalupe fur seals. Marine Mammal Science 12:318-321.

Gallo-Reynoso, J. P. and A.L. Figueroa-Carranza. 1995. Occurrence of bottlenose whales in the waters of Isla Guadalupe, Mexico. Marine Mammal Science 11(4):573-575.

Gallo-Reynoso, J.-P. 1994. Factors affecting the population status of Guadalupe fur seal, Arctocephalus townsendi (Merriam, 1897), at Isla de Guadalupe, Baja California, Mexico. Ph.D. Dissertation, University of California, Santa Cruz, CA. 199 pp.

Gambell, R. 1979. The blue whale. Biologist 26:209-215.

Gambell, R. 1985. Sei whale *Balaenoptera borealis* Lesson, 1828. Pages 155-170 in S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals. Volume 3: The Sirenians and baleen whales. San Diego: Academic Press. 362 pp.

Gannier, A. 2000. Distribution of cetaceans off the Society Islands (French Polynesia) as obtained from dedicated surveys. Aquatic Mammals. 26:111-126.

Gannon, D.P., A.J. Read, J.E. Craddock, K.M. Fristrup, and J.R. Nicolas. 1997a. Feeding ecology of the long-finned pilot whale in the western North Atlantic. Mar. Ecol. Progr. Ser. 148:1-10.

Garrigue, C. and J. Greaves, 2001. Cetacean records for the New Caledonian area (Southwest Pacific Ocean). Micronesica 34(1):27-33.

Gaskin, D.E. 1982. The ecology of whales and dolphins. Portsmouth, New Hampshire: Heinemann.

Gedamke, J., D.P. Costa, and A. Dunstan. 2001. Localization and visual verification of a complex minke whale vocalization. Journal of the Acoustical Society of America. 109:3038-3047.

Gentry, R. 1998. Behavior and Ecology of the Northern Fur Seal. Princeton: Princteon University Press.

Geraci, J. R. 1989. Clinical investigation of the 1987-88 mass mortality of bottlenose dolphins along the U.S. central and south Atlantic coast. Final report to the National Marine Fisheries Service, U. S. Navy, Office of Naval Research, and Marine Mammal Commission: 63.

Geraci, J. R. and V.J. Lounsbury. 2005. Marine Mammals Ashore: A Field Guide for Strandings (Second Edition) National Aquarium in Baltimore, Baltimore, MD.

Geraci, J.R. and D.J. St. Aubin. 1987. Effects of parasites on marine mammals. International Journal of Parasitology. 17:407-414.

Geraci, J.R. and V.J. Lounsbury. 1993. Marine Mammals Ashore: A Field Guide for Strandings. Texas A&M University Sea Grant College Program, Galveston, TX.

Geraci, J.R., J. Harwood and V.J. Lounsbury. 1999. Marine Mammal Die-offs: Causes, Investigations, and Issues. IN: J.R. Twiss and R.R. Reeves, eds., Conservation and Management of Marine Mammals. Washington, DC, Smithsonian Institution Press: 367-395.

Gilmore, R.M. (1960) A census of the California gray whale. US Fish and Wildlife Service Special Scientific. Report. Fisheries, 342, 1–30

Gjertz, I., Lydersen, C. and Ø. Wiig. 2001. Distribution and diving of harbour seals (*Phoca vitulina*) in Svalbard. Polar Biol. 24, 209–214.

Goertner, J.F. 1982. Prediction of underwater explosion safe ranges for sea mammals. NSWC/WOL TR-82-188. Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, MD. 25 pp.

Goldbogen, J.A., J. Calambokidis, R.E. Shadwick, E.M. Oleson, M.A. McDonald, and J.A Hildebrand. 2006. Kinematics of foraging dives and lunge-feeding in fin whales. The Journal of Experimental Biology. 209:1231-1244.

Goldstein, T.2, J.A. K. Mazet, T.S. Zabka, G. Langlois, K.M. Colegrove, M. Silver, S. Bargu, F. Van Dolah, T. Leighfield, P.A. Conrad, J. Barakos, D.C. Williams, S. Dennison, M.

Haulena, and F.M.D. Gulland. 2008. Novel symptomatology and changing epidemiology of domoic acid toxicosis in California sea lions (*Zalophus californianus*): an increasing risk to marine mammal health. Proceedings of the Royal Society B. 275:267–276.

Goold, J. C., 2000. A diel pattern in vocal activity of short-beaked common dolphins, Delphinus delphis. Marine Mammal Science 16(1):240-244.

Goold, J.C. and Jones, S.E. 1995. Time and frequency domain characteristics of sperm whale clicks. Journal of the Acoustical Society of America. 98:1279-1291.

Grachev, M.A. V.P. Kumarev, L.Mamaev, V.L. Zorin, L.V. Baranova, N.N. Denikina, S.I. Belikov, E.A. Petrov, V.S. Kolesnik, R.S. Kolesnik, V.M. Dorofeev, A.M.Beim, V.N. Kudelin, F.G. Nagieva, and V.N. Sidorov. 1989. Distemper virus in Baikal seals. Nature 338:209.

Green, G. A., J. J. Brueggeman, R.A. Grotefendt, C.E. Bowlby, M.L. Bonnell, and K.C. Balcomb III, 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Pages 1-1 to 1-100 in Brueggeman, J. J., ed. Oregon and Washington marine mammal and seabird surveys. OCS Study MMS 91- 0093. Los Angeles, California: Minerals Management Service.

Greene, C. H. and A.J. Pershing, 2004. Climate and the conservation biology of North Atlantic right whales: The right whale at the wrong time? Frontiers in Ecology and the Environment 2(1):29-34.

Gregr, E. J. and A.W. Trites, 2001. Predictions of critical habitat for five whale species in the waters of coastal British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 58:1265-1285.

Greig, D. J., F.M.D. Gulland and C. Kreuder. 2005. A decade of live California sea lion. (*Zalophus californianus*) strandings along the central California coast: Causes and trends, 1991-2000. Aquatic Mammals 31:11-22.

Guinet, C., L.G. Barrett-Lennard, and B. Loyer, 2000. Co-ordinated attack behavior and prey sharing by killer whales at Crozet Archipelago:strategies for feeding on negatively-buoyant prey. Marine Mammal Science. 16:829-834.

Gulland, F. M. D., M. Koski, L. J. Lowenstine, A. Colagross, L. Morgan,and T. Spraker, 1996. "Leptospirosis in California sea lions (*Zalophus califorianus*) stranded along the central California coast, 1981-1994," Journal of Wildife Diseases 32, 572-580.

Gulland, F.M.D. 2006. Review of the Marine Mammal Unusual Mortality Event Response Program of the National Marine Fisheries Service. Report to the Office of Protected Resources, NOAA/National Marine Fisheries Service, Silver Springs, MD. 32 pp.

Gulland, F.M.D. and A.J. Hall. 2005. The Role of Infectious Disease in Influencing Status and Trends. IN: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery, T.J. Ragen. Marine Mammal Research. John Hopkins University Press, Baltimore. pp. 47-61.

Gunther, E.R. 1949. The habits of fin whales. Discovery Reports. 24:115-141.

Hain, J. H. W., M.A.M. Hyman, R. D. Kenney, and H.E. Winn, 1985. The role of cetaceans in the shelf-edge region of the northeastern United States. Marine Fisheries Review 47(1):13-17.

Hain, J. H. W., S.L. Ellis, R.D. Kenney, P.J. Clapham, B.K. Gray, M.T. Weinrich, and I.G. Babb, 1995. Apparent bottom feeding by humpback whales on Stellwagen Bank. Marine Mammal Science 11(4):464-479.

Hamazaki, T, 2002. Spatiotemporal prediction models of cetacean habitats in the mid-western North Atlantic Ocean (from Cape Hatteras, North Carolina, U.S.A. to Nova Scotia, Canada). Marine Mammal Science 18(4):920-939.

Hanan, D. A. 1996. Dynamics of Abundance and Distribution for Pacific Harbor Seal, *Phoca vitulina richardsi*, on the Coast of California. Ph.D. Dissertation, University of California, Los Angeles. 158pp.

Hanggi, E. B. and R.J. Schusterman, 1994. Underwater acoustic displays and individual variation in male harbour seals, *Phoca vitulina*. Animal Behaviour 48:1275-1283.

Hanni, K.D., D.J. Long, R.E. Jones, P. Pyles, and L.E. Morgan. 1997. Sightings and strandings of Guadalupe fur seals in central and northern California, 1988-1995. J. of Mamm., 78:684-690.

Hansen, L. J. 1990. California coastal bottlenose dolphins. In: S.Leatherwood and R.R. Reeves (eds.), The Bottlenose Dolphin, p. 403-420. Academic Press, Inc., San Diego.

Hansen, L. J., K. D. Mullin, and C. L. Roden, 1994. Preliminary estimates of cetacean abundance in the northern Gulf of Mexico, and of selected cetacean species in the U. S. Atlantic Exclusive Economic Zone from vesselsurveys. Contribution Number MIA-93/94-58. Miami: National Marine Fisheries Service. 11 pp.

Hanson, M.B., and R.W. Baird. 1998. Dall’s porpoise reactions to tagging attempts using a remotely-deployed suction-cup attached tag. Marine Technology Society Journal 32(2):18-23.

Hanson, M.T., and R.H. Defran. 1993. The behavior and feeding ecology of the Pacific coast bottlenose dolphin, *Tursiops truncatus*. Aquatic Mammals. 19:127-142.

Harvey, J.T. and B.R. Mate. 1984. Dive characteristics and movements of radio-tagged gray whales in San Ignacio Lagoon, Baja California Sur, Mexico. In: The Gray Whale M.L. Jones, S. Swartz and S. Leatherwood (eds.), Academic Press, pp. 561-575.

Harwood, J. 2002. Mass Die-offs. IN: W.F. Perrin, B. Würsig and J.G.M. Thewissen. Encyclopedia of Marine Mammals. Academic Press, San Diego: pp. 724-726.

Harwood, J., 2001. Marine mammals and their environment in the Twenty-First Century. Journal of Mammalogy 82(3):630-640.

Hastie, G. D., R. J. Swift, et al. (2005). “Environmental models for predicting oceanic dolphin habitat in the Northeast Atlantic.” ICES Journal of Marine Science 62: 760-770.

Hastie, G.D., B. Wilson and P.M. Thompson. 2005. Diving deep in a foraging hotspot: acoustic insights into bottlenose dolphin dive depths and feeding behaviour. Marine Biology. 148:1181-1188.

Heath, C. B. 2002. California, Galapagos, and Japanese sea lions *Zalophus californianus, Z. wollebaeki*, and *Z. japonicus*. Pp. 180-186 in W. F. Perrin, B. Wursig, and J. G. M. Thiewissen, eds. Encyclopedia of marine mammals. Academic Press.

Heide-Jorgensen, M.P., R. Dietz, K.L. Laidre and P.R. Richard. 2002. Autumn movements, home ranges, and winter density of narwhals (*Monodon monoceros*) tagged in Tremblay Sound, Baffin Island. Polar Biology 25:342-349.

Heimlich, S.L., D.K. Mellinger, S.L. Nieukirk, and C.G. Fox. 2005. Types, distribution, and seasonal occurrence of sounds attributed to Bryde's whales (*Balaenoptera edeni*) recorded in the eastern tropical Pacific, 1999-2001. Journal of the Acoustical Society of America. 118:1830-1837.

Heise, K. 1997. Life history and population parameters of Pacific white-sided dolphins (*Lagenorhynchus obliquidens*). Report of the International Whaling Commission. 47: 817-825.

Heithaus M.R., Marshall G.J., Buhleier B.M., Dill L.M. 2001. Employing Crittercam to study habitat use and behavior of large sharks. Mar Ecol Prog Ser 209:307–310

Helweg, D.A., A.S. Frankel, J.R. Mobley, and L.H. Herman. 1992. Humpback whale song: Our current understanding. In J.A. Thomas, R.A. Kastelein and Y.A. Supin (eds.), Marine mammal sensory systems. Plenum, New York, NY. 773 pp.

Hennessy, J. and S. Levine. 1979. Stress, arousal and the pituitary-adrenal system: a psychoendocrine model. Prog. Psychobiol. Psychol. 8, J. Sprague and A. Epstein (Eds.) Academic Press, New York.

Herman, L. M., Forestell, P. H. & R.C. Antinoja. 1980. Study of the 1976/77 migration of humpback whales into Hawaiian waters: Composite description. Final report to the U.S.Marine Mammal Commission (Report No. MMC-77/19). United StatesNational Technical Information Services, Arlington, VA.

Hersh, S. L. and D. A. Duffield, 1990. Distinction between northwest Atlantic offshore and coastal bottlenose dolphins based on hemoglobin profile and morphometry. Pages 129-139 in Leatherwood, S. and R. R. Reeves, eds. The bottlenose dolphin. San Diego, California: Academic Press.

Herzing, D. L., 1996. Vocalizations and associated underwater behavior of free-ranging Atlantic spotted dolphins, Stenella frontalis and bottlenose dolphins, *Tursiops truncatus*. Aquatic Mammals 22(2):61-79.

Heyning, J. E. and J. G. Mead, 1996. Suction feeding in beaked whales: Morphological and observational evidence. Contributions in Science, Natural History Museum of Los Angeles County 464:1-12.

Heyning, J. E., and W. F. Perrin, 1994. Evidence for two species of common dolphins (genus Delphinus) from the eastern North Pacific. Contributions in Science, Natural History Museum of Los Angeles County 442:1-35.

Heyning, J.E. and T.D. Lewis. 1990. Entanglements of baleen whales in fishing gear of southern California, Report to the International Whaling Commission. 40:427-431.

Hildebrand, J. 2004. Impacts of Anthropogenic Sound on Cetaceans, Report to the Scientific Committee of the International Whaling Commission, Sorrento, Italy.

Hill, P. S. and E. Mitchell. 1998. Sperm whale interactions with longline vessels in Alaska waters during 1997. Unpubl. doc. Submitted to Fish. Bull. (available upon request - P. S. Hill, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98115).

Hill, P. S. and J. Barlow. 1992. Report on a marine mammal survey of the California coast aboard the research vessel McARTHUR July 28 - November 5, 1991. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-169.

Hill, P. S., and D. P. DeMaster. 1998. Alaska marine mammal stock assessments, 1998. U.S. Dep. Commer., NOAA Tech. Memo NMFS-AFSC-97, 166 p.

Hill, P. S., and D. P. DeMaster. 1999. Alaska marine mammal stock assessments, 1999. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-110, 166 pp.

Hiruki, L.M., M.K. Schwartz, and P.L. Boveng. 1999. Hunting and social behaviour of leopard seals (*Hydrurga leptonyx*) at Seal Island, South Shetland Islands, Antarctica. Journal of Zoology. 249:97-109.

Hobbs, R.C., & Rugh, D.J. 1999. The abundance of gray whales in the 1997/98 southbound migration in the eastern North Pacific. Paper SC/51/AS10 presented to the IWC Scientific Committee, May 1999 (unpublished). 13 p.

Hoelzel, A. R., 2003. Marine Mammal Biology: An Evolutionary Approach (Blackwell Publishing, Malden MA)

Hoelzel, A. R., E. M. Dorsey, and S. J. Stern, 1989. The foraging specializations of individual minke whales. Animal Behaviour 38:786-794.

Hohn, A. A., D. S. Rotstein, C. A. Harms, and B. L. Southall, 2006b. "Multispecies mass stranding of pilot whales (*Globicephala macrorhynchus*), minke whale (*Balaenoptera acutorostrata*), and dwarf sperm whales (*Kogia sima*) in North Carolina on 15-16 January 2005," (Department of Commerce), p. 222.

Hohn, A.A., D.S. Rotstein, C.A. Harms and B.L. Southall. 2006. Report on marine mammal unusual mortality event UMESE0501Sp: Multispecies mass stranding of pilot whales (*Globicephala macrorhynchus*), minke whale (*Balaenoptera acutorostrata*), and dwarf sperm whales (*Kogia sima*) in North Carolina on 15-16 January 2005: 222 pp.

Hooker SK, Boyd IL, Jessop M, Cox O, Blackwell J, Boveng PL, Bengtson JL. 2002. Monitoring the prey-field of marine predators: combining digital imaging with data logging tags. Mar Mamm Sci 18(3):680–697

Hooker, S.K. and R.W. Baird. 1999. Deep-diving behaviour of the northern bottlenose whale, *Hyperoodon ampullatus* (Cetacean: Ziphiidae). Proceedings of the Royal Society, London B. 266:671-676.

Horwood, J. 1987. The sei whale: Population biology, ecology and management. London: Croom Helm.

Horwood, J. 1990. Biology and exploitation of the minke whale. Boca Raton, Florida: CRC Press.

Houck W.J. and T.A. Jefferson. 1999. Dall's porpoise - *Phocoenoides dalli* (True, 1885). In: Handbook of Marine Mammals (Ridgway SH, Harrison SR Eds.) Vol. 6: The second book of dolphins and porpoises. pp. 443 - 472.

Houser, D. S. and J.J. Finneran. 2006. A comparison of underwater hearing sensitivity in bottlenose dolphins (*Tursiops truncatus*) determined by electrophysiological and behavioral methods. Journal of the Acoustical Society of America, 120, 1713-1722.

Houser, D.S., D.A. Helweg, and P.W.B. Moore. 2001. A bandpass filter-bank model of auditory sensitivity in the humpback whale. Aquatic Mammals. 27:82–91.

Huber, H. R. 1991. Changes in the distribution of California sea lions north of the breeding rookeries during the 1982-83 El Nino. In Pinnipeds and El Nino: responses to environmental stress (F. Trillmich and K. A. Ono, eds.) p. 129-137. Springer-Verlag, Berlin and Heidelberg, Germany.

Hui, C. A., 1979. Undersea topography and distribution of dolphins of the genus Delphinus in the southern California Bight. Journal of Mammalogy 60:521-527.

ICES, 2005a. Report of the Ad-hoc Group on the Impacts of Sonar on Cetaceans and Fish- 2nd edition. International Council for the Exploration of the Sea. ICES AGISC CM 2005/ACE:06. 25 pp.

ICES. 2005b. Answer to DG Environment request on scientific information concerning impact of sonar activities on cetacean populations. International Council for the Exploration of the Sea. 5 pp.

Ingebrigtsen, A. 1929. Whales caught in the North Atlantic and other seas.Rapports et Procèsverbaux des réunions, Cons. Perm. Int. L'Explor. Mer, Vol. LVI. Høst & Fils,Copenhagen. 26 pp.

Ivashin, M. V. and L. M. Votrogov, 1981. Minke whales, *Balaenoptera acutorostrata davidsoni*, inhabiting inshore waters of the Chukotka coast. Reports of the International Whaling Commission 31:231.

IWC (International Whaling Commission). 1980. Report of special meeting on Southern Hemisphere sei whales. Rep. int. Whal. Commn 30:493-511.

IWC (International Whaling Commission), 1997. Report on the International Whaling Commission Workshop on Climate Change and Cetaceans. Reports of the International Whaling Commission 47:293-319.

IWC (International Whaling Commission), 2005. Classification of the Order Cetacea (whales, dolphins and porpoises). Journal of Cetacean Research and Management 7(1):xi-xii.

Jansen, G. 1998. Physiological effects of noise. In Handbook of Acoustical Measurements and Noise Control, 3rd Edition. New York: Acoustical Society of America.

Jaquet. N., S. Dawson, and E. Slooten. 2000. Seasonal distribution and diving behaviour of male sperm whales off Kaikoura: Foraging implications. Canadian Journal of Zoology. 78:407-419.

Jefferson, T. A. and N. B. Barros, 1997. *Peponocephala electra*. Mammalian Species 553:1-6.

Jefferson, T. A., S. K. Hung and P. K. S. Lam. 2006. Strandings, mortality and morbidity of Indo-Pacific humpback dolphins in Hong Kong, with emphasis on the role of organochlorine contaminants. Journal of Cetacean Management and Research. 8:181-193.

Jefferson, T.A., S. Leatherwood and M.A. Webber. 1994. Marine Mammals of the World. Food and Agriculture Organization of the United Nations and United Nations Environment Programme, Rome.

Jefferson, T.A., S. Leatherwood, and M.A. Webber. 1993. FAO species identification guide. Marine mammals of the world. Rome: Food and Agriculture Organization of the United Nations.

Jensen, A.S. and G.K. Silber. 2004. Large whale ship strike database. NOAA Technical Memorandum NMFS-OPR-25, January 2004.

Jepson, P. D., M. Arbelo, R.Deaville, I. A. P. Patterson, P. Castro, J. R. Bakers, E. Degollada, H. M. Ross, P. Herraez, A. M. Pocknell, F.Rodriguez, F. E. Howie, A. Espinsoa, R. J. Reid, J. R. Jaber, V.Martin, A. A. Cunningham and A. Fernandez. 2003. Gas-bubble lesions in stranded cetaceans. Nature. 425:575-576.

Johnson, M. P., P. T. Madsen, et al. (2004). "Beaked whales echolocate on prey." Proceedings of the Royal Society of London, B 271(Supplement 6): S383-S386

Johnson, M.P. and P.L. Tyack. 2003. A digital acoustic recording tag for measuring the response of wild marine mammals to sound. IEEE Journal of Oceanic Engineering, 28: 3-12.

Jones, M.L. and S.L. Swartz. 2002. The Gray Whale (*Eschrichtius robustus*). Pp. 524-536. In: W.F. Perrin, B. Wursig, and J.G.M. Thewissen (Eds): Encyclopedia of Marine Mammals. Academic Press, San Diego.

Jurasz, C. M. and V. P. Jurasz, 1979. Feeding modes of the humpback whale, *Megaptera novaeangliae*, in southeast Alaska. Scientific Reports of the Whales Research Institute 31:69-83.

Kajimura, K. 1984. Opportunistic feeding of the northern fur seal, Callorhinus ursinus, in the eastern North Pacific Ocean and eastern Bering Sea. National Oceanic and Atmospheric Administration Technical Report NMFS SSRF-779.

Kastak, D., and R. J. Schusterman. 1996. Temporary threshold shift in a harbor seal (*Phoca vitulina*). Journal of the Acoustical Society of America. 100:1905-1908.

Kastak, D., and R. J. Schusterman. 1998. Low-frequency amphibious hearing in pinnipeds: methods, measurements, noise, and ecology. Journal of the Acoustical Society of America. 103:2216-2228.

Kastak, D., and R.J. Schusterman. 1999. In-air and underwater hearing sensitivity of a northern elephant seal (*Mirounga angustirostris*). Canadian Journal of Zoology. 77:1751-1758.

Kastak, D., and Schusterman, R.J. 2002. Changes in auditory sensitivity with depth in a free-diving California sea lion (*Zalophus californianus*). Journal of the Acoustical Society of America, 112:329-333.

Kastak, D., R. J. Schusterman, B. L. Southall, and C. J. Reichmuth. 1999a. Underwater temporary threshold shift induced by octave-band noise in three species of pinniped. Journal of Acoustical Society of America. 106:1142-1148.

Kastelein, R., M. Hagedoorn, W. W. L. Au, and D. De Haan, 2003. Audiogram of a striped dolphin (*Stenella coeruleoalba*). Journal of the Acoustical Society of America 113(2):1130-1137.

Kasuya, T. 1991. Densty-dependent growth in North Pacific sperm whales. Mar. Mammal Sci. 7: 230-257

Kasuya, T. 2002. Giant beaked whales *Berardius bairdii* and *B. arnuxii*. Pages 519-522 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego: Academic Press.

Kasuya, T., and S Ohsumi. 1984. Further analysis of the Baird's beaked whale stock in the western North Pacific. Rep. Int. Whaling Comm. 34:587-595.

Kato, H. 2002. Bryde's whales *Balaenoptera edeni* and *B. brydei*. Pages 171 -176 in W.F. Perrin, B. Wursig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego: Academic Press.

Kawamura, A. (1980). Food habits of the Bryde's whales taken in the South Pacific and Indian Oceans. Scientific Reports of the Whales Research Institute, Tokyo 32: 1-23

Keeler, J.S. 1976. Models for noise-induced hearing loss. In Effects of Noise on Hearing, ed. Henderson et al., 361–381. New York: Raven Press.

Keenan, R.E. 2000. An Introduction to GRAB Eigenrays and CASS Reverberation and Signal Excess. Science Applications International Corporation, MA.

Kennedy, S., T. Kuiken, P.D. Jepson, R. Deaville, M. Forsyth, T. Barrett, M.W.G. vande Bildt, A.D.M.E. Osterhaus, T. Eybatov, C. Duck, A. Kydyrmanov, I. Mitrofanov, and S. Wilson. 2000. Mass die-off of Caspian seals caused by canine distemper virus. Emerging Infectious Diseases. 6:637-639.

Kenney, R. D., G. P. Scott, T. J. Thompson, and H. E. Winn, 1997. Estimates of prey consumption and trophic impacts of cetaceans in the USA Northeast Continental Shelf ecosystem. Journal of Northwest Atlantic Fishery Science 22:155-171.

Kenney, R.D., and H.E. Winn. 1987. Cetacean biomass densities near submarine canyons compared to adjacent shelf/slope areas. Continental Shelf Research. 7:107-114.

Kenney, R.D., P.M. Payne, D.W. Heinemann, and H.E. Winn. 1996. Shifts in northeast shelf cetacean distributions relative to trends in Gulf of Maine/Georges Bank finfish abundance. Pages 169-196 in K. Sherman, N.A. Jaworski, and T.J. Smayda, eds. The northeast shelf ecosystem: assessment, sustainability, and management. Boston: Blackwell Science.

Kenyon, K. W. 1969. The sea otter in the Eastern Pacific Ocean. USDI, North Amer. Fauna No. 68. 352pp.

Kenyon, K.W. 1975. The sea otters of the eastern Pacific Ocean. Dover Publications Inc., New York. 352pp.

Ketten, D. 2005. Beaked whale necropsy findings for strandings in the Bahamas, Puerto Rico, and Madeira, 1999-2002. Woods Hole Oceanographic Institution, Woods Hole, MA. Pp. 36.

Ketten, D. R. (2000). Cetacean ears. In Hearing by Whales and Dolphins (ed. W. Au, A. N. Popper and R. R. Fay), pp. 43-108. New York: Springer-Verlag.

Ketten, D.R. 1992. The marine mammal ear: Specializations for aquatic audition and echolocation. Pages 717-750 in D. Webster, R. Fay, and A. Popper, eds. The evolutionary biology of hearing. Berlin: Springer-Verlag.

Ketten, D.R. 1997. Structure and functions in whale ears. Bioacoustics. 8:103-135.

Ketten, D.R. 1998. Marine mammal auditory systems: A summary of audiometric and anatomical data and its implications for underwater acoustic impacts. NOAA-TM-NMFS-SWFSC-256, Department of Commerce.

Kieckhefer, T.R., J. Calambokidis, G.H. Steiger, and N.A. Black. 1995. Prey of humpback and blue whales off California based on identification of hard parts in feces. P. 62 in: Abstracts Eleventh Biennial Conference on the Biology of Marine Mammals, Orlando, Florida, 14-18 December 1995. Society for Marine Mammalogy, Lawrence,KA.

Kirshvink, J.L., A.E. Dizon, and J.A. Westphal. 1986. Evidence from strandings for geomagnetic sensitivity in cetaceans. Journal of Experimental Biology. 120:1-24.

Klatsky, L.J., R.S. Wells, and J.C. Sweeney. 2007. Offshore bottlenose dolphins (*Tursiops truncatus*): movement and dive behavior near the bermuda pedestal. Journal of Mammalogy. 88:59-66.

Klinowska, M. 1985. Cetacean Live Stranding Sites Relate to Geomagnetic Topography. Aquatic Mammals. 11:27-32.

Klinowska, M. 1986. Cetacean Live Stranding Dates Relate to Geomagnetic Disturbances. Aquatic Mammals. 11:109-119.

Knowlton, A.R., and Kraus, S.D. 2001. Mortality and serious injury of northern right whales (*Eubalaena glacialis*) in the western North Atlantic Ocean. Journal of Cetacean Research and Management (Special Issue). 2:193-208.

Knowlton, A.R., C.W. Clark, and S.D. Kruse. 1991. Sounds recorded in the presence of sei whales, Balaenoptera borealis. Abstract. Ninth Biennial Conference on the Biology of Marine Mammals, Chicago, IL. pp. 76.

Kompanje, E.J.O. 1995. On the occurrence of spondylosis deformans in white-beaked dolphins *Lagenorhynchus albirostris* (Gray, 1846) stranded on the Dutch coast. Zooligische Mededekingen Leiden. 69:231-250.

Kooyman, G.L., D.D. Hammond, and J.P. Schroeder. 1970. Brochogramks and tracheograms of seals under pressure. Science. 169:82-84.

Kopelman, A.H., and S.S. Sadove. 1995. Ventilatory rate differences between surface-feeding and nonsurface-feeding fin whales (*Balaenoptera physalus*) in the waters off eastern Long Island, New York, U.S.A., 1981-1987. Marine Mammal Science. 11:200-208.

Krafft, B. A., C. Lydersen, I. Gjertz, and K. M. Kovacs, 2002. Diving behaviour of sub-adult harbour seals (*Phoca vitulina*) at Prins Karls Forland, Svalbard. Polar Biology 25:230-234.

Krausman, Paul R., Vernon C. Bleich, James W. Cain III, Thomas R. Stephenson, Don W. DeYoung, Philip W. McGrath, Pamela K. Swift, Becky M. Pierce, and Brian D. Jansen. 2004. From the Field: Neck lesions in ungulates from collars incorporating satellite technology. Wildlife Society Bulletin 32(3):987-991.

Krieger, K.J., and B.L. Wing. 1986. Hydroacoustic monitoring of prey to determine humpback whale movements. USDC. NOAA Tech. Mem. NMFS F/NWC-98, Auke Bay, AK

Kruse, S., D.K. Caldwell, and M.C. Caldwell. 1999. Risso's dolphin *Grampus griseus* (G. Cuvier, 1812). Pages 183-212 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises. San Diego: Academic Press.

Kryter, K.D. W.D. Ward, J.D. Miller, and D.H. Eldredge. 1966. Hazardous exposure to intermittent and steady-state noise. Journal of the Acoustical Society of America. 48:513-523.

Kryter, K.D., Daniels, R., Fair, P., et al. (1965). Hazardous Exposure to Intermittent and Steady-State Noise. Report of Working Group 46, NAS-NRC Committee on Hearing, Bioacoustics, and Biomechanics (CHABA), ONR Contract NONR 2300(05).

Laake, J.L., S.T. Buckland, D.R. Anderson, and K.P. Burnham. 1994. Distance. User's Guide V 2.1. Fort Collins: Colorado Cooperative Fish and Wildlife Research Unit.

Laerm, J., F. Wenzel, J.E. Craddock, D. Weinand, J. McGurk, M.J. Harris, G.A. Early, J.G. Mead, C.W. Potter and N.B. Barros. 1997. New prey species for northwestern Atlantic humpback whales. Marine Mammal Science 13:705-711.

Lafortuna, C. L., M. Jahoda, A. Azzellino, F. Saibene, and A. Colombini, 2003. Locomotor behaviours and respiratory pattern of the Mediterranean fin whale (*Balaenoptera physalus*). European Journal of Applied Physiology 90:387-395.

Lagerquist, B.A., K.M. Stafford, and B.R. Mate. 2000. Dive characteristics of satellite-monitored blue whales *(Balaenoptera musculus*) off the central California coast. Marine Mammal Science. 16:375-391

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science. 17:35–75.

Lambertsen, R.H. (1992). Crassicaudosis: a parasitic disease threatening the health and population recovery of large baleen whales. Scientific and Technical Review, Organisation Internationale d'Epyzoologie (OIE). 11:1131-11.

Lance, M.M., S.A. Richardson, and H.L. Allen. 2004. Sea Otter Recovery Plan. Washington Department of Fish and Wildlife, Wildlife Program, 600 Capitol Way, N. Olympia, Washington 98501. 91pp.

Largier, J. L., C. J. Hearn, and D. B. Chadwick (1996). Density Structures in "Low Inflow Estuaries," in Buoyancy Effects on Coastal Esturine Dynamics Coastal Esturine Stud., vol. 53, edited by D. G. Aubrey and C. T. Friedrichs, pp 227-242, American Geophysical Union, Washington, D.C.

Largier, J.L. 1995. San Diego Bay Circulation. Report prepared for the California State Water Resources Control Board and the California Regional Water Quality Control Board, San Diego Region (Interagency Agreement # 1-188-190-0).

Larkman, V.E ., Veit, R.R ., 1998 . Seasonality and abundance of blue whales off southern California. California Cooperative Oceanic Fisheries Investigations Reports.

Le Boeuf B and D. Crocker. 2005. Ocean climate and seal condition. BMC (BioMed Central) Biol 3:9

Le Boeuf, B.J. and J. Reiter. 1991. Biological effects associated with El Nino Southern Oscillation, 1982-83m on northern elephant seals breeding at Ano Nuevo, California. IN: F. Trillmich and K.A. Ono, eds. Pinnipeds and El Nino: Responses to Environmental Stress, Springer-Verlag, Berlin. Pp. 206-218.

Le Boeuf, B.J. and L.F. Petrinovich. 1974. Dialects of northern elephant seals, *Mirounga angustirostris*: Origin and reliability. Animal Behavior. 22:656-663.

Le Boeuf, B.J. and M.L. Bonnell. 1980. Pinnipeds of the California islands: abundance and distribution. Pages 475-493 in D.M. Power (ed.), The California Islands: Proceedings of a multidisciplinary symposium. Santa Barbara Museum of Natural History, Santa Barbara, CA. 787 pp.

Le Boeuf, B.J., D.E. Crocker, D.P. Costa, S.B. Blackwell, P.M. Webb, and D.S. Houser. 2000. Foraging ecology of northern elephant seals. Ecological Monographs. 70:353-382.

Le Boeuf, B.J., Y. Naito, A.C. Huntley, and T. Asaga. 1989. Prolonged, continuous, deep diving by northern elephant seals. Canadian Journal of Zoology. 67:2514-2519.

Learmonth, J.A., C.D. MacLeod, M.B. Santos, G.J. Pierce, H.Q.P. Crick and R.A. Robinson. 2006. Potential effects of climate change on marine mammals. Oceanography and Marine Biology. 44:431-464.

Leatherwood, J. S. 1974. A Note on Gray Whale Behavioral Interactions with Other Marine Mammals. Mar. Fish. Rev. 36 (4):50-51.

Leatherwood, S. 1975. Some Observations of Feeding Behavior of Bottle-Nosed Dolphins (*Tursiops truncatus*) in the Northern Gulf of Mexico and (*Tursiops* cf *T. gilli*) off Southern California, Baja California, and Nayarit, Mexico. Marine Fisheries Review 37(9):10-16.

Leatherwood, S. and R. R. Reeves, 1983. The Sierra Club handbook of whales and dolphins. San Francisco, California: Sierra Club Books.

Leatherwood, S. and W. A. Walker. 1979. The northern right-whale dolphin *Lissodelphis borealis* Peale in the eastern North Pacific. In: Winn, H. E. and B. L. Olla (eds.), Behavior of Marine Mammals, p. 85-141. Plenum Press, New York - London.

Leatherwood, S., Balcomb, K. C., Matkin, C. O., and E. Ellis. 1984. Killer whales (Orcinus orca) of southern Alaska. Hubbs/Sea World Research Institute Technological Report (84-175), 1-59.

Leatherwood, S., et al. 1980. Distribution and movements of Risso's dolphin, *Grampus griseus*, in the eastern North Pacific. Fish. Bull. 77:951-963

Leatherwood, S., Gilbert, J. R., and D.G. Chapman, D. G. 1978. An evaluation of some techniques for aerial censuses of bottlenosed dolphins. Journal of Wildlife Management 42(2):239-250.

Leatherwood, S., Kastelein, R.A. and Hammond, P.S. 1988. Estimate of numbers of Commerson's dolphins in a portion of the northeastern Strait of Magellan, January-February 1984. Rep. int. Whal. Commn (special issue 9):93-102.

Leatherwood, S., R.R. Reeves, W.F. Perrin, and W.E. Evans. 1982. Whales, Dolphins, and Porpoises of the Eastern North Pacific and adjacent Arctic Waters: A Guide to Their Identification. NMFS, NOAA, U.S. Dept. Commerce, NOAA Technical Report NMFS Circular 444.

Lowry, M. S., and O. Maravilla-Chavez. 2005. Recent abundance of California sea lions in western Baja California, Mexico and the United States. In Proceedings 6th California Islands symposium, Ventura, California, U.S., December 1-3, 2003. Pp. 485-497. National Park Service Tech Publ. CHIS-05-01, Institute for Wildlife Studies, Arcata, CA.

Lowry, M.S. 2002. Counts of northern elephant seals at rookeries in the Southern California Bight - 1981-2001. NOAA-TM-NMFS-SWFSC-345. 68 pp.

Lowry, M.S. and J.V. Carretta. 2003. Pacific harbor seal, *Phoca vifulina richardii*, Census in California during May-July 2002. NOAA-TM-NMFS-SWFSC-353. 55 pp.

Macfarlane, J.A.F. 1981. Reactions of whales to boat traffic in the area of the confluence of the Saguenay and St. Lawrence rivers, Quebec. Manuscript cited in Richardson et al. 1995. 50 pp.

MacGarvin, M., and M. Simmonds, 1996. Whales and climate change. Pages 321-332 in M. P. Simmonds and J. Hutchinson, eds. The conservation of whales and dolphins: Science and practice. Chichester, United Kingdom: John Wiley & Sons, Ltd.

MacLeod, C. D. and A. F. Zuur, 2005. Habitat utilization by Blainville's beaked whales off Great Abaco, northern Bahamas, in relation to seabed topography. Marine Biology 147:1-11.

MacLeod, C. D., G. J. Pierce and M. Begoña Santos. 2004. Geographic and temporal variations in strandings of beaked whales. Ziphiidae) on the coasts of the UK and the Republic of Ireland from 1800-2002. Journal of Cetacean Management and Research 6(1): 79-86.

MacLeod, C. D., M. B. Santos, and G. J. Pierce, 2003. Review of data on diets of beaked whales: Evidence of niche separation and geographic segregation. Journal of the Marine Biological Association of the United Kingdom 83:651-665.

MacLeod, C.D. 1999. A review of beaked whale acoustics, with inferences on potential interactions with military activities. European Research on Cetaceans. 13:35-38.

Madsen, P.T., D.A. Carder, W.W.L. Au, P.E. Nachtigall, B. Møhl, and S.H. Ridgway. 2003. Sound production in neonate sperm whales (L). Journal of the Acoustical Society of America. 113:2988-2991.

Madsen, P.T., M.A. Johnson, P.J. Miller, A.N. Soto, J. Lynch, and P.L. Tyack. 2006. Quantitative measures of air-gun pulses recorded on sperm whales (Physeter macrocephalus) using acoustic tags during controlled exposure experiments. Journal of the Acoustic Society of America. 120:2366-2379.

Malme, C.I., B. Wursig, J.E. Bird, and P.L. Tyack., 1986. Behavioral responses of gray whales to industrial noise: Feeding observations and predictive modeling, National Oceanic and Atmospheric Administration, Outer continental Shelf Environmental Assessment Program, Final Report of the Principal Investigators, Anchorage, Alaska: BBB Report No. 6265. OCS Study MMS 88-0048; NTIS PB88-249008.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack and J.E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration. BBN Rep. 5586. Report from Bolt Beranek & Newman Inc., Cambridge, MA, for U.S. Minerals Management Service, Anchorage, AK. NTIS PB86-218377.

Mangels, K.F. and T. Gerrodette, 1994. Report of cetacean sightings during a marine mammal survey in the eastern Pacific Ocean and the Gulf of California aboard the NOAA ships

McArthur and David Starr Jordan, July 28–November 6, 1993. NOAA Technical Memorandum NMFS-SWFSC-211. Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA.

Maravilla-Chavez, M.O. and M.S Lowry, 1999. Incipient breeding colony of Guadalupe fur seals at Isla Benito del Este, Baja California, Mexico. Marine Mammal Science 15:239-241.

Marten, K., 2000. Ultrasonic analysis of pygmy sperm whale (*Kogia breviceps*) and Hubbs' beaked whale (*Mesoplodon carlhubbsi*) clicks. Aquatic Mammals 26(1):45-48.

Mate, B.R., B.A. Lagerquist, and J. Calambokidis. 1999. Movements of North Pacific blue whales during the feeding season off southern California and their southern fall migration. Marine Mammal Science. 15:1246-1257.

Mate, B.R., K.M. Stafford, R. Nawojchik and J.L. Dunn. 1994. Movements and dive behavior of a satellite-monitored Atlantic white-sided dolphin (*Lagenorhynchus acutus*) in the Gulf of Maine. Marine Mammal Science. 10: 116-121.

Mate, B.R., S.L. Nieukirk, and S.D. Kraus. 1997. Satellite-monitored movements of the northern right whale. Journal of Wildlife Management. 61:1393-1405.

Mattila, D.K., L.N. Guinee, and C.A. Mayo. 1987. Humpback whale songs on a North Atlantic feeding ground. Journal of Mammalogy. 68:880-883.

Maybaum, H.L. 1989. Effects of a 3.3 kHz sonar system on humpback whales, Megaptera novaeangliae, in Hawaiian waters. M.S. Thesis, University of Hawaii, Manoa. 112 pp.

Mazzuca, L., S. Atkinson, B. Keating and E. Nitta. 1999. Cetacean Mass Strandings in the Hawaiian Archipelago, 1957-1998. Aquatic Mammals. 25:105-114.

McAlpine, D. F., L. D. Murison, and E. P. Hoberg, 1997. New records for the pygmy sperm whale, *Kogia breviceps* (Physeteridae) from Atlantic Canada with notes on diet and parasites. Marine Mammal Science 13(4):701-704.

McAlpine, D.F. 2002. Pygmy and dwarf sperm whales Kogia breviceps and K. sima. Pages 1007-1009 in W.F. Perrin, B. Wursig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego: Academic Press.

McConnell, B. J., and M. A. Fedak, 1996. Movements of southern elephant seals. Canadian Journal of Zoology 74:1485-1496.

McCowan, B., and D. Reiss, 1995. Maternal aggressive contact vocalizations in captive bottlenose dolphins (*Tursiops truncatus*): Wide-band, low frequency signals during mother/aunt-infant interactions. Zoo Biology 14:293-309.

McDonald, M. A., and C. G. Fox, 1999. Passive acoustic methods applied to fin whale population density estimation. Journal of the Acoustical Society of America 105(5):2643-2651.

McDonald, M. A., J. A. Hildebrand, S. M. Wiggins, D. Thiele, D. Glasgow, S. E. Moore. 2005. Sei whale sounds recorded in the Antarctic. Journal of the Acoustical Society of America. 118:3941-3945.

McDonald, M.A., J. Calambokidis, A.M. Teranishi, and J.A. Hildebrand. 2001. The acoustic calls of blue whales off California with gender data. Journal of the Acoustical Society of America 109:1728-1735.

McDonald, M.A., J.A Hildebrand, and S.M. Wiggins. 2006. Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California. Journal of the Acoustical Society of America. 120:711-718.

McEwen, B., and J. Wingfield, 2003. The concept of allostasis in biology and biomedicine. Hormonal Behavior 2003 Jan 43(1):2-15. The rockefeller University, NY.

McGrath, J.R. 1971. Scaling Laws for Underwater Exploding Wires. Journal of the Acoustical Society of America. 50:1030-1033.

Mead, J.G. 1989. Beaked whales of the genus - Mesoplodon. Pages 349-430 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 4: River dolphins and the larger toothed whales. London: Academic Press.

Melin, S. R. and R.L. DeLong. 1999. Observations of a Guadalupe Fur Seal (*Arctocephalus townsendi*) Female and pup at San Miguel Island, California. Marine Mammal Science. 15:885-888.

Mellinger, D.K., and C.W. Clark. 2003. Blue whale (*Balaenoptera musculus*) sounds from the North Atlantic. Journal of the Acoustical Society of America. 114:1108-1119.

Mellinger, D.K., C.D. Carson, and C.W. Clark. 2000. Characteristics of minke whale (*Balaenoptera acutorostrata*) pulse trains recorded near Puerto Rico. Marine Mammal Science. 16:739-756.

Mesnick, S.L., B.L. Taylor, B. Nachenberg, A. Rosenberg, S. Peterson, J. Hyde, and A.E. Dizon. 1999. Genetic relatedness within groups and the definition of sperm whale stock boundaries from the coastal waters off California, Oregon and Washington. Southwest Fisheries Center Administrative Report LJ-99-12:1-10. La Jolla, California: National Marine Fisheries Service.

Michel, J, R Nairn,.J.A. Johnson, and D Hardin. 2001. Development and design of biological and physical monitoring protocals to evaluate the long-term impacts of offshore dredging operations on the marine environment. Final Report to the U.S. Department of Interior, Minerals Management Service, International Activities and Marine Minerals Divisions (INTERMAR), Herndon, CA. Contract No. 14-35-0001-31051. 116 p.

Mignucci-Giannoni, A. A., 1998. Zoogeography of cetaceans off Puerto Rico and the Virgin Islands. Caribbean Journal of Science 34(3-4):173-190.

Mignucci-Giannoni, A.A., Toyos-Gonzalez, G.M., Perez-Padilla, J., Rodriguez-Lopez, M.A., and Overing, J. 2000. Mass stranding of pygmy killer whales (*Feresa attenuata*) in the British Virgin Islands. Journal of the Marine Biology Association. U.K. 80:759-760.

Miksis J.L., Grund, M.D., Nowacek, D.P., Solow, A.R., Connor R.C. and Tyack, P.L. 2001. Cardiac Responses to Acoustic Playback Experiments in the Captive Bottlenose Dolphin, *Tursiops truncatus*. Journal of Comparative Psychology. 115:227-232.

Miller, J.D. 1974. Effects of noise on people. Journal of the Acoustical Society of America. 56:729–764.

Miller, J.D., C.S. Watson, and W.P. Covell. 1963. Deafening effects of noise on the cat. Acta Oto-Laryngologica Supplement. 176:1–91.

Miller, P.J.O., M.P. Johnson, and P.L. Tyack. 2004. Sperm whale behaviour indicates the use of echolocation click buzzes 'creaks' in prey capture. Proceedings of the Royal Society of London, Part B: 271:2239-2247.

Mills, J.H., R.M. Gilbert, and W.Y. Adkins. 1979. Temporary threshold shifts in humans exposed to octave bands of noise for 16 to 24 hours. Journal of the Acoustical Society of America. 65:1238–1248.

Mitchell, E. D., Jr., 1991. Winter records of the minke whale (*Balaenoptera acutorostrata acutorostrata* Lacépède 1804) in the southern North Atlantic. Reports of the International Whaling Commission 41:455-457.

Miyazaki, N. and W.F. Perrin. 1994. Rough-toothed dolphin-*Steno bredanensis* (Lesson, 1828). Pages 1-21 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego, California: Academic Press.

Moberg, G.P. 2000. Biological response to stress: implications for animal welfare. Pages 1 - 21 In: G.P. Moberg and J.A. Mench, editors. The biology of animal stress. Basic principles and implications for animal welfare. Oxford University Press, Oxford, United Kingdom.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA92038. 26 pp.

Mobley, J. R., Jr., R. A. Grotefendt, P. H. Forestell, and A. Frankel. 1999. Results of aerial surveys of marine mammals in the major Hawaiian Islands 1993-98): Report to the Acoustic Thermometry of Ocean Climate Marine Mammal Research Program (ATOC MMRP) (unpublished). 39 pp

Mobley, J.R., S.W. Martin, D. Fromm, and P. Nachtigall. 2007. Lunar influences as possible causes for simultaneous aggregations of melon-headed whales in Hanalei Bay, Kauai and Sasanhaya Bay, Rota. Abstract for oral presentation at the Seventeeth Biennial Conference on the Biology of Marine Mammals. Cape Town, South Africa, 29 November -3 December 2007.

Møhl, B., M. Wahlberg, P. T. Madesen, A. Heerfordt, and A. Lund, 2003. The monopulsed nature of sperm whale clicks. Journal of the Acoustical Society of America 114:1143-1154.

Møhl, B., Wahlberg, M., Madsen, P.T., Miller, L.A. and Surlykke, A. 2000. Sperm whale clicks: Directionality and source level revisited. Journal of the Acoustical Society of America 107(1): 638-648.

Moore, M. and G. A. Early. 2004. Cumulative sperm whale bone damage and the bends. Science 306:2215.

Moore, M.J., B. Rubinstein, S.A. Norman, and T. Lipscomb. 2004. A note on the most northerly record of Gervais' beaked whale from the western North Atlantic Ocean. Journal of Cetacean Research and Management. 6:279-281.

Moore, P.W.B., and R.J. Schusterman, 1987. Audiometric assessment of northern fur seals, *Callorhinus ursinus*. Marine Mammal Science 3:31-53.

Moore, S. E. 2005. Long-term Environmental Change and Marine Mammals. IN: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery, T.J. Ragen. Marine Mammal Research: Conservation Beyond Crisis. John Hopkins University Press, Baltimore. pp 137-147.

Moore, S. E., W. A. Watkins, M. A. Daher, J. R. Davies, and M. E. Dahlheim, 2002. Blue whale habitat associations in the Northwest Pacific: Analysis of remotely-sensed data using a Geographic Information System. Oceanography 15(3):20-25.

Moore, S.E. and J.T. Clarke. 2002. Potential impact of offshore human activities on gray whales. *Eschrichtius robustus*. J. Cetacean Res. Manag. 4:19-25.

Morimitsu, T., T. Nagai, M. Ide, H. Kawano, A. Naichuu, M. Koono, and A. Ishii. 1987. Mass stranding of Odontoceti caused by parasitongenic eighth cranial neuropathy. Journal of Wildlife Diseases. 28:656-658.

Moulton, V. D., E. H. Miller, and H. Ochoa-Acuña, 2000. Haulout behaviour of captive harp seals (*Pagophilus groenlandicus*): Incidence, seasonality, and relationships to weather. Applied Animal Behaviour Science 65:367-378.

Muñoz-Hincapié, M. F., D. M. Mora-Pinto, D. M. Palacios, E. R. Secchi, and A. A. Mignucci-Giannoni, 1998. First osteological record of the dwarf sperm whale in Colombia, with notes on the zoogeography of Kogia in South America. Revista Academia Colombiana de Ciencias 22(84):433-444.

Nachtigall, P.E., A. Supin, J.L. Pawloski, and W.W.L. Au. 2004. Temporary threshold shift after noise exposure in bottlenosed dolphin (*Tursiops truncatus*) measured using evoked auditory potential. Marine Mammal Science. 20:673-687.

Nachtigall, P.E., D.W. Lemonds, and H.L. Roitblat. 2000. Psychoacoustic studies of dolphins and whales in Hearing by Dolphins and Whales, W.W.L. Au, A.N. Popper, and R.R. Fay, eds. Springer, New York. Pp. 330-363.

Nachtigall, P.E., J.L. Pawloski, and W.W.L. Au. 2003. Temporary threshold shift and recovery following noise exposure in the Atlantic bottlenosed dolphin (*Tursiops truncatus*). Journal of the Acoustical Society of America. 113:3425-3429.

Nachtigall, P.E., W.W.L. Au, J.L. Pawloski, and P.W.B. Moore. 1995. Risso's dolphin (*Grampus griseus*) hearing thresholds in Kaneohe Bay, Hawaii. Pages 49-53 in R.A. Kastelein, J.A. Thomas, and P.E. Nachtigall, eds. Sensory systems of aquatic mammals. Woerden, The Netherlands: De Spil Publishers.

National Oceanic and Atmospheric Administration (NOAA). 2001. Final Rule for the Shock Trial of the WINSTON S. CHURCHILL (DDG-81), Federal Register, Department of Commerce; NMFS, FR 66, No. 87, 22450-67.

National Research Council (NRC). 2003. Ocean noise and marine mammals. The National Academic Press, Washington D.C. 208 pp.

Nawochik, R., D.J. St. Aubin and A. Johnson. 2003. Movements and dive behavior of two stranded, rehabilitated long-finned pilot whales (*Globicephala melas*) in the Northwest Atlantic. Marine Mammal Science. 19:232-239.

Nedwell, J.R., B. Edwards, A.W.H. Turnpenny, and J. Gordon. 2004. Fish and marine mammal audiograms: A summary of available information. Subacoustech Ltd. Report, Ref. 19534R0213.

Nemoto, T., and A. Kawamura. 1977. Characteristics of food habits and distribution of baleen whales with special reference to the abundance of North Pacific sei and Bryde's whales. Reports of the International Whaling Commission, Special Issue. 1:80-87.

Nerini, M. 1984. A review of gray whale feeding ecology. p. 451-463 In: M.L. Jones, S.L. Swartz, and S. Leatherwood (eds.), The Gray Whale, (*Eschrichtius robustus*). Academic Press, Inc., Orlando, Florida.

Nieri, M., E. Grau, B. Lamarche, A. Aguilar. 1999. Mass mortality of Atlantic spotted dolphins (*Stenella frontalis*) caused by a fishing interaction in Mauritania. Marine Mammal Science. 15:847–854.

NMFS, Office of Protected Resources. 2005. Assessment of Acoustic Exposures on Marine Mammals in Conjunction with U.S.S. SHOUP Active Sonar Transmissions in the Eastern Strait of Juan de Fuca and Haro Strait, Washington, 5 May 2003.

NMFS. 2005d. False Killer Whale (*Pseudorca crassidens*): Northern Gulf of Mexico Stock. Stock Assessment Report. December, 2005.

NMFS. 2005e. Dwarf Sperm Whale (*Kogia sima*): Western North Atlantic Stock. Stock Assessment Report. December, 2005.

NMFS. 1998a. Recovery plan for the blue whale (*Balaenoptera musculus*). Prepared by R.R. Reeves, P.J. Clapham, R.L. Brownell, and G.K. Silber. Silver Spring, Maryland: National Marine Fisheries Service.

NMFS. 2002. Endangered and threatened species: Determination on a petition to revise critical habitat for northern right whales in the Pacific. Federal Register 67:7660-7665.

NMFS. 2004. Interim Report on the Bottlenose Dolphin (*Tursiops truncates*) Unusual Mortality Event Along the Panhandle of Florida March-April 2004. National Marine Fisheries Service. 36 pp.

NMFS. 2005. Recovery Plan for the North Atlantic Right Whale (*Eubalaena glacialis*). National Marine Fisheries Service, Silver Spring, MD.

NMFS. 2005b. Long-Finned Pilot Whale (*Globicephala melas*): Western North Atlantic Stock. Stock Assessment Report. December, 2005.

NMFS. 2005b. Pygmy Sperm Whale (*Kogia breviceps*): Western North Atlantic Stock. Stock Assessment Report. December, 2005.

NMFS. 2006a. Proposed rule to implement speed restrictions to reduce the threat of ship collisions with North Atlantic right whales. Federal Register 71(122):36299-36313.

NMFS. 2006z. Endangered and threatened species; Proposed endangered status for North Atlantic right whales. Federal Register 71(248):77704-77716.

NMFS. 2007a. Biological Opinion on the U.S. Navy's proposed Composite Training Unit Exercises and Joint Task Force Exercises off Southern California from February 2007 to January 2009. National Marine Fisheries Service, Office of Protected Resources. 163 pp.

NMFS. 2008. National Marine Fisheries Office of Protected Resources Memorandum to Chief of Naval Operations, Environmental Readiness. In review Jan 08.

NOAA. 2002a. Final Rule SURTASS LFA Sonar. Federal Register, Department of Commerce; NMFS, FR 67, 136, 46712-89, 16 July.

NOAA. 2002b. Report of the workshop on acoustic resonance as a source of tissue trauma in cetaceans. NOAA Fisheries, Silver Spring, Maryland. April 2002.

NOAA. 2006a. National Marine Fisheries Service Biological Opinion for RIMPAC, 2006.

NOAA. 2006b. Incidental Harassment Authorization for RIMPAC 2006 issued by NOAA-NMFS.

Norman, A. A., C. E. Bowlby, M. S. Brancato, J. Calambokidis, D. Duffield, P. J. Gearin, T. A. Gornall, M. E. Gosho, B. Hanson, J. Hodder, S. J. Jeffries, B. Lagerquist, D. M. Lambourn, B. Mate, B. Norberg, R. W. Osborne, J. A. Rash, S. Riemer and J. Scordino. 2004. Cetacean strandings in Oregon and Washington between 1930 and 2002. Journal of Cetacean Research and Management. 6:87-99.

Norman, S.A. and J.G. Mead. 2001. *Mesoplodon europaeus*. Mammalian Species. 688:1-5.

Norris, K.S., and J.H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican waters. University of California Publications in Zoology. 63:291-402.

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

Nowacek, D. P., L. H. Thorne, D. W. Johnston, and P. L. Tyack, 2007. Responses of cetaceans to anthropogenic noise. Mammal Review. 37:81-115.

NRC. 2003. Ocean noise and marine mammals. National Academy Press, Washington, DC.

NRC. 2005. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. The National Academic Press, Washington D.C. 126 pp.

NRC. 2006. "Dynamic Changes in Marine Ecosystems: Fishing, Food Webs, and Future Options, Committee on Ecosystem Effects of Fishing: Phase II - Assessments of the Extent of Change and the Implications for Policy," (National Research Council, of the National Academes, National Academes Press, Washington, DC).

NSWC/Anteon Corp., Inc. 2005. Very shallow water explosion tests at Naval Amphibious Base, Coronado, CA and San Clemente Island, CA: Conditions, results, and model predictions.

Odell, D. K., and K. M. McClune, 1999. False killer whale *Pseudorca crassidens* (Owen, 1846). Pages 213-243 in S. H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises. San Diego: Academic Press.

Odell, D.K. 1987. The mystery of marine mammal strandings. Cetus 7:2.

Office of Naval Research, 2001. "Final Environmental Impact Statement for the North Pacific Acoustic Laboratory," Volumes I and II, January 2001.

Orr, R.T. and C.Helm, 1989. Marine mammals of California, revised edition. Berkeley, CA: University of California Press. 93 pp.

O'Hara, T.M. and C. Rice, 1996. Polychlorinated biphenyls. In: A. Fairbrother, L. Locke, and G Hoff (eds). Noninfectious diseases of wildlife, 2nd edition. Iowa State University Press, Ames, Iowa.

O'Hara, T.M., M.M. Krahn, D. Boyd, P.R. Becker, L.M. Philo, 1999. Organochlorine contaminant levels in eskimo harvested bowhead whales of arctic Alaska. Journal of Wildlife Diseases 35(4):741-752.

Oleson, E., J. Barlow, C. Clark, J. Gordon, S. Rankin, and J. Hildebrand. 2003. Low frequency calls of Bryde’s whales. Marine Mammal Science. 19:407-419.

Osborne, R., 2003. "Historical Information on Porpoise Strandings in San Juan County Relative to the May 5th Navy Sonar Incident," (The Whale Museum News and Events).

O'Shea, T. J., and R.L. Brownell Jr., 1994. Organochlorine and metal contaminants in baleen whales: a review and evaluation of conservation implications. Science of the Total Environment 154:179-200.

Oswald, J. N., J. Barlow, and T. F. Norris, 2003. Acoustic identification of nine delphinid species in the eastern tropical Pacific Ocean. Marine Mammal Science 19(1):20-37.

Pace, R.M, and G.K. Silber, 2005. Abstract- Simple analyses of ship and large whale collisions: Does speed kill? Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, December 2005.

Palacios, D. M., and B. R. Mate, 1996. Attack by false killer whales (*Pseudorca crassidens*) on sperm whales (*Physeter macrocephalus*) in the Galápagos Islands. Marine Mammal Science 12(4):582-587.

Palka, D., and M. Johnson, eds, 2007. Cooperative Research to Study Dive Patterns of Sperm Whales in the Atlantic Ocean. Minerals Management Service, New Orleans, LA. OCS Study MMS2007-033. 49 pp.

Panigada, S., G. Pesante, M. Zanardelli, F. Capoulade, A. Gannier and M. T. Weinrich. 2006. Mediterranean fin whales at risk from fatal ship strikes. Marine Pollution Bulletin 52: 1287-1298.

Panigada, S., M. Zanardelli, S. Canese, and M. Jahoda, 1999. Deep diving performances of Mediterranean fin whales. Page 144 in Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals. 28 November-3 December 1999. Wailea, Maui.

Parente, C. L., J. P. Araujo, and M. E. Araujo, 2007. Diversity of cetaceans as tool in monitoring environmental impacts of seismic surveys. Biota Neotrop 7(1):1-7.

Payne, K., P. Tyack, and R. Payne. 1983. Progressive changes in the songs of humpback whales (*Megaptera novaengliae*): A detailed analysis of two seasons in Hawaii. Pp. 9-57 in R. Payne, ed. Communication and behavior in whales. Washington, D.C.: American Association for the Advancement of Science.

Payne, P. M., D. N. Wiley, S. B. Young, S. Pittman, P. J. Clapham, and J. W. Jossi, 1990. Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in selected prey. Fishery Bulletin 88:687-696

Payne, P.M., J.R. Nicolas, L. O'Brien, and K.D. Powers. 1986. The distribution of the humpback whale, *Megaptera novaeangliae*, on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel, Ammodytes americanus. Fishery Bulletin. 84:271-277.

Perrin, W. F. and J. R. Geraci. 2002. Stranding. IN: W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego, Academic Press: pp. 1192-1197.

Perrin, W. F., and R. L. Brownell, Jr, 2002. Minke whales *Balaenoptera acutorostrata* and *B. bonaerensis*. Pages 750-754 in W. F. Perrin, B. Würsig, and J. G. M. Thewissen, eds. Encyclopedia of marine mammals. Academic Press: San Diego, California.

Perrin, W. F., and W. A. Walker, 1975. The rough-toothed porpoise, *Steno bredanensis*, in the eastern tropical Pacific. Journal of Mammalogy 56(4):905-907.

Perrin, W.F., 2002. Common dolphins *Delphinus delphis*, *D. capensis*, and *D. tropicalis*. Pages 245-248 in W. F.Perrin, B. Würsig, and J. G. M. Thewissen, eds. Encyclopedia of marine mammals. Academic Press: San Diego, California.

Perrin, W.F., and A.A. Hohn. 1994. Pantropical spotted dolphin.*Stenella attenuata*. Pages 71-98 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego: Academic Press.

Perrin, W.F., and J.W. Gilpatrick. 1994. Spinner dolphin--*Stenella longirostri*s (Gray, 1828). Pages 99-128 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego: Academic Press.

Perrin, W.F., and R.L. Brownell. 2002. Minke whales *Balaenoptera acutorostrata* and *B. bonaerensis*. Pages 750-754 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego: Academic Press.

Perrin, W.F., C.E. Wilson, and F.I. Archer. 1994a. Striped dolphin.*Stenella coeruleoalb*a (Meyen, 1833). Pages 129-159 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego: Academic Press.

Perrin, W.F., S. Leatherwood, and A. Collet. 1994. Fraser's dolphin-*Lagenodelphis hosei* (Fraser, 1956). Pages 225-240 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego: Academic Press.

Perry, S.L., D.P. DeMaster, and G.K. Silber. 1999. The great whales: History and status of six species listed as endangered under the U.S. Endangered Species Act of 1973. Marine Fisheries Review. 61:1-74.

Perryman, W.L., and T.C. Foster. 1980. Preliminary report on predation by small whales, mainly the false killer whale, Pseudorca crassidens, on dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern tropical Pacific. Southwest Fisheries Science Center Administrative Report LJ-80-05. La Jolla, California: National Marine Fisheries Service.

Philips, J.D., P.E. Nachtigall, W.W.L. Au, J.L. Pawloski, and H.L. Roitblat. 2003. Echolocation in the Risso's dolphin, *Grampus griseus*. Journal of the Acoustical Society of America 113:605-616.

Piantadosi, C. A. and E. D. Thalmann. 2004. Whales, sonar and decompression sickness arising from: Jepson, P. D. et al. Nature 425, 575-576. 2003. Nature. (15 April2004.

Pitman, R. L., L. T. Ballance, S. L. Mesnick, and S. J. Chivers, 2001. Killer whale predation on sperm whales: Observations and implications, Mar. Mammal Sci. 17, 494-507.

Pitman, R.L., 2002. Mesoplodont whales *Mesoplodon* spp. Pages 738-742 in W. F. Perrin, B. Würsig, and J. G. M. Thewissen, eds. Encyclopedia of marine mammals. Academic Press: San Diego, California.

Pivorunas, A., 1979. The feeding mechanisms of baleen whales. American Scientist 67:432-440.

Podesta, M., A. D'Amico, G. Pavan, A. Drouga, A. Komnenou, and N. Portunato, 2006. A review of *Ziphius cavirostris* strandings in the Mediterranean Sea. Journal of Cetacean Research and Mangagement 7(3):251-261.

Polefka, S., 2004. Anthropogenic Noise and the Channel Islands National Marine Sanctuary. Report by Environmental Defense Center, Santa Barbara, CA. 51 pp.

Popov, V. V., and V. O. Klishin, 1998. EEG study of hearing in the common dolphin, *Delphinus delphis*. Aquatic Mammals 24(1):13-20.

Quaranta, A., P. Portalatini, and D. Henderson. 1998. Temporary and permanent threshold shift: An overview. Scandinavian Audiology. 27:75–86.

Rankin, J.J. 1953. First record of the rare beaked whale, *Mesoplodon europaeus*, Gervais, from the West Indies. Nature 172: 873-874.

Rankin, S. and J. Barlow. 2007. Sounds recorded in the presence of Blainville's beaked whales, *Mesoplodon densirostris*, near Hawai'i. The Journal of the Acoustical Society of America. 122:42-45.

Rankin, S., and J. Barlow. 2003. Discovery of the minke whale “boing” vocalization, and implications for the seasonal distribution of the North Pacific minke whale. Page 134 in Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals. 14–19 December 2003. Greensboro, North Carolina.

Rankin. S., T. F. Norris, M. A. Smultea, C. Oedekoven, A. M. Zoidis, E. Silva, and J. Rivers. 2007. A visual sighting and acoustic detections of minke whales, *Balaenoptera acutorostrata* (Cetacea: Balaenopteridae), in nearshore Hawaiian waters. Pac. Sci. 61(3):395-398.

Read, A.J., P. Drinker and S. Northridge. 2006. Bycatch of Marine Mammals in U.S. and Global Fisheries. Conservation Biology. 20:163-169.

Redfern, J.V., M.C. Ferguson, E.A. Becker, K.D. Hyrenbach, C. Good, J. Barlow, K. Kaschner, M.F. Baumgartner, K.A. Forney, L.T. Ballance, P. Fauchald, P. Halpin, T. Hamazaki, A.J. Pershing, S.S. Qian, A. Read, S.B. Reilly, L. Torres, and F. Werner. 2006. Techniques for cetacean-habitat modeling: A review. Marine Ecology Progress Series 310:271-295.

Reeder D. M., and K. M. Kramer, 2005. Stress in free-ranging mammals: integrating physiology, ecology, and natural history. Journal of Mammalogy 86: 225-235.

Reeves, R.R., B.S. Stewart, and S. Leatherwood, 1992. The Sierra Club handbook of seals and sirenians. San Francisco, CA: Sierra Club. 359 pp

Reeves, R.R., B.S. Stewart, P.J. Clapham, and J.A. Powell. 2002. National Audubon Society guide to marine mammals of the world. New York: Alfred A. Knopf.

Reeves R.R., and E. Mitchell. 1988. History of whaling in and near North Carolina. NOAA Tech Rep NMFS 65:1–28

Reilly, S. B., 1990. Seasonal changes in distribution and habitat differences among dolphins in the eastern tropical Pacific. Marine Ecology Progress Series 66:1-11.

Reilly, S., and V.G. Thayer. 1990. Blue whale (*Balaenoptera musculus*) distribution in the eastern tropical Pacific. Marine Mammal Science. 6:265-277.

Rendell, L., and H. Whitehead. 2004. Do sperm whales share coda vocalizations? Insights into coda usage from acoustic size measurement. Animal Behaviour. 67:865-874.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-195 In: W. E. Schevill (ed.). The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.

Rice, D. W. 1978. Sperm whales. Pp. 83-87, in Marine mammals of eastern north Pacific and arctic waters (D. Haley, ed.). Pacific Search Press, Seattle

Rice, D. W., 1977. Synopsis of biological data on the sei whale and Bryde's whale in the eastern north Pacific. Reports of the International Whaling Commission Special Issue 1:92-97.

Rice, D. W., 1989. Sperm whale - *Physeter macrocephalus* (Linnaeus, 1758). Pages 177-234 in S. H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 4: River dolphins and the larger toothed whales. Academic Press: San Diego, California.

Rice, D.W. 1998. Marine mammals of the world: Systematics and distribution. Society for Marine Mammalogy Special Publication. 4:1-231.

Rice, D.W. and A.A. Wolman. 1971. The life history of the gray whale, (*Eschrichtius robustus*). American Society of Mammalogists, Special Publication 3. 142pp.

Richardson, W. J., C. R. J. Green, C. I. Malme and D. H. Thomson. 1995. Marine Mammals and Noise. San Diego, CA, Academic Press.

Ridgway, S. H., and D. A. Carder, 2001. Assessing hearing and sound production in cetaceans not available for behavioral audiograms: Experiences with sperm, pygmy sperm, and gray whales. Aquatic Mammals 27(3):267-276.

Ridgway, S.H. 2000. The auditory central nervous system. Pages 273-293 in W.W.L. Au, A.N. Popper, and R.R. Fay, eds. Hearing by whales and dolphins. New York: Springer-Verlag.

Ridgway, S.H. and M.D. Dailey. 1972. Cerebral and cerebellar involvement of trematode parasites in dolphins and their possible role in stranding. Journal of Wildlife Diseases. 8:33-43.

Ridgway, S.H., and R. Howard. 1979. Dolphin lung collapse and intramuscular circulation during free diving: evidence from nitrogen washout. Science. 206:1182–1183.

Ridgway, S.H., B.L. Scronce, and J. Kanwisher. 1969. Respiration and deep diving in the bottlenose porpoise. Science. 166:1651-1654.

Ridgway, S.H., D.A. Carder, R.R. Smith, T. Kamolnick, C.E. Schlundt, and W.R. Elsberry. 1997. Behavioral responses and temporary shift in masked hearing threshold of bottlenose dolphins, *Tursiops truncatus*, to 1-second tones of 141 to 201 dB re 1 µPa. Technical Report 1751, Revision 1. San Diego: Naval Sea Systems Command.

Riedman, M., 1990. The pinnipeds: Seals, sea lions, and walruses. University of California Press: Berkeley, California.

Ritter, F., and B. Brederlau, 1999. Behavioural observations of dense beaked whales (*Mesoplodon densirostris*) off La Gomera, Canary Islands (1995-1997). Aquatic Mammals 25(2):55-61.

Rivers, J.A. 1997. Blue whale, *Balaenoptera musculus*, vocalizations from the waters off central California. Marine Mammal Science. 13:186-195.

Robertson, K.M., and S.J. Chivers. 1997. Prey occurrence in pantropical spotted dolphins, Stenella attenuata, from the eastern tropical Pacific. Fishery Bulletin. 95:334-348.

Robinson, S., L. Wynen, and S. Goldsworthy, 1999. "Predation by a Hooker's sea lion (*Phocarctos hookeri*) on a small population of fur seals *Arctocephalus* spp.) at Macquarie Island," Mar. Mammal Sci. 15, 888-893.

Roden, C. L., and K. D. Mullin, 2000. Sightings of cetaceans in the northern Caribbean Sea and adjacent waters, winter 1995. Caribbean Journal of Science 36(3-4):280-288.

Romano, T.A., J.A. Olschowka, S.Y. Felten, V. Quaranta, S.H. Ridgway,and D.L. Felten. 2002. Immune response, stress, and environment: Implications for cetaceans. In: Cell and Molecular Biology of Marine Mammals. C.J. Pfeiffer (ed). Krieger Publishing Co., Inc. pp. 53-279.

Romano, T.A., M.J. Keogh, C. Kelly, P. Feng, L. Berk, C.E. Schlundt, D.A. Carder, and J.J. Finneran. 2004. Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure. Canadian Journal of Fisheries and Aquatic Science. 61:1124-1134.

Rommel, S.A., A.M. Costidis, A. Fernandez, P.D. Jepson, D.A. Pabst, W.A. McLellan, D.S. Houser, T.W. Cranford, A.L. vanHelden, D.M. Allen, and N.B. Barros. 2006. Elements of beaked whale anatomy and diving physiology and some hypothetical causes of sonar-related stranding. J. Cetacean Res. Management. 7(3):189-209.

Ronald, K., and B. L. Gots, 2003. Seals: Phocidae, Otariidae, and Odobenidae. Pages 789-854 in G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild mammals of North America: Biology, management, and conservation. Second edition. John Hopkins University Press: Baltimore, Maryland.

Ross, D. 1976. Mechanics of underwater noise. Pergamon, New York. 375 pp.

Roughgarden, J., S. Gaines, and H. Possingham, 1988. Recruitment dynamics in complex life cycles. Science 241(4872):1460-1466.

Salden, D. R. 1988. Humpback whale encounter rates offshore of Maui, Hawaii. Journal of Wildlife Management. 52:301-304.

Salden, D.R., and J. Mickelsen. 1999. Rare sighting of a North Pacific right whale (Eubalaena glacialis) in Hawaii. Pacific Science. 53:341-345.

Salden, D.R., L. M. Herman, M. Yamaguchi, and F. Sato. 1999. Multiple visits of individual humpback whales (*Megaptera novaeangliae*) between the Hawaiian and Japanese winter grounds. Canadian Journal of Zoology. 77:504-508.

Sanvito, S., and F. Galimberti. 2003. Source level of male vocalizations in the genus Mirounga: Repeatability and correlates. Bioacoustics. 14:47-59.

Sapolsky, R. M. 2005. The influence of social hierarchy on primate health. Science. 308: 648-652.

Saunders, J.C., J.H. Mills, and J.D. Miller. 1977. Threshold shift in the chinchilla from daily exposure to noise for six hours. Journal of the Acoustical Society of America. 61:558–570.

Schilling, M.R., I. Seipt, M.T. Weinrich, S.E. Frohock, A.E. Kuhlberg, and P.J. Clapham. 1992. Behavior of individually-identified sei whales *Balaenoptera borealis* during an episodic influx into the southern Gulf of Maine in 1986. Fishery Bulletin. 90:749-755.

Schlundt, C.E., J.J. Finneran, D.A. Carder, and S.H. Ridgway. 2000. Temporary shift in masked hearing thresholds of bottlenose dolphins, *Tursiops truncatus*, and white whales, *Delphinapterous leucas*, after exposure to intense tones. Journal of the Acoustical Society of America. 107:3496-3508.

Schlundt, C.E., R.L. Dear, D.A. Carder, and J.J. Finneran. 2006. Growth and recovery of temporary threshold shifts in a dolphin exposed to mid-frequency tones with durations up to 128 s. Journal of the Acoustical Society of America. 120:3227A.

Schneider, D. C., and P. M. Payne, 1983. Factors affecting haul-out of harbor seals at a site in southeastern Massachusetts. Journal of Mammalogy 64(3):518-520.

Schoenherr, J.R. 1991. Blue whales feeding on high concentrations of euphausiids around Monterey Submarine Canyon. Canadian Journal of Zoology. 69:583-594.

Schotten, M., W.W.L. Au, M.O. Lammers, and R. Aubauer. 2004. Echolocation recordings and localization of wild spinner dolphins (*Stenella longirostris*) and pantropical spotted dolphins (*S. attenuata*) using a four-hydrophone array. Pages 393-400 in J.A. Thomas, C.F. Moss and M. Vater, eds. Echolocation in bats and dolphins. Chicago, Illinois: University of Chicago Press.

Schreer, J.F., K.M. Kovacs, and R.J.O. Hines. 2001. Comparative diving patterns of pinnipeds and seabirds. Ecological Monographs. 71:137-162.

Schusterman, R.J. 1974. Auditory sensitivity of a California sea lion to airborne sound. Journal of the Acoustical Society of America, 56:1248-1251.

Schusterman, R.J. 1977. Temporal patterning in sea lion barking (*Zalophus californianus*). Behavioral Biology, 20:404-408.

Schusterman, R.J. 1978. Vocal communication in pinnipeds. In: Studies of Captive Wild Animals, H. Markowitz and V. Stevens (Eds), Nelson Hall, Chicago.

Schusterman, R.J., Balliet, R.F., and Nixon, J. 1972. Underwater audiogram of the California sea lion by the conditioned vocalization technique. Journal of the Experimental Analysis of Behavior, 17:339-350.

Schusterman, R.J., Gentry, R., and Schmook, J. 1967. Underwater sound production by captive California sea lions. Zoologica, 52:21-24.

Schusterman, R.J., Gentry, R., and Schmook, J. 1996. Underwater vocalizations by sea lions: social and mirror stimuli. Science, 154:540-542.

Schusterman, R.J., Kastak, D., Levenson, D.H., Reichmuth, C.J., and Southall, B.L. 2000. Why pinnipeds don't echolocate. Journal of the Acoustical Society of America, 107(4):2256-2264.

Schwartz, M., A. Hohn, A. Bernard, S. Chivers, and K. Peltier. 1992. Stomach contents of beach cast cetaceans collected along the San Diego County coast of California, 1972-1991. Southwest Fisheries Science Center Adminstrative Report LJ-92-18. La Jolla, California: National Marine Fisheries Service.

Scott M.D., A.A. Hohn., A.J. Westgate, J.R. Nicolas., B.R. Whitaker and W.B Campbell. 2001. A note on the release and tracking of a rehabilitated pygmy sperm whale (*Kogia breviceps*). Journal of Cetacean Research and Management. 3:87-94.

Scott, M.D., and K.L. Cattanach. 1998. Diel patterns in aggregations of pelagic dolphins and tuna in the eastern Pacific. Marine Mammal Science. 14:401-428.

Scott, T. M., and S. S. Sadove, 1997. Sperm whale, Physeter macrocephalus, sightings in the shallow shelf waters off Long Island, New York. Marine Mammal Science 13(2):317-321.

Skov, H., T. Gunnlaugsson, W.P. Budgell, J. Horne, L. Nøttestad, E. Olsen, H. Søiland, G. Víkingsson and G. Waring. 2007. Small-scale spatial variability of sperm and sei whales in relation to oceanographic and topographic features along the Mid-Atlantic Ridge. Deep Sea Research Part II: Topical Studies in Oceanography 55(1-2):254-268.

Seagars, D.J., 1984.The Guadalupe fur seal: a status review. Administrative Report SWR-84-6. Southwest Region, National Marine Fisheries Service, Terminal Island, CA.

Selzer, L.A. and P.M. Payne. 1988. The distribution of white-sided dolphins (*Lagenorhynchus acutus*) and common dolphins. *Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States. Marine Mammal Science. 4:141-153

Sergeant, D.E. 1982. Some biological correlates of environmental conditions around Newfoundland during 1970-1979: harp seals, blue whales and fulmar petrels. North Atlantic Fisheries Organization. NAFO. Scientific Council Studies. 5:107-110.

Seyle, H. 1950. Stress and the general adaptation syndrome. British Medical Journal. 1383-1392.

Shane, S. H., 1995. Behavior patterns of pilot whales and Risso's dolphins off Santa Catalina Island, California. Aquatic Mammals 21(3):195-197.

Shane, S.H. 1994. Occurrence and habitat use of marine mammals at Santa Catalina Island, California from 1983-91. Bulletin of the Southern California Academy of Sciences. 93:13-29.

Shipley, C., B.S. Stewart, and J. Bass. 1992. Seismic communication in northern elephant seals. Pages 553-562 in J.A. Thomas, R.A. Kastelein, and A.Y. Supin, eds. Marine mammal sensory systems. New York: Plenum Press.

Silber, G.K. 1986. The relationship of social vocalizations to surface behavior and aggression in the Hawaiian humpback whale (*Megaptera novaeangliae*). Canadian Journal of Zoology. 64:2075-2080.

Simão, S. M., and S. C. Moreira, 2005. Vocalizations of female humpback whale in Arraial do Cabo (RJ, Brazil). Marine Mammal Science 21(1):150-153.

Simmonds, M. P. and L. F. Lpez-Jurado, 1991. Whales and the military. Nature 351:448.

Simmonds, M.P, and J.D. Hutchinson, 1996. "The Conservation of Whales and Dolphins: Science and Practice". John Wiley & Sons, Chichester, UK.

Simmonds, M.P. and S.J. Mayer. 1997. An evaluation of environmental and other factors in some recent marine mammal mortalities in Europe: implication for conservation and management. Environmental Review. 5(2):89-98.

Širović, A., J.A. Hildebrand, and Sean M. Wiggins. 2007. J. Acoust. Soc. Am. 122:1208-1215.

Skov, H., J. Durinck, and D. Bloch, 2003. Habitat characteristics of the shelf distribution of the harbour porpoise (Phocoena phocoena) in the waters around the Faroe Islands during summer. North Atlantic Marine Mammal Commission (NAMMCO) Scientific Publications 5:31-40.

Slijper, E. J., W. L. van Utrecht, and C. Naaktgeboren, 1964. Remarks on the distribution and migration of whales, based on observations from Netherlands ships. Bijdragen Tot de Dierkunde 34:3-93.

Smith, M.E., A.S. Kane, and A.N. Popper. 2004. Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water?. Journal of Experimental Biology. 207:3591-3602.

Soto, N. A., M. A. Johnson, P. T. Madsen, P. L. Tyack, A. Bocconcelli and J. F. Borsani. 2006. Does intense ship noise disrupt foraging in deep-diving Cuvier's beaked whales (*Ziphius cavirostris*)? Marine Mammal Science. 22(3): 690-699.

Southall, B.L., R. Braun, F.M. D. Gulland, A.D. Heard, R. Baird, S. Wilkin and T.K. Rowles. 2006. Hawaiian melon-headed whale (*Peponocephala electra*) mass stranding event of July 3-4, 2004. NOAA Technical Memorandum NMFS-OPR-31. 73 pp.

Stacey, P.J., and R.W. Baird. 1991. Status of the false killer whale, *Pseudorca crassidens*, in Canada. Canadian Field-Naturalist. 105:189-197.

Stafford, K.M., S.E. Moore, and C.G. Fox. 2005. Diel variation in blue whale calls recorded in the eastern tropical Pacific. Animal Behaviour. 69:951-958.

Stafford, K.M., S.L. Nieukirk, and C.G. Fox. 2001. Geographic and seasonal variation of blue whale calls in the North Pacific. Journal of Cetacean Research and Management. 3:65-76.

Steiger, G.H., J. Calambokidis, R. Sears, K.C. Balcomb, and J.C. Cubbage, 1991. Movement of humpback whales between California and Costa Rica. Marine Mammal Science 7:306-310.

Stern, J.S. 1992. Surfacing rates and surfacing patterns of minke whales (*Balaenoptera acutorostrata*) off central California, and the probability of a whale surfacing within visual range. Reports of the International Whaling Commission. 42:379-385.

Stevick, P.T., B.J. McConnell, and P.S. Hammond. 2002. Patterns of movement. Pages 185-216 in A.R. Hoelzel, ed. Marine mammal biology: An evolutionary approach. Oxford: Blackwell Science.

Stewart, B. S. and S. Leatherwood, 1985. Minke whale *Balaenoptera acutorostrata* Lacepede, 1804. Pages 91-136 in Ridgway, S. H. and R. Harrison, eds. Handbook of marine mammals. Volume 3: The sirenians and baleen whales. Academic Press: San Diego, California.

Stewart, B.S. 1997. Ontogeny of differential migration and sexual segregation in northern elephant seals. Journal of Mammalogy. 78:1101-1116.

Stewart, B.S., and R.L. DeLong. 1995. Double migrations of the northern elephant seal, *Mirounga angustirostris*. Journal of Mammalogy. 76:196-205

Stone, C. J. and M. J. Tasker, 2006. The effects of seismic airguns on cetaceans in U. K. waters. Journal of Cetacean Research and Management 8(3):255-263.

Stone, G.S., S.K. Katona, A. Mainwaring, J.M. Allen, and H.D. Corbett. 1992. Respiration and surfacing rates for finback whales (*Balaenoptera physalus*) observed from a lighthouse tower. Reports of the International Whaling Commission. 42:739-745.

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

Sweeny, M. M., J. M. Price, G. S. Jones, T. W. French, G. A. Early, and M. J. Moore, 2005. "Spondylitic changes in long-finned pilot whales (*Globicephala melas*) stranded on Cape Cod, Massachusetts, USA, between 1982 and 2000," J. Wildlife Dis. 41, 717-727.

Swingle, W. M., S. G. Barco, T. D. Pitchford, W. A. McLellan, and D. A. Pabst, 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. Marine Mammal Science 9(3):309-315.

Szymanski, M.D., D.E. Bain, K. Kiehl, S. Pennington, S. Wong, and K.R. Henry. 1999. Killer whale (*Orcinus orca*) hearing: auditory brainstem response and behavioral audiograms. Journal of the Acoustical Society of America. 106:1134-1141.

Terhune, J., and S. Turnbull, 1995. Variation in the psychometric functions and hearing thresholds of a harbour seal. Pages 81-93 in Kastelein, R. A., J. A. Thomas, and P. E. Nachtigall, eds. Sensory Systems of Aquatic Mammals. De Spil Publishers: Woerden, The Netherlands.

Terhune, J.M. and W.C. Verboom. 1999. Right whales and ship noise. Marine Mammal Science. Vol 15. No.1. pp. 256-258.

Thode, A., D.K. Mellinger, S. Stienessen, A. Martinez, and K. Mullin. 2002. Depth-dependent acoustic features of diving sperm whales (*Physeter macrocephalus*) in the Gulf of Mexico. Journal of the Acoustical Society of America. 112:308-321.

Thomas, J. and R. Kastelein. 1990. Sensory Abilities of Cetaceans. Plenum Press, New York.

Thomas, J., N. Chun, W. Au, and K. Pugh. 1988. Underwater audiogram of a false killer whale (*Pseudorca crassidens*). Journal of the Acoustical Society of America. 84:936-940.

Thompson, D., P. S. Hammon, K. S. Nicholas, and M. A. Fedak, 1991. Movements, diving and foraging behaviour of grey seals (*Halichoerus grypus*). Journal of Zoology, London 224:223-232.

Thompson, P. O., W. C. Cummings, and S. J. Ha, 1986. Sounds, source levels, and associated behavior of humpback whales, southeast Alaska. Journal of the Acoustical Society of America 80(3):735-740.

Thompson, P.O., and W.A. Friedl. 1982. A long term study of low frequency sounds from several species of whales off Oahu, Hawaii. Cetology. 45:l -1 9.

Thompson, T.J., H.E. Winn, and P.J. Perkins. 1979. Mysticete sounds. In Behavior of marine animals, Volume 3. H.E. Winn and B.L. Olla, (eds.), Plenum, NY. 438 pp.

Trimper, P. G., N. M. Standen, L. M. Lye, D. Lemon, T. E. Chubbs, and G. W. Humphries., 1998. Effects of lowlevel jet aircraft noise on the behaviour of nesting osprey. The Journal of Applied Ecology. 35:9.

Turl, C. W., 1993. Low-frequency sound detection by a bottlenose dolphin. Journal of the Acoustical Society of America 94(5):3006-3008.

Tyack, P., and H. Whitehead, 1983. Male competition in large groups of wintering humpback whales. Behaviour 83:132-153.

Tyack, P.L., J. Gordon, and D. Thompson. 2004. Controlled Exposure Experiments to Determine the Effects of Noise on Marine Mammals. Marine Technology Society Journal. 37(4): 41-53.

Tyack, P.L., M.P. Johnson, M.A. de Soto, A. Sturlese, and P.T. Madsen. 2006b. Extreme diving of beaked whales. Journal of Experimental Biology. 209:4238-4253.

Tyack, P.L., M.P. Johnson, W.M.X. Zimmer, P.T. Madsen, and M.A. de Soto. 2006a. Acoustic behavior of beaked whales, with implications for acoustic monitoring. Oceans. 2006. 1-6.

United States Fish and Wildlife Service (USFWS). 2003. Final Revised Recovery Plan for the Southern Sea Otter (Enhydra lutris nereis). Portland, Oregon. 165 pp.

United States Fish and Wildlife Service (USFWS). 2001. Notice of Policy Regarding Capture and Removal of Southern Sea Otters in a Designated Management Zone. Federal Register. Volume 66, Number 14. Pp. 6649-6652.

Urian, K. W., D. A. Duffield, A. J. Read, R. S. Wells, and E. D. Shell, 1996. Seasonality of reproduction in bottlenose dolphins, *Tursiops truncatus*. Journal of Mammalogy 77(2):394-403.

Urick, R. J. 1983. Principles of Underwater Sound for Engineers, McGraw-Hill, NY, 1975.

Van Dolah, F.M. 2005. Effects of Harmful Algal Blooms. IN: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery, T.J. Ragen. Marine Mammal Research. John Hopkins University Press, Baltimore. pp. 85-99.

Van Dolah, F.M., G.J. Doucette, F.M.D. Gulland, T.L. Rowles, and G.D. Bossart. 2003. Impacts of algal toxins on marine mammals. IN: J.G. Vos, G.D. Bossart, M. Fournier, and T.J. O'Shea, eds. Toxicology of Marine Mammals, Taylor & Francis, London and New York. pp. 247-269.

Van Parijs, S. M., P. J. Corkeron, J. Harvey, S. A. Hayes, D. K. Mellinger, P. A. Rouget, P. M. Thompson, M. Wahlberg, and K. M. Kovacs, 2003. Patterns in the vocalizations of male harbor seals. Journal of the Acoustical Society of America 113(6):3403-3410.

Vanderlaan, A. S. M. and C. T. Taggart. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science. 23(1): 144-156.

Veirs, V. 2004. Source levels of free-ranging killer whale (*Orcinus orca*) social vocalizations. Journal of the Acoustical Society of America. 116:2615.

Vidal, O. and J.-P. Gallo-Reynoso. 1996. Die-offs of marine mammals and sea birds in the Gulf of California, Mexico. Marine Mammal Science. 12(4): 627-635.

Visser, I.K.G., J.S. Teppema, and A.D.M.E. Ostrhaus. 1991. Virus infections of seals and other pinnipeds. Reviews in Medical Microbiology. 2:105-114.

Von Saunder, A., and J. Barlow. 1999. A report of the Oregon, California and Washington line-transect experiment (ORCAWALE) conducted in West Coast waters during Summer/Fall 1996. NOAA Technical Memorandum NMFS-SWFSC-264:1-49.

Wade, P.R, and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Reports of the International Whaling Commission. 43:477-493.

Wahlberg, M. 2002. The acoustic behaviour of diving sperm whales observed with a hydrophone array. Journal of Experimental Marine Biology and Ecology. 281:53-62.

Walker, M. M., J. L. Kirschvink, G. Ahmed and A. E. Dizon. 1992. Evidence that fin whales respond to the geomagnetic field during migration. Journal of Experimental Biology. 171(1): 67-78.

Walker, W.A. 1981. Geographical variation in morphology and biology of bottlenose dolphins (Tursiops) in the eastern North Pacific. Southwest Fisheries Science Center Administrative Report LJ-81-03C. La Jolla, California: National Marine Fisheries Service.

Walker, W.A., J.G. Mead, and R.L. Brownell. 2002. Diets of Baird's beaked whales Berardius bairdii, in the southern Sea of Okhotsk and off the Pacific Coast of Honshu, Japan. Marine Mammal Science. 18:902-919.

Walsh, M. T., R. Y. Ewing, D. K. Odell and G. D. Bossart. 2001. Mass Stranding of Cetaceans. CRC Handbook of Marine Mammals. L. A. Dierauf and F. M. D. Gulland, CRC Press: pp. 83-93.

Wang, M.-.C., W.A. Walker, K.T. Shao, and L.S. Chou. 2002. Comparative analysis of the diets of pygmy sperm whales and dwarf sperm whales in Taiwanese waters. Acta Zoologica Taiwanica. 13:53-62.

Ward, W.D. 1960. Recovery from high values of temporary threshold shift. Journal of the Acoustical Society of America. 32:497–500.

Ward, W.D. 1997. Effects of high-intensity sound. In Encyclopedia of Acoustics, ed. M.J. Crocker, 1497-1507. New York: Wiley.

Ward, W.D., A. Glorig, and D.L. Sklar. 1959. Temporary threshold shift from octave-band noise: Applications to damage-risk criteria. Journal of the Acoustical Society of America. 31:522–528.

Ward, W.D., A. Glorig, and DL. Sklar. 1958. Dependence of temporary threshold shift at 4 kc on intensity and time. Journal of the Acoustical Society of America. 30:944–954.

Waring, G. T., and J. T. Finn, 1995. Cetacean trophic interactions off the northeast USA inferred from spatial and temporal co-distribution patterns. Unpublished meeting document. ICES C.M, 1995/N:7:1-44. International Council for the Exploration of the Sea: Copenhagen, Denmark.

Waring, G. T., J. M. Quintal, and C. P. Fairfield, eds, 2002. U. S. Atlantic and Gulf of Mexico marine mammal stock assessments – 2002. NOAA Technical Memorandum NMFS-NE-169:1-318.

Waring, G. T., T. Hamazaki, D. Sheehan, G. Wood, and S. Baker, 2001. Characterization of beaked whale (Ziphiidae) and sperm whale (*Physeter macrocephalus*) summer habitat in shelf-edge and deeper waters off the northeast U. S. Marine Mammal Science 17(4):703-717.

Wartzok, D., A. N. Popper, J. Gordon, and J. Merrill, 2004. Factors affecting the responses of marine mammals to acoustic disturbance. Marine Technology Society Journal 37, 6-15.

Wartzok, D., A. N. Popper, J. Gordon, and J. Merrill. 2003. Factors affecting the responses of marine mammals to acoustic disturbance. Marine Technology Society Journal. 37:6–15.

Wartzok, D., and Ketten, D. 1999. Marine mammal sensory systems. IN: J.E. Reynolds III and S. A. Rommel, eds. The Biology of Marine Mammals. Smithsonian Institution Press, Washington, DC.

Watkins, W. A., and W. E. Schevill, 1977. Sperm whale codas. Journal of the Acoustical Society of America 62(6):1485-1490.

Watkins, W.A., K.E. Moore, and P. Tyack. 1985. Sperm whale acoustic behaviors in the southeast Caribbean. Cetology. 49:1-15.

Watkins, W.A., M.A. Daher, K.M. Fristrup, and T.J. Howald. 1993. Sperm whales tagged with transponders and tracked underwater by sonar. Marine Mammal Science. 9:55-67.

Watkins, W.A., M.A. Daher, N.A. DiMarzio, A. Samuels, D. Wartzok, K.M. Fristrup, P.W. Howey, and R.R. Maiefski. 2002. Sperm whale dives tracked by radio tag telemetry. Marine Mammal Science. 18:55-68.

Watkins, W.A., P. Tyack, K.E. Moore, and J.E. Bird. 1987. The 20-Hz signals of finback whales (*Balaenoptera physalus*). Journal of the Acoustical Society of America. 82:1901-1912.

Watwood, S.L., P.J.O. Miller, M. Johnson, P.T. Madsen and P.L. Tyack. 2006. Deep-diving foraging behaviour of sperm whales (*Physeter macrocephalu*s). Journal of Ecology. 75:814-825.

Weilgart, L. and H. Whitehead. 1993. Coda communication by sperm whales (*Physeter microcephalus*) off the Galapagos Islands. Canadian Journal of Zoology. 7 1:744-752.

Weilgart, L. and H. Whitehead. 1997. Group-specific dialects and geographical variation in coda repertoire in South Pacific sperm whales. Behavioral Ecology and Sociobiology 40:277-285.

Weise, M.J., D.P. Costa, and R.M. Kudela. 2006. Movement and diving behavior of male California sea lion (*Zalophus californianus*) during anomalous oceanographic conditions of 2005. Geophysical Research Letters. 33:L22S10.

Welch, B. L. and A. S. Welch (eds.). 1970. Physiological effects of noise. Plenum Press, New York, NY.

Weller, D. W., B. Würsig, H. Whitehead, J. C. Norris, S. K. Lynn, R. W. Davis, N. Clauss, and P. Brown, 1996. Observations of an interaction between sperm whales and short-finned pilot whales in the Gulf of Mexico. Marine Mammal Science 12(4):588-594.

Weller, D. W., B. Würsig, S. K. Lynn, and A. J. Schiro, 2000. Preliminary findings on the occurrence and site fidelity of photo-identified sperm whales (*Physeter macrocephalus*) in the northern Gulf of Mexico. Gulf of Mexico Science 18(1):35-39.

Wells, R. S., L. J. Hansen, A. Baldridge, T. P. Dohl, D. L. Kelly, and R. H. Defran, 1990. Northward extension of the range of bottlenose dolphins along the California coast. Pages 421-431 in S. Leatherwood and R. R. Reeves, eds. The bottlenose dolphin. Academic Press: San Diego, California.

Wells, R.S., D.J. Boness, and G.B. Rathbun. 1999. Behavior. Biology of Marine Mammals (ed. J.E. Reynolds III and S.A. Rommel), pp 117-175.

Weston, D.E. 1960. Underwater Explosions as Acoustic Sources. Proceedings of the Physics Society. 76: 233.

Whitehead, H, S. Brennan and D. Grover. 1992. Distribution and behaviour of male sperm whales on the Scotian Shelf, Canada. Canadian Journal of Zoology. 70:912-918.

Whitehead, H. 2003. Sperm whales: Social evolution in the ocean. Chicago: University of Chicago Press.

Whitehead, H., and L. Weilgart. 1991. Patterns of visually observable behaviour and vocalizations in groups of female sperm whales. Behaviour. 118:276-296.

Wiley, D. N., R. A. Asmutis, T. D. Pitchford, and D. P. Gannon, 1995. Stranding and mortality of humpback whales, *Megaptera novaeangliae*, in the mid-Atlantic and southeast United States, 1985-1992. Fishery Bulletin 93:196-205.

Wilkinson, D.M. 1991. Report to the Assistant Administrator for Fisheries, in Program Review of the Marine Mammal Stranding Network. U.S. Department of Commerce, National Oceanographic and Atmospheric Administrations, National Marine Fisheries Service, Silver Springs, MD. 171 pp.

Williams, A. D., R. Williams, and T. Brereton, 2002. The sighting of pygmy killer whales (Feresa attenuata) in the southern Bay of Biscay and their association with cetacean calves. Journal of the Marine Biological Association of the U. K. 82:509-511.

Willis, P.M., and R.W. Baird. 1998. Status of the dwarf sperm whale, *Kogia simus*, with special reference to Canada. Canadian Field-Naturalist. 112:114-125.

Wilson, J., L. Rotterman, and D. Epperson, 2006. Minerals Management Service Overview of Seismic Survey Mitigation and Monitoring on the U. S. Outer Continental Shelf. Presented to the Scientific Committee of the International Whaling Commission, SC/58/E8. 13 pp.

Winn, H.E., and P.J. Perkins. 1976. Distribution and sounds of the minke whale, with a review of mysticete sounds. Cetology. 19:1-12.

Winn, H.E., J.D. Goodyear, R.D. Kenney, and R.O. Petricig. 1995. Dive patterns of tagged right whales in the Great South Channel. Continental Shelf Research. 15:593-611.

Wolski, L. F., R. C. Anderson, A. E. Bowles, and P. K. Yochem, 2003. Measuring hearing in the harbor seal (*Phoca vitulina*): Comparison of behavioral and auditory brainstem response techniques. Journal of the Acoustical Society of America 113:629-637.

Woodward, B.L. and J.P. Winn. 2006. Apparent lateralized behavior in gray whales feeding off the central British Columbia coast. Marine Mammal Science. 22:64-73.

Würsig, B., R. R. Reeves, and J. G. Ortega-Ortiz, 2002. Global climate change and marine mammals. Pages 589-608 in P. G. H. Evans and J. A. Raga, eds. Marine mammals: Biology and conservation. Kluwer Academic/Plenum Publishers: New York.

Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquatic Mammals. 24:41-50.

Würsig, B., T. A. Jefferson, and D. J. Schmidly, 2000. The marine mammals of the Gulf of Mexico. Texas A&M University Press: College Station, Texas.

Yelverton, J.T. 1981, Underwater Explosion Damage Risk Criteria for Fish, Birds, and Mammals, Manuscript, presented at 102nd Meeting of the Acoustical Society of America, Miami Beach, FL, December, 1982. 32pp.

Yen PPW, Sydeman WJ, Hyrenbach KD. 2004. Marine bird and cetacean associations with bathymetric habitats and shallow-water topographies: implications for trophic transfer and conservation. Journal of Marine Systems. 50:79-99.

Yost, W.A. 1994. Fundamentals of Hearing: An Introduction. San Diego: Academic Press.

Yu, H-Y., H-K. Mok, R-C. Wei, and L-S., Chou. 2003. Vocalizations of a rehabilitated rough-toothed dolphin, Steno bredanensis. Page 183 in Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals. 14–19 December 2003. Greensboro, North Carolina.

Yuen, M.E., Nachtigall, P.E., and Supin, A.Ya. 2005. Behavioral and AEP Audiograms of a false killer whale (*Pseudorca crassidens*). Journal of the Acoustical Society of America. 118: 2688-2695.

Zeeberg, J., A. Corten and E. de Graaf. 2006. Bycatch and release of pelagic megafauna in industrial trawler fisheries off Northwest Africa. Fisheries Research. 78: 186-195.

Zimmer, W. M. X., M. P. Johnson, P. T. Madsen, and P. L. Tyack, 2005. Echolocation clicks of free-ranging Cuvier's beaked whales (*Ziphius cavirostris*). Journal of the Acoustical Society of America 117(6):3919-3927.

Zimmerman, S. T. 1991. A History of Marine Mammal Stranding Networks in Alaska, with Notes on the Distribution of the Most Commonly Stranded Cetacean Species, 1975-1987. Marine Mammal Strandings in the United States, Miami, FL, NMFS.

SEA BIRDS

Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington D.C.

Ackerman J, Mason J, Takekawa J. 1004. Seabirds off southern California—surveys reveal patterns in abundance and distribution. Sound Waves November. Sound Waves, Coastal Science & Research News from Across the USGS. U.S. Geological Survey. Accessed 6 Apr 2007. http://soundwaves.usgs.gov/index.html.

Ainley DG, Boekelheide RJ (eds). 1990. Seabirds of the Farallon Islands: ecology, dynamics, and structure of an upwelling-system community. Stanford University Press, Stanford, California. 450 pp.

Ainley, D. G., et al., 1990. Leach's Storm-Petrel and Ashy Storm-Petrel in Seabirds of the Farallon Islands, ecology, dynamics and structure of an upwelling-system community. Stanford University Press, Stanford, CA.

Ainley DG, Everett WT. 2001. Black storm-petrel (*Oceanodroma melania*). In The Birds of North America, No. 577 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, Pennsylvania.

Ainley DG, Sydeman WJ, Hatch SA, Wilson WJ. 1994. Seabird population trends along the west coast of North America: causes and extent of regional concordance. Studies in Avian Biology 15:119-133.

Ainley DG, Sydeman WJ, Norton J. 1995. Upper trophic level predators indicate interannual negative and positive anomalies in the California Current food web. Marine Ecology Progress Series 118:69-79.

Anderson DW, Gress F. 1983. Status of the northern population of California brown pelicans. Condor 85:79-88.

Anderson DW, Jehl JR, Risebrough RW, Woods LA, DeWeese LR, Edgecomb WG. 1975. Brown pelicans: improved reproduction off the southern California coast. Science 190:806-808.

Anderson DW, Gress F, Mais MF. 1982. Brown pelicans: influence of food supply on reproduction. Oikos 39:23-31.

Atwood JL, Minsky DE. 1983. Least tern foraging ecology at three major California breeding colonies. Western Birds 14:57-72.

Audubon. 2002 accessed online, http://www.audubon2.org/watchlist/viewSpecies.jsp?id=32

Audubon. 2005. Birds and science, Accessed online 30 April, 2007. http://web1.audubon.org/waterbirds/species.php?speciesCode=piggui

BirdLife International. 2004a. *Gavia stellata*. In: IUCN 2006. 2006 IUCN Red List of Threatened Species. www.iucnredlist.org. Accessed on 10 May 2007.

BirdLife International. 2004b. *Gavia immer*. In: IUCN 2006. 2006 IUCN Red List of Threatened Species. www.iucnredlist.org. Accessed on 10 May 2007.

Birdweb. 2005. Seattle Audubon's guide to the birds of Washington, Accessed online 27 Apr 2006. http://www.birdweb.org/birdweb/index.aspx.

Bretagnolle V. 1990. Effect of moon on activity of petrels (Class Aves) from the Selvagen Islands (Portugal). Canadian Journal of Zoology 68: 1404-1409.

Briggs KT, et al. 1981. Distribution, numbers, and seasonal status of seabirds of the Southern California Bight. In: Summary report 1975-1978: marine mammal and seabird survey of the Southern California Bight area. Vol. III, Book 3. U.S. Department of Commerce, NTIS Rpt. PB-81-248-197. Springfield, VA.

Briggs KT, Tyler WB, Lewis DB, Carlson DR. 1987. Bird communities at sea off California: 1975 to 1983. Studies in Avian Biology 11:1-74.

Burger AE. 2002. Conservation assessment of marbled murrelets in British Columbia, a review of the biology, populations, habitat associations and conservation. Canadian Wildlife Service TechnicalReport 387:1-168.

Burkett EE, Rojek NA, Henry AE, Fluharty MJ, Comrack L, Kelly PR, Mahaney AC, Fien KM. 2003. Status review of Xantus's Murrelet (*Synthliboramphus hypoleucus*) in California. California Department of Fish and Game, Habitat Conservation Planning Branch Status Report 2003-01:1-96+ appendices.

Burr T. 2005. Personal communication via review comments between Mr. Timothy Burr, and Tierra Data Inc., April 25, 2007.

Byrd, G. V., E. C. Murphy, G. W. Kaiser, A. Y. Kondratyev, and Y. V. Shibaev. 1993. Status and ecology of offshore fish-feeding alcids (murres and puffins) in the North Pacific Pages1 76-186 in The status, ecology and conservation of marine birds of the North Pacific (K. Vermeer, K. T. Briggs, K. H. Morgan and D. Siegel-Causey, Eds.). Canadian Wildlife Service Special Publication, Ottawa, Ontario.

California Department of Fish and Game [CDFG]. 1998 California least tern. Accessed 1 May 2007. California Department of Fish and Game endangered species Information System, http://www.dfg.ca.gov/hcpb/info/bm_research/bm_pdfrpts/2000_01.pdf

California Department of Fish and Game. 2003. Status review of Xantus' murrelet: Report to the California Fish and Game Commission. November 2003.

California Department of Fish and Game. 2005a. California Department of Fish and Game natural diversity database (CNDDB). Sacramento, California: Wildlife and Habitat Data Analysis Branch.

California Department of Fish and Game. 2005b. California least tern nesting data for 2004. Sacramento: California Department of Fish and Game, Wildlife and Habitat Data Analysis Branch.

California Department of Fish and Game. 2006. News Release, accessed online at: http://www.dfg.ca.gov/OSPR/organizational/admin/news/2006news/brownpelicans-nr-060606.pdf

Capitolo, P.J., Davis, J.N., Henkel, L.A., Tyler, W.B., Carter, H.R., and Kelly, P.R., 2007, Monitoring cormorant populations in Southern California in 2005-06: Asilomar, California, Pacific Seabird Group Annual Meeting, Abstracts:53-54 (www.pacificseabirdgroup.org/).

Carter, H. 2007. Personal Communication. Humboldt State University and Carter Biological Consulting, Arcata, CA.

Carter, H. 2007. Unpublished data. Humboldt State University and Carter Biological Consulting, Arcata, CA.

Carter HR, Morrison ML (eds). 1992. Status and conservation of the marbled murrelet in North America. Proceedings of a 1987 Pacific Seabird Group Symposium. Proceedings of the Western Foundation of Vertebrate Zoology 5. Camarillo, California. 134 pp.

Carter HR, McChessney GJ, Jaques DL, Strong CS, Parker MW, Takekawa JE, Jory DL, Whitworth DL. 1992. Breeding Populations of Seabirds in California, 1989-1991. Vol. 1 – Population Estimates, Unpublished Final Report, U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Dixon, California.

Channel Island National Park. 2005. Seabird Monitoring Annual Report (in prep), National Park Service, Department of the Interior, Washington, D.C.

Committee on the Status of Endangered Wildlife in Canada [COSEWIC]. 2003. COSEWIC assessment and update status report on the short-tailed albatross *Phoebastria albatrus* in Canada. Ottawa: Committee on the Status of Endangered Wildlife in Canada.

Croxall JP (ed). 1991. Seabird status and conservation: A supplement. International Council for Bird Preservation (ICBP) Technical Publication.

Cummings JL, Sheffer KH. 2007. Wildlife hazard assessment for Naval Auxiliary Landing Field, San Clemente Island, Naval Base Coronado, California, Prepared by National Wildlife Research Center, United States Department of Agriculture, Wildlife Services, 4101 La Porte Avenue, Fort Collins, CO 80525.

Dailey MD, Reish DJ, Anderson JW (eds). 1993. Ecology of the Southern California Bight: A Synthesis and Interpretation. Univ. Calif. Press, Berkeley

Del Hoyo J, Elliot A, Sargatal J (eds). 1992. Handbook of the birds of the world. Barcelona, Spain: Lynx Edicions.

DoN, 2007. Wildlife Hazard Assessment for Naval Auxiliary Landing Field, San Clemente Island, Naval Base Coronado, California, 2002. Prepared by U.S. Department of Agriculture Wildlife Services, National Wildlife Research Center, Fort Collins, CO.

Drost, C.A., 1989. Predation and population cycles on a southern California island. M.Sc. Thesis, University of California, Davis.

Drost CA, Lewis DB. 1995. Xantus's murrelet (*Synthliboramphus hypoleucus*). In The Birds of North America 164 (A. Poole and F. Gill, eds.) The Academy of Natural Sciences, Philadelphia and the American Ornithologists Union. Washington, D.C.

Emms, S.K. and N.A.M. Verbeek, 1989. Significance of the Pattern of Nest Distribution in the Pigeon Guillemot (Cepphus Columba), The Auk. Vol. 106, No. 2. (1989), pg 193-202.

Enticott J, Tipling D. 1997. Seabirds of the world: The complete reference. Mechanicsburg, Pennsylvania: Stackpole Books.

Erickson RA, Hamilton RA, Howell SNG, Pyle P, Patten MA. 1995. First record of the marbled murrelet and third record of the ancient murrelet for Mexico. Western Birds 26:39-45.

Farrand F. 1983. The Audubon Society master guide to birding. Volume 1: Loons-sandpipers. New York: Alfred A. Knopf.

Forest Ecosystem Management Assessment Team [FEMAT]. 1994. Forest ecosystem management: and ecological, economic, and social assessment. U.S. Departments of Agriculture and Interior, Washington, D.C..

Gaston AJ, Dechesne SBC. 1996. Rhinoceros auklet (*Cerorhinca monocerata*). In: The birds of North America, No. 212 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Gaston AJ, Jones LL. 1998. The auks. Oxford University Press, New York. Birdlife, 2006, accessed online at http://www.birdlife.org/datazone/species/index.html?action= SpcHTMDetails.asp&sid=3312&m=0.

Green, J.E. & Arnold, L.W. 1939. An unrecognized race of murrelet on the Pacific Coast of North America. Condor 41: 25-29

Gress F, Risebrough RW, Anderson DW, Kiff LF, Jehl JR Jr. 1973. Reproductive failures of double-crested cormorants in southern California and Baja California. Wilson Bull. 85:197-208.

Grinnell J. 1926. The evidence of the former breeding of the rhinoceros auklet in California. Condor 28:37-40.

Hobson, K.A., 1997. Pelagic Cormorant in The Birds of North America. No. 282. A. Poole and F. Gill (eds.). The Birds of North America Inc. Philadelphia, PA.

Hodder J, Graybill MR. 1985. Reproduction and survival of seabirds in Oregon during the 1982-83 El Niño.

Howell SNG, Engel SJ. 1993. Seabird observations off western Mexico. Western Birds 24:167-181.

Howell, S.N.G. and S. Webb, 1995. A Guide to the Birds of Mexico and northern Central America. Oxford University Press. New York, NY

Hunt G Jr, Butler JL. 1980. Reproductive ecology of western gulls and Xantus' murrelets with respect to food resources in the Southern California Bight. CalCOFI Reports 21:62-67.

IUCN. 2006 IUCN Red List of Threatened Species. Accessed 27 August 2006. http://www. iucnredlist.org.

Jaques DL, Strong CS, Keeney TW. 1996. Brown pelican roosting patterns and responses to disturbance at Mugu Lagoon and other nonbreeding sites in the southern California Bight. Technical Report Number 54. Tucson, Arizona: National Biological Service. 63 pp.

Jehl JR, Bond SI. 1975. Morphological variation and species limits in murrelets of the genus *Endomychura*. Transactions and Memoirs of the San Diego Society of Natural History, California 18(2):9-24.

Johnsgard PA. 1993. Cormorants, darters, and pelicans of the world. Washington, D.C.: Smithsonian Institution Press.

Kuletz KJ, Marks DK. 1997. Post-fledging behavior of a radio-tagged juvenile marbled murrelet. Journal of Field Ornithology 68(3):421-425.

Kushlan JA, Steinkemp MJ, Parsons KC, Capp J, Cruz MA, Coulter M, Davidson I, Dickson L, Edelson N, Elliot R, Erwin RM, Hatch S, Kress S, Milko R, Miller S, Mills K, Paul R, Phillips R, Saovoa JE, Sydeman W, Trapp J, Wheeler J, Wohl K. 2002. Waterbird conservation for the Americas: The North America waterbird conservation plan, version 1. Waterbird Conservation for the Americas, Washington, D.C., USA.

Massey BW, Fancher JM. 1989. Renesting by California least terns. Journal of Field Ornithology. 60(3):350-357.

Manuwal DA, Thorensen AC. 1993. Cassin's Auklet (*Ptychoramphus aleuticus*). In The Birds of North America, No. 50 (A Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists' Union, Washington, D.C.

McCaskie G, Garrett K. 2002. Southern Pacific Coast. North American Birds 56(2):222-226.

McChesney GJ, Carter HR, Parker MW. 2000. Nesting ashy storm-pestrels and Cassin's auklets in Monterey County, California. Western Birds 31:178-183.

McDermond, D.K., Morgan, K.H., 1993. Status and conservation of North Pacific albatrosses. In: Vermeer, K., Briggs, K.T., Morgan, K.H., Siegel-Causey, D. (Eds.), The Status, Ecology and Conservation of Marine Birds in the North Pacific. Canadian Wildlife Service Special Publication, Ottawa, pp. 70–81.

Mills KL, Sydeman WJ, Hodum PJ (eds). 2005. The California current marine bird conservation plan, version 1. PRBO Conservation Science, Stinson Beach, CA.

Murphy, R.C., 1936. Oceanic Birds of South America. Vol 2. American Museum of Natural History, New York.

Murray KG, Winnett-Murray K, Eppley ZA, Hunt GL Jr, Schwartz DB. 1983. Breeding biology of the Xantus' s murrelet. The Condor 85:12-21.

Nelson, D.A. 1989. Gull predation on Cassin's auklet varies with lunar cycle. Auk, 106, 495–497.

Nelson SK. 1997. Marbled murrelet (*Brachyramphus marmoratus*). The Birds of North America 290:1-32.

NPS, 2007, Annual report in prep. Seabird monitoring program, Channel Islands National Park, Ventura, CA.

Nur N. 1999. Population status, prospects, and risks faced by two seabirds of the California current: the ashy storm-petrel, *Oceanodroma homochroa*, and Xantus' murrelet, *Synthliboramphus hypoleucus*. Unpublished Report. Point Reyes Bird Observatory. Stinson Beach, CA.

Piatt, J.F. and A.S. Kitaysky, 2002. Horned Puffin (Fratercula corniculata) in The Birds of North America, A. Poole and F. Gill (eds.). Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington D.C.

Pierotti, R. and Annett, C., 1995. Western Gull (Larus occidentalis). In The Birds of North America. No. 174, A. Poole and F. Gill (eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

PRBO 2003. A summary of knowledge and recommendations for the conservation of marine birds and their habitats throughout the California Current Large Marine Ecosystem. Marine Ecology Division, PRBO, Conservation Science, Stinson Beach, CA.

Roberson D. 2000. California short-tailed albatrosses: A summary at the turn of the 21st century. Accessed 23 April 2005. http://www.montereybay.com/creagrus/CA_STAL.html.

Sanger, G.A., 1972. The recent pelagic status of the short-tailed Albatross (Diomedea albatrus). Biol.Conserv. 4(3): 189-193.

Shields M. 2002. Brown pelican (*Pelecanus occidentalis*). The Birds of North America 609:1-36.

Sibley DA. 2000. The Sibley Guide to Birds. National Audubon Society. Chanticleer Press, Sixth Addition, 242 pp.

Singer SW, Naslund NL, Singer SA, Ralph CJ. 1991. Discovery and observations of two tree nests of the marbled murrelet. The Condor 93:330-339.

Sowls AL, DeGange AR, Nelson JW, Lester GS. 1980. Catalog of California seabird colonies. U.S. Fish and Wildlife Service. FWS/OBS 37/80. 371 pp.

Speich SM, Wahl TR. 1989. Catalog of Washington seabird colonies. U.S. Fish and Wildlife Service, Biological Rep. 88(6). 510 pp.

Springer, Alan M.; Kondratyev, Alexander Y.; Ogi, Haruo; Shibaev, Yurij V.; van Vliet, Gus B. 1993. Status, ecology, and conservation of Synthliboramphus murrelets and auklets. In: Vermeer, Kees; Briggs, Kenneth T.; Morgan, Ken H.; Siegel-Causey, Douglas, eds. The status, ecology and conservation of marine birds of the north Pacific. Special Publication. Ottawa, ON: Canadian Wildlife Service, Environment Canada; 187-203.

Sydeman W, Nurr N, McLaren E, McChesney G. 1998. Status and trends of the ashy storm-petrel on southeast Farallon Island, California, based upon capture-recapture analyses. Condor 100: 438-447 [10]

Thompson BC, Jackson JA, Burger J, Hill LA, Atwood JL. 1997. Least tern (*Sterna antillarum*). The Birds of North America 290:1-32.

Unitt P. 2004. San Diego County bird atlas. San Diego, CA: San Diego Natural History Museum. Ibis Publishing Company.

U.S. Department of the Navy [DoN]. 2002a. San Clemente Island integrated natural resources management plan draft final. Prepared for the U.S. Department of the Navy, Southwest Division (USDON, SWDIV), San Diego, CA by Tierra Data Systems, Escondido, CA. October 2001.

U.S. Department of the Navy. 2002b. Final environmental impact statement/overseas environmental impact statement—Point Mugu Sea Range. Prepared for the Naval Air Warfare Center Weapons Division, Point Mugu, California by Ogden Environmental and Energy Services, Inc., Santa Barbara, California.

U.S. Department of the Navy. 2002c. Naval Base Coronado integrated natural resources management plan. Prepared for the Navy Region Southwest, San Diego, California by Tierra Data Systems, Escondido, California.

U.S. Department of the Navy. 2002d. Foraging behavior of the California least tern adjacent to piers in San Diego Bay. Prepared for SWDIV NAVFACENGCOM, Contract No. N68711-97-D-8814, Delivery order No. 0014. Merkel & Associates, San Diego, CA.

U.S. Department of the Navy. 2005. Marine resources assessment for the Southern California operating area. Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. Contract # N62470-02-D-9997, CTO 0025, Prepared by Geo-Marine, Inc., Plano,Texas.

U.S. Fish and Wildlife Service [USFWS]. 1983. The California brown pelican recovery plan. Prepared by the USFWS under contract with Franklin Gress (California Department of Fish and Game) and Daniel W. Anderson (University of California-Davis). 40 pp.

U.S. Fish and Wildlife Service. 1985. Recovery plan for the California least tern, *Sterna antillarum browni*. Portland, Oregon: U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service. 1997. Recovery plan for the threatened marbled murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Portland, Oregon: U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service. 2000. Endangered and threatened wildlife and plants; final rule to list the short-tailed albatross as endangered in the United States. Federal Register 65(147):46643-46654.

U.S. Fish and Wildlife Service. 2005a. Regional seabird conservation plan, Pacific region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region, Portland, Oregon.

U.S. Fish and Wildlife Service. 2005b. Short-tailed albatross Draft Recovery Plan, Accessed online 17 April 2006. http://ecos.fws.gov/docs/recovery_plans/2005/051027.pdf.

U.S. Fish and Wildlife Service. 2006. Species profile, Accessed online19 April 2006. http://ecos.fws.gov/docs/federal_register/fr5083.pdf

U.S. Fish and Wildlife Service. 2007. Listed distinct population segment of the brown pelican (*Pelecanus occidentalis*), 5 Year Review: Summary and Evaluation, accessed online at: http://www.fws.gov/arcata/es/birds/brnPelican/documents/2007.

U.S. Geological Survey [USGS]. 2005. Marine Habitat/Seabirds, Accessed online 25 April 2006. http://www.absc.usgs.gov/research/seabird_foragefish/seabirds/index.html

U.S. Marine Corps [USMC]. 2001. Integrated natural resources management plan—Marine Corps Base and Marine Corps Air Station Camp Pendleton. Camp Pendleton, California: U.S. Marine Corps.

Wallace, E. A. H. and G. E. Wallace, 1998. Brandt's Cormorant. In The Birds of North America: Life Histories for the 21st Century. No. 362. A. Poole. and F. Gill. (eds.). The Academy of Natural Sciences, Philadelphia, PA and the American Ornithologists' Union, Washington, D.C.

Wetlands International and IUCN SSC Threatened Waterfowl Specialist Group. 2002. Ducks, geese, swans and screamers: an action plan for the conservation of Anseriformes; second external draft for comment. Wetlands International & IUCN.

Weseloh CVC, Pekarik C, Blokpoel H. 1999. Breeding populations of cormorants, gulls and terns of the Canadian Great Lakes in 1997/98. Bird Trends (Canadian Wildlife Service) 7:30-34.

Yelverton, John T., Donald R. Richmond, E. Royce Fletcher, and Robert K. Jones. 1973. Safe distances from underwater explosions for mammals and birds. Lovelace Foundation for Medical Education and Research Albuquerque, NM.

TERRESTRIAL BIOLOGICAL RESOURCES

Axelrod, D.I. 1967. Geologic history of the Californian insular flora, p. 267-315. In: R.N. Philbrick (ed.). Proc.Symp. on the Biology of the California Islands. Santa Barbara Botanic Gardens, Santa Barbara, CA.

Barash DP. 1975. Evolutionary aspects of parental behavior: distraction behavior of the Alpine Accentor. Wilson Bulletin 87: 367-373.

Beason RC. 2003. Through a bird's eye—exploring avian sensory perception. USDA/Wildlife Services/National Wildlife Research Center/Ohio Field Station, Sandusky OH. http://www.aphis.usda.gov/ws/nwrc/is/03pubs/beason031.pdf.

Beaudry F, Munkwitz NM, Kershner EL, Garcelon DK. 2003. Population monitoring of the San Clemente sage sparrow—2002. Final report. Unpublished report *prepared by* the Institute for Wildlife Studies *for* the U.S. Navy, Commander Navy Region Southwest, Natural Resources Office, San Diego, California. 69pp.

Beaudry F, Munkwitz NM, Kershner EL, Garcelon DK. 2004. Population monitoring of the San Clemente sage sparrow—2003. Final report. Unpublished report prepared by the Institute for Wildlife Studies for the U.S. Navy, Navy Region Southwest, Natural Resources Office, San Diego, California. 78pp.

Bezy RL, Gorman GC, Adesr GA, Kim YJ. 1980. Divergence in the island night lizard, *Xantusia riversiana*. The California Islands: Proceedings of a Multidisciplinary Symposium. Pp. 565-583. Santa Barbara Museum of Natural History.

Bitterroot Restoration Incorporated. 2002. Wetland Delineation And Endangered Species Surveys On Naval Auxiliary Landing Field San Clemente Island. Draft Final Report, June 2002. Prepared for: Commander Navy Region Southwest, Environmental Department. Prepared under Contract N68711-00-D-4415 for Southwest Division, Navy Facilities Engineering Command.

Blackburn T, Anderson K. 1993. Before the wilderness: Environmental management by native Californians. Menlo Park, California. Ballena Press.

Bradley JE, Stuart SW, Hudgens BR, Garcelon DK. 2006. Draft breeding report—2006 population monitoring of the San Clemente loggerhead shrike on NALF, San Clemente Island, California. U.S. Navy, Environmental Department, Southwest Division, Naval Facilities Engineering Command, San Diego, California.

Brock K. 2000. Personal communication. San Clemente Loggerhead Shrike Program Manager, Navy Region Southwest, Natural Resources Office, NAS North Island. June 9.

Brown AL. 1990. Measuring the effect of aircraft noise on sea birds. Environment International, 16:587-592.

Busnel RG (ed), Briot J. 1980. Wildlife and airfield noise in France. Proc. 3rd Int’l Congress on Noise as a Public Health Problem. pp. 621-631.

California Native Plant Society. Inventory of Rare and Endangered Plants. V7-08a 2-1-08 http://cnps.web.aplus.net/cgi-bin/inv/inventory.cgi

Carroll MC, Laughrin L, Bromfield AC. 1993. Fire in the California Islands: Does it play a role in chaparral and closed cone pine forest habitats? In F. G. Hochberg [ed.] Proceedings of the Third California Islands Symposium: Recent Advances in Research on the California Islands. Santa Barbara, California. Santa Barbara Museum of Natural History. pp 73-88.

Conomy JT, Collazo JA, Dobovsky JA, Fleming WJ. 1998a. Dabbling duck behavior and aircraft activity in coastal North Carolina. Journal of Wildlife Management 62(3): 1127-1134.

Conomy JT, Dubovsky JA, Collazo JA, Fleming WJ. 1998b. Do black ducks and wood ducks habituate to aircraft disturbance? Journal of Wildlife Management 62: 1135-1142.

Cunningham SC, Babb RD, Jones TR, Taubert BD, Vega R. 2002. Reaction of lizard populations to a catastrophic wildfire in a central Arizona mountain range. Biological Conservation 107: 193-201.

D'Antonio CM, Vitousek PM. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecology and Systematics 23:13-26.

Delaney DK, Grubb TG, Beier P, Pater LL, Reiser MH. 1999. Effects of helicopter noise on Mexican spotted owls. J. Wildl. Manage. 63:60-76.

Delaney DK, Pater LL, Hayden TJ, Swindell LL, Beaty TA, Carlile LD, Spadgenske WE. 2000. Assessment of training noise impacts on the red-cockaded woodpecker: 1999 results. U.S. Army Corps of Engineers, Engineer Research and Development Center.

Delaney DK, Pater LL, Dooling RJ, Lohr B, Brittan-Powell BF, Swindell LL, Beaty TA, Carlile LD, Spadgenske EW, MacAllister BA, Melton RH. 2002. Assessment of training noise impacts on the red-cockaded woodpecker: 1998-2000. U.S. Army Corps of Engineers, Engineer Research and Development Center. November.

Dooling RJ, Ryals BM, Manabe K. 1997. Recovery of hearing and vocal behavior after hair-cell regeneration. Psychology. 94: 14206-14210.

Dunn, Jonathan and Thomas A. Zink. 2004. San Clemente Island Native Habitat Restoration Program. Seed Collection, Propagation, and Outplanting in Support of San Clemente Island Endangered Species Programs. 2003 Annual Report. Prepared for Natural Resources Office, Environmental Department Commander Navy Region Southwest, San Diego California under cooperative agreement with Naval Facilities Engineering Command, Southwest Division by Soil Ecology and Restoration Group, San Diego State University, San Diego, CA. 5pp.

Dunn, Jonathan and Thomas A. Zink. 2006. Final Report. Invasive species control and native habitat enhancement. Veldt grass and mustard sites. Prepared for Natural Resources Office, Environmental Department Commander Navy Region Southwest, San Diego California under cooperative agreement with Naval Facilities Engineering Command, Southwest Division by Soil Ecology and Restoration Group, San Diego State University, San Diego, CA. 25pp.

Eisler R. 1988. Lead hazards to fish, wildlife, and invertebrates: A synoptic review. U. S. Fish and Wildlife Service. Patuxent Wildlife Research Center. Laurel, MD 20708. Biological Report 85(1.14) Contaminant Hazard Reviews Report No. 14.

Ellis DH. 1981. Responses of raptorial birds to low level military jets and sonic booms. Result of the 1980-1981 Joint USAF-USFWS Study. 59 pp.

Ellis DH, Ellis CH, Mindell DP. 1991. Raptor responses to low-level jet aircraft and sonic booms. Environmental Pollution 74:53-83.

Elvin M. 1996. Unpublished field notes. Ranch Santa Ana Botanic Garden. 3.8-24

Farabaugh, S. M., Bukowinski, A, Swanson, L., Littlefeather, T., and Grant, T. 2005. Final Report: 2004 Propagation and abehavior of the captive population of the San Clemente loggerhead shrike (Lanius ludovicianus mearnsi). D.o.D., U. S. Navy, Natural Resources Specialist Support Team, Southwest Div., Nav. Eng. Command, San Diego, California. 20 September.

Finney MA. 1998. FARSITE ver. 4.1. Systems for Environmental Management, Missoula, MT. http://farsite.org/.

Foster, BD. 1998. Monitoring of the western snowy plover at NALF, San Clemente Island, California, 1994-1997. Unpublished report prepared for the Natural Resources Specialist Support Team, Southwestern Division Naval Facilities Engineering Command, San Diego, California. 64pp.

Foster BD, Copper E. 2000. Status report of the western snowy plover at Naval Auxiliary Landing Field, San Clemente Island, Los Angeles, California. Unpublished report prepared for the Natural Resources Office, Environmental Department Commander Navy Region Southwest, Southwest Division, Naval Facilities Engineering Command, San Diego, California.

Foster BD, Copper E. 2001. Status report of the western snowy plover at Naval Auxiliary Landing Field, San Clemente Island, Los Angeles, California, 2000. Unpublished report prepared for the Natural Resources Office, Environmental Department Commander Navy Region Southwest, Southwest Division, Naval Facilities Engineering Command, San Diego, California.

Foster BD, Copper E. 2003. Status of the western snowy plover at Naval Auxiliary Landing Field San Clemente Island, Los Angeles, CA. Unpublished report prepared for the Natural Resources Office, Environmental Department (N45RN) Commander, Navy Region Southwest, Southwestern Division, Naval Facilities Engineering Command, San Diego, California. 46pp.

Goldberg SR, Bezy RL. 1974. Reproduction in the island night lizard, *Xantusia riversiana*. Herpetologica, 30:350-360.

Grant T, Wiese R. 2006. Master plan and breeding recommendations: San Clemente loggerhead shrike (*Lanius ludovicianus mearnsi*), population biology management plan. Zoological Society of San Diego. 6 April.

Greenlee, Jason M. and Jean H. Langenheim. 1990. Historic Fire Regimes and their Relation to Vegetation Patterns in the Monterey Bay Area of California. Amer. Midl. Naturalist 124(2):239-253.

Grinnell J. 1897. Report on the birds recorded during a visit to the islands of Santa Barbara, San Nicholas, and San Clemente, in the spring of 1897. Pasadena Academy of Science 1: 26.

Grubb TG, Bowerman WW. 1997. Variations in breeding bald eagle response to jets, light planes, and helicopters. J. Raptor Res. 31:213-222.

Harvey NC. 1996. Laboratory records for San Diego Zoo captive breeding and release program. Unpublished.

Hayden TJ, Melton RH, Willis B, Martin III LB, Beaty T. 2002. Assessment of effects of maneuver training activities on red-cockaded woodpecker populations on Fort Stewart, GA. U.S. Army Corps of Engineers, Construction Engineering Research Laboratory.

Hickman JC (ed). 1993. The Jepson manual: higher plants of California. University of California Press, Berkeley.

Holland VL, Keil DJ. 1995. California vegetation. Kendall/Hunt Publishing Company. Dubuque, Iowa.

Howell AB. 1917. Birds of the islands off the coast of Southern California. Pacific Coast Avifauna No. 12. 27 pp.

Hyde KM. 1984. San Clemente Island loggerhead shrike/sage sparrow study, 1980-1983: final report. Natural Resources Office, Naval Air Station North Island.

Interagency Federal Wildland Fire Policy Review Working Group. 2001. Review and Update of the 1995 Federal Wildland Policy. 78pp. http://www.nifc.gov/fire_policy/history/index.htm

Jones L. 1975. The birds of San Clemente Island: An annotated species list. Unpublished report. 8 pp.

Jorgenson, P. D. and H. L. Ferguson. 1984. The birds of San Clemente Island. Western Birds 15:111-130.

Junak S. 2003. Distribution of selected invasive plant species on San Clemente Island, California. Santa Barbara Botanic Garden Technical Report No. 6 submitted to Kim O'Connor, Southwest Division, Naval Facilities and Engineering Command.

Junak S. 2005. Personal Communication. Botanist, Santa Barbara Botanic Garden. Compilation of new field data on locations of sensitive plant species locations through December 2004.

Junak S. 2006**.** Sensitive plant status survey Naval Auxiliary Landing Field San Clemente Island, California. Draft Final Report. Prepared for Department of the Navy Southwest Division, Naval Facilities Engineering Command, and Natural Resources Office, Commander, Navy Region Southwest San Diego, California. Letter of Agreement No. N68711-02-LT-00036. Santa Barbara Botanic Garden Technical Report**.** December.

Junak SA, Wilken DH. 1998. Sensitive plant status survey: NALF San Clemente Island, California. Final report prepared for Department of the Navy Southwest Division, Naval Facilities Engineering Command and Natural Resources Office, Staff Civil Engineer, Naval Air Station North Island, San Diego, California.

Kaiser, Sara A., Jennifer M. Turner, and David K. Garcelon. 2007. Population Monitoring of the San Clemente Sage Sparrow-2006. Final Report. Unpublished report prepared by the Institute for Wildlife Studies for the United States Navy, Navy Region Southwest, Natural Resources Office, San Diego, California. 94 pp.

KEA Environmental, Inc. 1997. San Clemente sage sparrow census and habitat suitability study San Clemente Island, California. Report attachment 1. Prepared for Southwest Division, Naval Facilities Engineering Command, San Diego, California.

Kendall RJ, Lacher Jr TE, Bunck C, Daniel B, Driver C, Grue CE, Leighton F, Stansley W, Watanabe PG, Whitworth M. 1996. An ecological risk assessment of lead shot exposure in non-waterfowl avian species: Upland game birds and raptors. Environmental Toxicology and Chemistry 15:4-20.

Kershner EL, Cooper DM, Garcelon DK. 2004. San Clemente loggerhead shrike non-native predator control program—2003: Final report. U.S. Navy, Natural Resources Management Branch, Southwest Division Naval Facilities Engineering Command, San Diego, CA. 59pp.

Knight RL, Temple SA. 1986. Why does intensity of avian nest defense increase during the nesting cycle? Auk 103:318-327.

Lee JC. 1975. The autecology of *Xantusia henshawi henshawi* (Sauria: Xantusiidae). Trans. San Diego Soc. Natural History, 17:259-277.

Linton CB. 1908. Notes from San Clemente Island. Condor 10:82-86.

Lynn S, Cesh LS, Kershner E, Garcelon DK. 2002. Research efforts to aid in the recovery of the San Clemente loggerhead shrike—2001. Unpublished report prepared by the Institute of Wildlife Studies, Arcata, California for the U.S. Navy, Natural Resources Management Branch, Southwest Div., Nav. Fac. Eng. Command, San Diego, California. 47pp.

Lynn S, Condon AM, Kershner EL, Garcelon DK. 2003. Winter ecology of loggerhead shrikes on San Clemente Island—final report. Unpublished report prepared by the Institute of Wildlife Studies, Arcata, California for U.S. Navy, Natural Resources Management Branch, Southwest Div., Nav. Fac. Eng. Command, San Diego, California. 31pp.

Lynn S, Carlisle HA, Chartier NA, Warnock N. 2004a. Western snowy plover surveys on Naval Auxiliary Landing Field San Clemente Island, Los Angeles County, California, 2003–2004. U. S. Navy, Environmental Department, Southwest Division, Naval Facilities Engineering Command, San Diego, California. 27pp. + electronic appendices.

Lynn S, Sullivan BL, Carlisle HA, Chartier NA, Warnock N. 2004b. 2003 population monitoring of the San Clemente loggerhead shrike on NALF, San Clemente Island, California, U.S. Navy, Environmental Department, Southwest Division, Naval Facilities Engineering Command, San Diego, California. 184pp + electronic appendices.

Lynn, S., B. L. Sullivan, H. A. Carlisle, and N. Warnock. 2005. Final Report - 2004 Population Monitoring of the San Clemente Loggerhead Shrike on NALF, San Clemente Island, California, U.S. Navy, Environmental Department, Southwest Division, Naval Facilities Engineering Command, San Diego, California. 225 pp. + electronic appendices.

Lynn, S., H. A. Carlisle, and N. Warnock. 2005. Western Snowy Plover surveys on Naval Auxiliary Landing Field San Clemente Island, Los Angeles County, California, 2004 – 2005. U. S. Navy, Environmental Department, Southwest Division, Naval Facilities Engineering Command, San Diego, California. 29pp + electronic appendices.

Lynn S, Leumas CM, Carlisle HA, Warnock N. 2006. 2005 Population monitoring of the San Clemente loggerhead shrike on NALF San Clemente Island, California. Natural/Cultural Resources Specialized Operations Team, Southwest Division Naval Facilities Engineering Command and U.S. Navy, Environmental Department, Southwest Division, Naval Facilities Engineering Command, San Diego, California.

Lynn S, Carlisle HA, Warnock N. 2006. Western snowy plover surveys on Naval Auxiliary Landing Field San Clemente Island, Los Angeles County, California, June-November 2005. U. S. Navy, Environmental Department, Southwest Division, Naval Facilities Engineering Command, San Diego, California. 28pp + electronic appendices.

Lynn S, Leumas CM, Carlisle HA, Warnock N. 2006. 2005 Population monitoring of the San Clemente loggerhead shrike on NALF San Clemente Island, California. Natural/Cultural Resources Specialized Operations Team, Southwest Division Naval Facilities

Engineering Command and U.S. Navy, Environmental Department, Southwest Division, Naval Facilities Engineering Command, San Diego, California.

Mack RN, Simberloff D, Lonsdale WM, Evans H, Clout M, Bazzaz F. 2000. Biotic invasions: Causes, epidemiology, global consequences and control. Issues in Ecology 5: 1-20.

Martin J. 1999. Personal communication. Biologist, Institute of Wildlife Studies.

Mautz WJ. 1979. Thermoregulation, metabolism, water loss and microhabitat selection in Xantussid lizards. PhD Dissertation, Cornell University, Ithaca, N.Y.

Mautz WJ. 1982. The status of the island night lizard, *Xantusia (=Klauberina) riversiana* on San Clemente Island. Report prepared for the Natural Resources Office, Staff Civil Engineer, NAS North Island, Dan Diego, CA. Contract NOO246-80M-7274.

Mautz WJ. 2001. The biology and management of the island night lizard, *Xantusia riversiana*, on San Clemente Island, California. Final Draft Report prepared for the Natural Resources Office, Environmental Department (N45RN) Commander, Navy Region Southwest, Southwestern Division, Naval Facilities Engineering Command, San Diego, California. 70pp. including appendices. Submitted to USFWS with Petition to Delist INL.

Mautz WJ. 2004. Island night lizard surveys on the Naval Auxiliary Landing Field, San Clemente Island, California. Report of Survey of July, 2003. Prepared for: Natural Resources Office, Staff Civil Engineer Code 18K. NAS North Island. San Diego, California.

Miller MR. 1951. Some aspects of the life history of the yucca night lizard, *Xantusia vigilis*. Copeia, 1951:114-120.

Mooney HA, Conrad CE (eds). 1977. Proceedings of the symposium on the environmental consequences of fire and fuel management in Mediterranean ecosystems, USDA Forest Service General technical Report WO-3, 498 pp.

Moran, R. 1995. The subspecies of *Dudleya virens* (Crassulaceae). Hazeltonia 3:1-9.

Mundy NI, Woodruff DS. 1996. Conservation genetics of the endangered San Clemente loggerhead shrike. The Journal of Heredity 87(1): 1-26.

Munkwitz NM, Beaudry MF, Garcelon DK. 2002. Population monitoring of the San Clemente sage sparrow—2001. Final Report. U.S. Navy, Commander Navy Region Southwest, Natural Resources Office, San Diego, California. 71 pp.

New Zealand Ministry of the Environment. 2001. Good practice guide for assessing and managing the environmental effects of dust emissions. Wellington, NZ. http://www.mfe.govt.nz/ publications/air/dust-guide-sep01.pdf.

Oberbauer TA. 1978. Distribution and dynamics of San Diego grasslands. Thesis. San Diego State University.

Page, G. W., F. C. Bidstrup, R. J. Ramer, and L. E. Stenzel. 1986. Distribution of wintering Snowy Plovers in California and adjacent states. Western Birds 17:145-170.

Page, G. W., L. E. Stenzel, W. D. Shuford, and C. R. Bruce. 1991. Distribution and abundance of the Snowy Plover on its western North American breeding grounds. J. Field Ornithology 62:245-255.

Page, G.W., J.S. Warriner, J.C. Warriner, and P.W.C. Paton. 1995. Snowy plover (Charadrius alexandrinus). In The Birds of North America, No. 154 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Pater LL, Delaney DK, Hayden TJ, Lohr B, Dooling R. 1999. Assessment of training noise impacts on the red-cockaded woodpecker: Preliminary results. CERL Technical Report (TR) 99/51, ADA 367234.

Philbrick, Ralph N., and Robert J. Haller. 1977. The Southern California Islands. In: Barbour, Michael G. and Jack Major (eds.). Terrestrial Vegetation of California. John Wiley and Sons, New York.

Pimm SL, Gilpin ME. 1989. Theoretical issues in conservation biology. In: Roughgarden, J., R. May, and S. A. Levin (eds.). Perspectives in Ecological Theory. Princeton University Press, Princeton, NJ.Plissner, J., A.V. Blackford, H.Carlisle, and N. Warnock. 2002. 2001 Population Monitoring of the San Clemente Loggerhead Shrike on NALF, San Clemente Island, California, U.S. Navy, Natural Resources Office, Southwest Div., Nav. Fac. Eng. Command, San Diego, California. pp 207-305.

Plissner J, Blackford AV, Carlisle H, Warnock N. 2002. 2001 population monitoring of the San Clemente loggerhead shrike on NALF, San Clemente Island, California, U.S. Navy, Natural Resources Office, Southwest Div., Nav. Fac. Eng. Command, San Diego, California.

Powell, A.N., J.M. Terp, C. L. Collier, and B. L. Peterson. 1997. The status of western snowy plovers (Charadrius alexandrinus nivosus) in San Diego County, 1997. Report to the California Department of Fish and Game and the US Fish and Wildlife Service.

Raven, PH. 1963. A flora of San Clemente Island, California. Aliso, 5:289-347.

Ross TS, Boyd S, Junak S. 1997. Additions to the vascular flora of San Clemente Island, Los Angeles County, California, with notes on clarifications and deletions. Aliso 15: 27-40.

Schmidt, G. A., and D. K. Garcelon. 2005. Island fox monitoring and research on Naval Auxiliary Landing Field, San Clemente Island, California. Final Report: June 2003-April 2004. Unpublished report prepared by the Institute for Wildlife Studies, Arcata, CA. 30pp.

Scott TA, Morrison ML. 1990. Natural history and management of the San Clemente

Scott TA, Morrison ML. 1995. Opportunistic foraging behavior of loggerhead shrikes. In Yosef, R., and F. Loher (eds.), Proc. of the Western Foundation of Vert. Zoology 6(1).

Smith JK (ed). 2000. Wildland fire in ecosystems: effects of fire on fauna. USDA Forest Service, Rocky Mountain Research Station. General Technical Report RMRS-GTR-42-Volume 1.

Stalmaster MV. 1997. Flushing responses of wintering bald eagles to military activity. Journal of Wildlife Management 61(4): 1307-1313.

Sward WL, Cohen RH. 1980. Plant community analysis of San Clemente Island. Unpublished report to Naval Ocean Systems Center, San Diego, California.

Thorne RF. 1976. The vascular plant communities of California. In J. Latting (ed.) Plant Communities of Southern California, Symposium Proceedings. California Native Plant Society Special Publication No. 2. pp 1-32.

Tiller A, Bollhall P, Black B, Collopy M, Percival H. 1984. Effects of low-level military training flights on wading bird colonies in Florida. Technical Report 190 pp. Performing organization. Florida Cooperative Fish Wildlife Research Unit. Naturalist 103:501-516.

Timbrook J, Johnson JR, Earle DD. 1982. Vegetation burning by the Chumash. Journal of California and Great Basin Anthropology 4(2): 163-186.

Tinkle DW. 1969. The concept of reproductive effort and its relation to the evolution of the life histories of lizards. American Naturalist 103:501-516.

Turner JM, Kershner EL, Struthers JL, Brubaker DL, Garcelon DK. 2002. San Clemente loggerhead shrike release program—2001, Draft Final Report. U.S. Navy, Natural Resources Management Branch, Southwest Div., Nav. Fac. Eng. Command, San Diego, California. 81 pp.

Turner JM, Sulzman CL, Kershner EL, Garcelon DK. 2004. San Clemente loggerhead shrike release program—2003, Final Report. Prepared by the Institute for Wildlife Studies for the U.S. Navy, Natural Resources Management Branch, Southwest Div., Nav. Fac. Eng. Command, San Diego, California. 57pp.

Turner JM, Kaiser SA, Kershner EL, Garcelon DK. 2005. Population monitoring of the San Clemente sage sparrow–2004, Final Report. Prepared by the Institute for Wildlife Studies for the U.S. Navy, Natural Resources Management Branch, Southwest Div., Nav. Fac. Eng. Command, San Diego, California. 85pp.

Turner JM, Kaiser SA, Hudgens BR, Kershner EL, Garcelon DK. 2006. Population monitoring of the San Clemente sage sparrow—2005, Final Report. Prepared by the Institute for Wildlife Studies for the U.S. Navy, Natural Resources Management Branch, Southwest Div., Nav. Fac. Eng. Command, San Diego, California. 86 pp.

U. S. Air Force. 1999. Final environmental impact statement: F-22 force development evaluation and weapons school beddown, Nellis AFB. October.

U. S. Air Force, U. S. Army, and U. S. Department of the Navy. 1978. Environmental protection: Planning in the noise environment. Document Prepared under Air Force Contract No. F49642-74-90035. 259pp.

U. S. Army. 2001. Installation environmental noise management plan: Camp Shelby, Mississippi. Prepared by Environmental Noise Program, Directorate of Environmental Health Engineering, U.S. Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving Ground, MD.

U. S. Army. 2004. Final environmental impact statement: Transformation of the 2nd Brigade, 25th Infantry Division (L) to a Stryker Brigade Combat Team in Hawai'i. Prepared by Tetra Tech, Inc. Honolulu, Hawai'i for the Department of the Army and the U.S. Army Corps of Engineers Honolulu Engineer District. May. (http://www.sbcteis.com/).

U.S. Department of Defense. 2000. Fire and Emergency Services Program. DoD Instruction 6055.6. 10 October 2000.

U.S. Department of the Navy [DoN]. 1993. Operational/land use compatibility study for NALF San Clemente Island. Southwest Division Naval Facilities Engineering Command, San Diego, California.

U.S. Department of the Navy. 1996a. Biological assessment: Fire effects on listed and proposed species, NALF San Clemente Island, California. Prepared for Natural Resources Office, Staff Civil Engineer, Naval Air Station, North Island, San Diego, California.

U.S. Department of the Navy. 1996b. Environmental assessment for testing of the joint standoff attack weapon (JSOW).

U.S. Department of the Navy. 1999a. Southern California offshore range (SCORE) users' manual. FACSFACSDINST 3550.1. August.

U.S. Department of the Navy. 1999b. Summary report fiscal year 1999 Southern California offshore range (SCORE) operations.

U.S. Department of the Navy. 2002. San Clemente Island integrated natural resources management plan: Final. San Diego, California. Prepared by Tierra Data Systems, Escondido, CA. May.

U.S. Department of the Navy, 2004. San Clemente Island vegetation condition and trend analysis 2003: Draft. Prepared for: Southwest Division, U.S. Naval Facilities Engineering Command, San Diego, CA under Contract: N68711-00-D-4413/0015. February.

U.S. Department of the Navy. 2004a. Biological assessment of military construction project P-493: Operational access to shore bombardment area at Naval Auxiliary Landing Field San Clemente Island California (12 January 2004, submitted to USFWS, and consulted on).

U.S. Department of the Navy. 2004b. Petition to designate San Clemente Island and San Nicholas Island populations of island night lizard (*Xantusia riversiana*) as distinct population segments and removal as such from the Federal list of threatened species pursuant to the Endangered Species Act of 1973. Attention: USFWS, Listing and Recovery Branch. Prepared by Commander, Navy Region Southwest. 22 March 2004.

U. S. Department of the Navy. 2005. San Clemente Island wildland fire management plan. Commander, Navy Region Southwest Natural Resource Office. Screencheck Draft. September.

U. S. Department of the Navy. 2006. San Clemente Island wildland fire management plan biological assessment. Commander, Navy Region Southwest Natural Resource Office. Draft.

U.S. Department of the Navy, 2007. Projected increases in sheet and rill erosion due to military operations Proposed on San Clemente Island. Prepared for Naval Facilities Engineering Command Southwest, Coastal Integrated Products Team, San Diego. Escondido, CA. March.

U.S. Fish and Wildlife Service [USFWS]. 1984. Recovery plan for the endangered and threatened species of the California Channel Islands. 26 January. Portland, OR. 165 pp.

U. S. Fish and Wildlife Service. 1993. Endangered and threatened wildlife and plants: determination of threatened status for the Pacific coast population of the Western Snowy Plover. Federal Register 58:12864-12874.

U.S. Fish and Wildlife Service. 1997a. Amendment to biological opinion 1-6-97-F-18. 11 June 1997.

U.S. Fish and Wildlife Service. 1997b. Biological/conference opinion on training activities on San Clemente Island, San Diego County, California (1-6-97-F-21). 15 March 1997.

U.S. Fish and Wildlife Service. 1997c. Biological opinion for impacts to island night lizard caused by existing and proposed naval activities on San Clemente Island (1-6-97-F-58). 15 December 1997.

U.S. Fish and Wildlife Service. 1999. Endangered and threatened wildlife and plants: Designation of critical habitat for the Pacific coast population of the western snowy plover. Final rule. Federal Register 64: 234.

U.S. Fish and Wildlife Service. 2001a. Training area ranges on San Clemente Island, Los Angeles County, California (Biological Opinion 1-6-00-F-19). 17 January 2001.

U.S. Fish and Wildlife Service. 2001b. Western snowy plover (*Charadrius alexandrinus nivosus*) Pacific Coast population draft recovery plan. Portland, Oregon. 228 pp. and Appendices.

U.S. Fish and Wildlife Service. 2002. Re-initiation of consultation on naval training activities that cause fires on San Clemente Island, Los Angeles County California (Biological Opinion 1-6-97-F-21). 23 July 2002.

U.S. Fish and Wildlife Service. 2004. Biological opinion for military construction project P-493 (San Clemente Island road improvement project), Los Angeles County, California (1-6-04-F-3934.1). 10 May 2004.

U.S. Fish and Wildlife Service and National Marine Fisheries Service [NMFS]. 1998. Endangered species consultation handbook: Procedures for conducting consultation and conference activities under Section 7 of the Endangered Species Act. http://www.fws.gov/ endangered/consultations/s7hndbk/s7hndbk.htm. March.

U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration [NOAA], and National Marine Fisheries Service. 1995. Joint counterpart Endangered Species Act Section 7 consultation regulations. 50 CFR Part 402. Federal Register 60 (150). pp 39921-39925. 5 August.

U.S. Marine Corps. 2000. Hearing Conservation Program, Marine Corps Order 6260.1E, 5 April 2000.

U.S. Marine Corps. 2003. Environmental impact statement for the advanced amphibious assault vehicle (AAAV) at Marine Corps Base Camp Pendleton, California.

U.S. Marine Corps. 2004. Environmental assessment for testing of the expeditionary fighting vehicle prototypes at Marine Corps Base Camp Pendleton, California. January.

VanderWerf E, Ebisu Y, and Associates, Wil Chee-Planning, Inc. 2000. A study to determine the effects of noise from military training on the endangered Oahu 'elepaio: United States Army Engineer District, Honolulu Programs and Project Management Division Environmental/DoD Support Branch, Contract No. DACA83-96-D-0007, Schofield Military Reservation, Island of Oahu.

Warriner, J.S., J.C. Warriner, G.W. Page and L.E. Stenzel. 1986. Mating system and reproductive success of asmall population of polygamous snowy plovers. Wilson Bulletin. 98:15-37.

Weisenberger ME, Krausman PR, Wallace MC, De Young DW, Maughan OE. 1996. Effects of simulated jet aircraft noise on heart rate and behavior of desert ungulates. J. Wildlife Management 60(1):52-61.

Workman GW, Bunch TD, Call JW, Evans RC, Neilson LS, Rawlings EM. 1992. Sonic boom/animal disturbance studies on pronghorn antelope, rocky mountain elk, and bighorn sheep. Utah State University Foundation, Logan. Prepared for U.S. Air Force, Hill AFB, Contract F42650-87-C-0349.

Zweifel RG, Lowe CH. 1966. The ecology of a population of *Xantusia vigilis*, the desert night lizard. American Museum Novitates (2247):1-57.

CULTURAL RESOURCES

Andrews VR. 1996. An historical geographical study of San Clemente Island. Unpublished Master’s Thesis. Department of Geography, California State University Long Beach. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Apple RM, Allen R. 1996. Cultural resource phase I survey inventory report. Contract No. N68711-93-D-1555. Delivery Order 9. Prepared for U.S. Department of the Navy, Southwest Division, Naval Facilities Engineering Command. Prepared by KEA Environmental, Inc., San Diego, CA.

Apple RM, Dolan C, Wahoff T. 1997. Cultural resource phase I inventory report for small arms, demolition ranges, and training areas for Naval Special Warfare Group One, San Clemente Island, California. Contract No. N68711-95-D-7692, Delivery Order 12. Prepared for U.S. Department of the Navy, Southwest Division, Naval Facilities Engineering Command. Prepared by KEA Environmental, Inc., San Diego, CA.

Apple RM, Dolan C, Pettus R. 2003. San Clemente Island cultural resources summary report. Contract No. N68711-96-C-2164. Subconsultant Contract SRS-NPB98-002. Prepared for SRS Technologies, Newport Beach. Prepared by KEA Environmental, Inc., San Diego, CA.

Axford LM. 1975. Archaeological research on San Clemente Island (research proposal submitted to Naval Undersea Center, San Diego, California). On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Axford LM. 1976. Archaeological research on San Clemente Island. Progress Report. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Axford LM. 1977. Archaeological research on San Clemente Island. Progress Report. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Axford LM. 1978. Current archaeological investigations on San Clemente Island, California. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Axford LM. 1984. Four years of archaeological investigations on San Clemente Island, California. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Axford LM. 1987. Late historic Chinese abalone collectors on San Clemente Island. Paper presented to the Third California Island Symposium.

Berryman JA. 1995. Archival information, abalone shell, broken pots, hearths, and windbreaks: clues to identifying nineteenth century California abalone collection and processing sites San Clemente Island: A case study. Unpublished PhD Dissertation, Department of Anthropology, University of California Riverside. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Berryman JA. 2003. Archaeological evaluation of two sites, SCRR-3 and SCRR-5, Central San Clemente Island. Prepared by Recon. Prepared for U.S. Department of the Navy, Southwest Division.

Bruce SC. 1994. Historical geography of San Clemente Island 1542-1935. Unpublished honors thesis, University Scholars Program, California State University Long Beach. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Byrd BF, Andrews S. 2001Ridge Road archaeological survey and site recording project, central San Clemente Island, California. Prepared by ASM Affiliates, Encinitas, California Contract No. N68711-98-D-5402, D.O. No. 08.

Byrd BF, Hale M. 2003. Archaeological technical report for special project RC20-01 (road improvements) on San Clemente Island, California. Prepared by ASM Affiliates for Natural Resources Office, Naval Region Southwest, San Diego, CA.

Byrd BF, O'Neill C. 2001. DC and U21 archaeological survey and site recording project, northern San Clemente Island, California. Prepared for Natural Resources Office, Navy Region Southwest, Naval Air Station North Island. Prepared by ASM Affiliates and Department of Anthropology, CSU Northridge. Contract No. N68711-D-5402, D.O. 06. On file at Natural Resources Office, Fleet ASW Training Center, San Diego, CA.

Chiswell C. No date. Final report: University of San Diego field class, spring 1992. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Doolittle CJ, Grenda DR, Ciolek-Torrello RS. 1997. Archaeological sites significance evaluation report for nine sites on San Clemente. Prepared for U.S. Department of the Navy. Prepared by Statistical Research Inc. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, California.

Ehringer. 2003. Roosters and raptors: Cultural continuity and change at big dog cave, San Clemente Island, California. Unpublished Master’s Thesis, Department of Anthropology, California State University, Northridge. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Eisentraut P. 1988. Investigations of prehistoric seed caches for site CA-SCLI-1524, San Clemente Island. Paper for Honors Program, Department of Anthropology, University of California, Los Angeles. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Erlandson JM, Kennett D, Ingraham BL, Gutherie DA, Morris D, Tveskov M, West GJ, Walker PL. 1996. An archaeological and paleontological chronology for Daisy Cave (CA-SMI-261), San Miguel Island, CA. Radiocarbon 38(2):355-373.

Fiore CM. 1998. These old houses: Aboriginal domestic structures at Eel Point, San Clemente Island. Unpublished Master’s Thesis, Department of Anthropology, California State University, Northridge. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Foley AM. 1987. Xantusia Cave San Clemente Island: An ocean view. Unpublished Master’s Thesis, Department of Anthropology, University of California, Los Angeles. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Garlinghouse TS. 2000. Human responses to insularity: The intensification of a marine-oriented economy on San Clemente Island, California. PhD Dissertation, Department of Anthropology, University of California, Davis. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Ghirardelli F. 1984. A chronological cultural development sequence for the Eel Point Site, San Clemente Island, California. Unpublished Master’s Thesis, Department of Anthropology, University of California, Los Angeles. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, California.

Gross GT, Schultz RD, Alter RC. 1996a. An archaeological site survey of burned areas on central San Clemente Island, California. Prepared for Naval Air Station, North Island. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Gross GT, Schultz RD, Alter RC. 1996b. Archaeological site documentation in NATACMS test areas central San Clemente Island, California. Prepared for Naval Air Station, North Island. Prepared by Affinis, San Diego. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Hale AE. 1995. The world in a basket: Late period Gabrielino ceremonial features from the Lemon Tank Sites, San Clemente Island, California. Unpublished Master's Thesis, Department of Anthropology, California State University, Northridge. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Hatheway RG, Greenwood RS. 1981. Part 2: An overview of history and historical archaeology San Clemente Island. Prepared for Cambers Consultants and Planners. In Draft Cultural Resources of San Clemente Island, California. Prepared for Naval Air Station, North Island. Prepared by Jack L. Zahniser, Chamber Consultants and Planners. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Howard W. 1991. Over the edge: The archaeological investigation of lithic raw material on the eastern escarpment of San Clemente Island, California. Unpublished Master's Thesis, Department of Anthropology, California State University, Northridge. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Huey DM. 1992. Aboriginal houses in the California Bight: The investigation of prehistoric house structures at San Clemente Island, California. Unpublished Master's Thesis, Department of Anthropology, San Diego State University. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

JRP Historical Consulting Services. 1997. Inventory and evaluation of National Register eligibility TAR 4, TAR 10, and TAR 17, San Clemente Island, Los Angeles County, California. Prepared for KEA Environmental, Inc. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

JRP Historical Consulting Services. 2000. Inventory and evaluation for National Register of Historic Places eligibility for cold war-era buildings and structures, San Clemente Island, Los Angeles County, California. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

King EM. 2005. The anatomy of 8,500 years: Site formation processes at Eel Point (CA-SCLI-43), San Clemente Island, California. Unpublished Master's Thesis, Department of Anthropology, California State University, Northridge. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, California.

Manley WR, Van Wormer SR. 1998. Draft historic resources eligibility survey of 30 buildings in Wilson Cove, San Clemente Island, California. Prepared for the U.S. Department of the Navy, Southwest Division. Prepared by William Manley Consulting. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Noah AC. 1987. A meeting of paradigms: A late-century analysis of mid-century excavations of San Clemente Island. Unpublished Master's Thesis, Department of Anthropology, San Diego State University. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Porcasi JF. 1995. Trans-Holocene marine mammal hunting on San Clemente Island, California: Additional data to assess a prehistoric "tragedy of the commons" and declining mammalian foraging efficiency. Unpublished Masters Thesis, Department of Anthropology, California State University, Northridge. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

PS Associates. 1987. Archaeological resource study: Morro Bay to the Mexican border. Final Report. Prepared for U.S. Minerals Management Service. OCS Study MMS-87-0025.

Raab LM. 1991a. An optimal foraging analysis of prehistoric shellfish collection on San Clemente Island, California. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Raab LM. 1991b. Human keystone predators on prehistoric San Clemente Island, California. On file, Center for Public Archaeology, California State University, Northridge, CA.

Raab LM, Yatsko A. 1990. Prehistoric human ecology of Quinquina, a research design for archaeological studies on San Clemente Island, Southern California. Pacific Coast Archaeological Society Quarterly 26(2 & 3):10-37.

Raab LM, Bradford MK, Yatsko A. 1994. Advances in southern Channel Islands archaeology: 1983-1993. Journal of California and Great Basin Anthropology, 16(2):243-270.

Rechtman R. 1985. The historic period occupation at the aboriginal site of ledge, San Clemente Island: An analysis of historic artifacts. Unpublished Master's Thesis, Department of Anthropology, University of California, Los Angeles. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Salls R. 1988. Prehistoric fisheries of the California Bight. PhD Dissertation, University of California, Los Angeles. San Clemente Island. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Scalise JL. 1994. San Clemente Island's social and economic exchange networks: A diachronic view of interaction among the maritime adapted southern and northern Channel Islands, California. PhD Dissertation, Department of Anthropology, University of California, Los Angeles. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Storey NC. 2002. The archaeology of industrial agrarian capitalism and framework for the evaluation of a rural historic landscape: A case study on San Clemente Island. Unpublished Master's Thesis, Department of Anthropology, Sonoma State University. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Strauss MC. 2001. Milling equipment on San Clemente Island, California: A trans-Holocene technological study in a maritime environment. Unpublished Master's Thesis, Department of Anthropology, California State University, Northridge. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Taskiran AN. 2001. Flaked-stone technological organization on the Channel Islands, California. PhD Dissertation, Department of Anthropology, University of California, Riverside. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Titus MD. 1987. Evidence for prehistoric occupation of sites on San Clemente Island by Hokan and Uto-Aztecan Indians. Unpublished Master's Thesis, Department of Anthropology, San Diego State University. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

U.S. Department of the Navy [DoN]. 1998. Draft environmental assessment for cultural resource phase I inventory report for small arms, demolition ranges, and training areas for Naval Special Warfare Group One San Clemente Island, California. Southwest Division, San Diego. KEA Environmental Inc., San Diego for Southwest Division Naval Facilities Engineering Command (SWDIV). On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, California.

U.S. Department of the Navy. 2007. Programmatic agreement among the Commander Navy Region Southwest, California State Historic Preservation Officer, and Advisory Council on Historic Preservation regarding operational and development undertakings at the San Clemente Island Range Complex, California, Draft. August.

Vance DW. 2000. Maritime subsistence technology change in the late Holocene: A study of the functional and stylistic characteristics of circular shell fishhooks at Eel Point, San Clemente Island. Unpublished Master's Thesis, Department of Anthropology, California State University, Northridge. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Yatsko A. 1987. Scope of work: An archaeological site survey at San Clemente Island, California. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Yatsko A. 1988. Repair of overhead electric lines, San Clemente Island. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Yatsko A. 1989. Reassessing archaeological site density at San Clemente Island. In Proceedings of the Society for California Archaeology 2:187-204. San Diego, CA.

Yatsko A. 1990. San Clemente Island: An introduction. Pacific Coast Archaeological Society Quarterly 26(2&3):1-9.

Yatsko A. 1991-1992. Project design/scope of work for the legacy program demonstration project: A probabilistic archaeological site survey, NALF San Clemente Island, California. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Yatsko A. 1995. Project design for archaeological site evaluations, missile impact areas, San Clemente Island, California. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

Yatsko A. 1997. Supplemental information and clarifications to the NAS North Island's biological assessment for the establishment of and island night lizard management area on San Clemente Island. NAS North Island Resource Management Program.

Yatsko A. 2000. Late Holocene paleoclimatic stress and prehistoric human occupation on San Clemente Island. PhD Dissertation, Department of Anthropology, University of California, Los Angeles. On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

TRAFFIC

FACSFAC San Diego 2007. http://www.facsfacsd.navy.mil/

Marine Link. 2004. Vessel traffic up at Los Angeles/Long Beach. http://www.marinelink.com. 14 January.

NAWCWPNS Point Mugu. 1996. Ship traffic study, southern California operations area, status report. Prepared by William C. O'Connell, Test Operations Division. Point Mugu, CA. 9 April.

National Oceanic and Atmospheric Administration [NOAA]. 2007. Marine forecasts. http://www.weather.gov/os/marine/cwd.htm.

Port of San Diego. 2003. www.portofsandiego.org/sandiego_maritime/assets/documents/statistics/maritime_statsDecember02.pdf

U.S. Department of Defense [DoD]. 2007. https://www.notams.jcs.mil. Accessed 21 August.

U.S. Department of the Navy [DoN]. 2007. http://www.scisland.org/schedules/schedules.php. Accessed 21 Aug.

SOCIOECONOMICS

California Department of Fish and Game [CDFG]. 2007. Average annual commercial landing of fish and invertebrates and value within the SOCAL range (2002-2005).

Global Security. 2007. http://www.globalsecurity.org/military/facility/san_diego.htm. 13 Jun.

U.S. Department of the Navy [DoN]. 2007. Environmental assessment: Joint task force exercises and composite training unit exercises. Prepared for Commander, U.S. Pacific Fleet and Commander, THIRD Fleet.

U.S. Department of Transportation [DOT]. 2007. http://www.bts.gov. 13 Jun.

ENVIRONMENTAL JUSTICE AND PROTECTION OF CHILDREN

No references in this section

PUBLIC SAFETY

U.S. Department of Defense [DoD]. 1981. Use of airspace by U.S. military seas. Directive 4540.1.

U.S. Department of the Navy [DoN]. 1981. Use of airspace by U.S. military aircraft and firing over the high seas. OPNAVINST 3770.4A.

U.S. Department of the Navy. 1993. Naval Auxiliary Landing Filed San Clemente Island compatibility study: Land use, operations, and natural resource compatibility report. KTU&A, Contract Number N68711-91-C-0035 for Southwest Division Naval Facilities Engineering Command (SWDIV). On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA.

U.S. Department of the Navy. 1996. Final environmental impact statement, disposal of U.S. Navy shipboard solid waste. Naval Facilities Engineering Command, Lester, PA. August.

U.S. Department of the Navy. 1997. Manual of the Third Fleet operating areas. FACSFACDINST 3120.1D. pp 1-78.

U.S. Department of the Navy. 1999. Southern California Offshore Range users manual. FACSFACDINST 3550.1. Naval Air Station North Island, San Diego, CA.

U.S. Department of the Navy. 2004. Southern California Offshore Range users manual. FACSFACDINST 3550.1. Naval Air Station North Island, San Diego, CA.

CHAPTER 4

No references in this section

CHAPTER 5

No references in this section

CHAPTER 6

No references in this section

CHAPTER 7

No references in this section

9 Distribution List

This Page Intentionally Left Blank

9 DISTRIBUTION LIST

The individuals, agencies, and organizations listed in this Chapter received a compact disk (CD) with a copy of the Southern California Range Complex Environmental Impact Statement / Overseas Environmental Impact Statement.

Federal Agencies

Advisory Council on Historic Preservation
Ronald Anzalone
Washington, DC

Army Corps of Engineers
Los Angeles District
David Castanon
Ventura, CA

Army Corps of Engineers
San Diego Project Office
Mark Tucker
San Diego, CA

Army Corps of Engineers,
Los Angeles District
Thomas H. Magness, IV
Los Angeles, CA

Bureau of Indian Affairs
Jim Cason
Washington, DC

Bureau of Indian Affairs,
Southern California Agency
Virgil Townsend
Riverside, CA

Bureau of Land Management
Maitland Sharpe
Washington, DC

Bureau of Land Management,
California Coastal National Monument
Rick Hanks
Monterey, CA

Bureau of Land Management,
Palm Springs-South Coast Field Office
Gail Acheson
Palm Springs, CA

Bureau of Oceans and International Environmental and Scientific Affairs (OES/EHC)
Office of Ecology, Health, and Conservation
David Balton
Washington, DC

Channel Islands National Marine Sanctuaries
Chris Mobley
Santa Barbara, CA
Channel Islands National Park
Dan Richard
Ventura, CA

Council on Environmental Quality
Washington, DC

Department of Education
David Hammond
Sacramento, CA

Department of the Interior
Dirk Kempthorne
Washington, DC

Department of the Interior,
Office of Environmental Policy & Compliance
Mary Josie Blanchard
Washington, DC

Department of the Interior,
Office of Environmental Policy & Compliance
Patricia S. Port
Oakland, CA

Federal Aviation Administration
Augustin Moses
Renton, WA

Federal Aviation Administration
Air Traffic Division, Western Pacific Region (AWP-532),
Lawndale, CA

Federal Emergency Management Agency,
Region IX
Nancy Ward
Oakland, CA

Federal Maritime Commission,
Office of Information Resource Management
Stephanie Burwell
Washington, DC

Marine Mammal Commission
Michael L. Gosliner
Bethesda, Maryland

Mineral Management Service National Offshore Office
Herndon, VA

Minerals Management Service,
Pacific OCS Region
Camarillo, CA

NOAA National Marine Fisheries Service
Christina Fahy
Long Beach, CA

NOAA Marine Protected Areas Center
Joseph Uravitch
Silver Spring, MD

NOAA Southwest Fisheries Science Center
Meghan Donahue
La Jolla, CA

NOAA Southwest Fisheries Science Center
William Perrin
La Jolla, CA

NOAA
Office of Protected Resources, National Marine Fisheries Service
Ken Hollingshead
Silver Spring, MD

NOAA
Office of Protected Resources, National Marine Fisheries Service
Jaclyn Daly
Silver Spring, MD

NOAA
Office of Protected Resources, National Marine Fisheries Service
Craig Johnson
Silver Spring, MD

Pacific Fisheries Management Council
John Coon
Portland, OR

Pacific States Marine Fisheries Commission
Randy Fisher
Portland, OR

U.S. Coast Guard
T.J. Granito
Washington, DC

U.S. Coast Guard
Mr. Daniels
Long Beach, CA

U.S. Coast Guard
Port Operations
Kathleen Garza
San Diego, CA

U.S. Coast Guard
Sector San Diego
Drew Cheney
San Diego, CA

U.S. Coast Guard,
Eleventh Coast Guard District
Marine Safety Division
Long Beach, CA

U.S. Coast Guard,
Los Angeles-Long Beach Unit
San Pedro, CA

U.S. Department of Agriculture,
Animal and Plant Health Inspection Service
Shannon Starratt
Portland, OR

U.S. Department of Transportation
Daniel W. Leubecker
Maritime Administration (MAR-820),
Washington, DC

U.S. Environmental Protection Agency
Kim DePaul
Washington, DC

U.S. Environmental Protection Agency
Region IX
Karen Vitulano
San Francisco, CA

U.S. Environmental Protection Agency
Region IX
David Farrel
San Francisco, CA

U.S. Fish and Wildlife Service
California - Nevada Operations
Steve Thompson
Sacramento, CA

U.S. Fish and Wildlife Service,
Carlsbad Office
Sandy Vissman
Carlsbad, CA

U.S. Fish and Wildlife Service,
San Diego NWRC
Chula Vista, CA

U.S. Geological Survey
Gordon Eaton
Palo Alto, CA

U.S. Geological Survey,
Marine Coastal Group
Michael Fisher
Menlo Park, CA

State of California Agencies

California Air Resources Board
Enforcement Division
Jim Ryden
Sacramento, CA

California Air Resources Board
Compliance Division
James J. Morgester
Sacramento, CA

California Coastal Commission
Peter Douglas
San Francisco, CA

California Coastal Commission
Mark Delaplaine
San Francisco, CA

California Coastal Commission,
Energy and Ocean Resource Unit
Susan M. Hansch
San Francisco, CA

California Department of Boating and Waterways
David Johnson
Sacramento, CA

California Department of Conservation
Brian Baird
Sacramento, CA

California Department of Fish and Game
Air Services Division
Thomas Evans
Hemet, CA

California Department of Fish and Game,
Environmental Services Division
Sacramento, CA

California Department of Fish and Game,
Marine Region
Los Alamitos, CA

California Department of Fish and Game,
Marine Region
Patricia Wolf
San Diego, CA

California Department of Fish and Game,
Region 5
San Diego, CA

California Department of Fish and Game,
Region 6
Curt Taucher
Los Alamitos, CA

California Department of Health Services
Environmental Health Division
David Spath
Sacramento, CA

California Department of Health Services
Toxic Substances Control Division
Glendale, CA

California Department of Parks and Recreation
Milford Wayne Donaldson
Sacramento, CA

California Department of Parks and Recreation
Resource Management Division
Paul Romero
Sacramento, CA

California Department of Transportation
Will Kempton
Sacramento, CA

California Energy Commission
Jackalyne Pfannenstiel
Sacramento, CA

California Environmental Protection Agency
Linda Adams
Sacramento, CA

California Fish and Game Commission
Michael Flores
Sacramento, CA

California Regional Water Quality Control Board,
Los Angeles Region
Carlos Urrunaga
Los Angeles, CA

California Regional Water Quality Control Board,
San Diego Region
San Diego, CA

California Resources Agency
Mike Chrisman
Sacramento, CA

California Resources Agency,
Department of Conservation
Brian Leahy
Sacramento, CA

California Resources Agency,
Department of Conservation
Carolyn Baker
Sacramento, CA

California State Lands Commission
Dwight Sanders
Sacramento, CA

California State Lands Commission
Marina Voskanian
Long Beach, CA

California State Lands Commission
Minerals Resources Management Division
Paul Mount
Long Beach, CA

California State Water Resources Control Board
Sacramento, CA

California Wildlife Conservation Board
John Donnelly
Sacramento, CA

Governor's Office of Planning and Research
Cynthia Bryant
Sacramento, CA

Office of Environmental Health Hazard Assessment
Joan Denton
Sacramento, CA

Silver Strand State Beach
Coronado, CA

South Coast Air Quality Management District
William Burke
Diamond Bar, CA

State Water Resources Control Board, Div. of Water Quality
Connie Anderson
Sacramento, CA

State Water Resources Control Board, Div. of Water Quality
Senior Environmental Scientist Ocean Unit
Dominic Gregorio
Sacramento, CA

Municipalities and Local Jurisdictions

City of Avalon
Jack Cook
Avalon, CA

City of Avalon
Bob Kennedy
Avalon, CA

City of Chula Vista
Cheryl Cox
Chula Vista, CA

City of Coronado
Mark Ochenduszko
Coronado, CA

City of Imperial Beach
Gary Brown
Imperial Beach, CA

City of Laguna Beach
Toni Iseman
Laguna Beach, CA

City of Los Angeles
Misty Sandford
Los Angeles, CA

City of Newport Beach
Steven Rosansky
Newport Beach, CA

City of San Diego
San Diego, CA

City of San Diego Central Library
Gary Klockenga
San Diego, CA

City of San Diego Parks and Recreation Department
Robin Stribley
San Diego, CA

County of San Diego
Helen Robbins-Meyer
San Diego, CA

County of San Diego,
Dept. of Planning & Land Use
Jennifer Campos
San Diego, CA

Los Angeles County Board of Supervisors District 4
Don Knabe
Los Angeles, CA

Los Angeles County Planning Office
Tabatha Lam
Los Angeles, CA

Los Angeles County Public Works
Dennis Hunter
Alhambra, CA

Orange County Board of Supervisors District 5
Pat Bates
Santa Ana, CA

Port of Long Beach
Robert Kanter
Long Beach, CA

Port of San Diego
San Diego, CA

Regional Water Quality Control Board
Shirley Virosik
Monterey Park, CA

San Diego Air Pollution Control District
Scott Underhill
San Diego, CA

San Diego Association of Governments
Rob Rundle
San Diego, CA

San Diego Unified Port District
David Merk
San Diego, CA

Elected Officials

U.S. Senate
Hon. Dianne Feinstein
Los Angeles, CA

U.S. Senate
Hon. Barbara Boxer
Los Angeles, CA

U.S. House of Representatives 49th District
Hon. Darrell Issa
Vista, CA

U.S. House of Representatives 50th District
Hon. Bilbray Brian
Solana Beach, CA

U.S. House of Representatives 51st District
Hon. Robert Filner
Chula Vista, CA

U.S. House of Representatives 52nd District
Hon. Duncan Hunter
El Cajon, CA

U.S. House of Representatives, District 44
Hon. Loretta Sanchez
Garden Grove, CA

U.S. House of Representatives, District 46
Hon. Dana Rohrabacher
Huntington Beach, CA

U.S. House of Representatives, District 48
Hon. John Campbell
Newport Beach, CA

U.S. House of Representatives, District 53
Hon. Susan Davis
San Diego, CA

Governor of California
Arnold Schwarzenegger
Sacramento, CA

California State Assembly
Hon. Betty Karnette
Long Beach, CA

California State Assembly
Hon. Lori Saldana
San Diego, CA

California State Assembly
Hon. Shirley Horton
Lemon Grove, CA

California State Senate, District 27
Hon. Alan Lowenthal
Long Beach, CA

California State Senate, District 33
Hon. Dick Ackerman
Tustin, CA

California State Senate, District 35
Hon. Tom Harman
Costa Mesa, CA

California State Senate, District 38
Hon. Mark Wyland
Carlsbad, CA

California State Senate, District 39
Hon. Christine Kehoe
San Diego, CA

San Diego County Board of Supervisors District 1
Hon. Gregory Cox
San Diego, CA

San Diego County Board of Supervisors District 2
Hon. Dianne Jacob
San Diego, CA

San Diego County Board of Supervisors District 3
Hon. Pam Slater
San Diego, CA

San Diego County Board of Supervisors District 4
Hon. Ron Roberts
San Diego, CA

San Diego County Board of Supervisors District 5
Hon. Bill Horn
San Diego, CA

Others

Coast Guard Auxiliary
Coronado Bay Flotilla 16-05
Fred Brown
Coronado, CA

Hubbs-Sea World Research Institute
Ann Bowles / Brent Stewart
San Diego, CA

Maritime Shoshone, Inc.
c/o The Island Gabrieleno Group
Louise Jeffredo-Warden
Moss Beach, CA

San Diego Port Tenants Association
Kristin Tyson
San Diego, CA

Southern California Association of Governments
Maggie Idle
Los Angeles, CA

State Clearinghouse and Other Repositories

California State Clearinghouse
Sacramento, CA

Imperial Beach Branch Library
Jose A. Aponte
Imperial Beach, CA

San Diego Environmental Library
Environmental Services Department
San Diego, CA

Oceanside Public Library
Oceanside, CA

San Clemente Library
San Clemente, CA

San Pedro Regional Branch Library
San Pedro, CA

Individuals

Ahlquist, Dale
Chanhassen, MN

Alarcon, Leonardo
San Ysidro, CA

Allen, Tom
Newport Beach, CA

Alps, Bernado
San Pedro, CA

Alps, Diane
San Pedro, CA

Amoroso, Orlando
San Pedro, CA

Anderson, Jo Ellen
San Diego, CA

Anderson, Scott
San Diego, CA
Anderson, Sean
El Cajon, CA

Anes, Paul
San Diego, CA

Angel, Bradley
San Francisco, CA

Arnold, Jeanne
Los Angeles, CA

Arnold, Jeanne
Los Angeles, California

Arrington, Walt
Orange, CA

Balcomb, Ken
Friday Harbor, WA

Ball, Tom
Santa Barbara, CA
Barnyak, Frank
Studio City, CA

Beck, Joe
Escondido, CA

Beldofe, Herbert
Washington DC

Bishop, Charles
San Diego, CA

Black, Steve
San Diego, CA
Bohlman, Bob
Washington, DC

Bossier, Bob
San Diego, CA

Bowen, Joanne
Irvine, CA

Brade, Edith
San Dimas, CA

Bradstreet, Kailee
San Diego, CA

Bravo, Jose T.
Albuquerque, NM

Brennan, Bat
Santa Ana, CA

Brown, John "Locky"
Ventura, CA

Brown, Liz
Laguna Beach, CA

Byrd, Chris
San Diego, CA

Cahil, Jim
Coronado, CA

Carey, Bill
San Diego, CA

Carl, Karyn V.
Harrisburg, PA

Carman, Bret
Avalon, CA

Carpino, Elizabeth
Oakland, CA

Cathcart, Lynn
Newport Beach, CA

Claibourne, Bill
Lafayette, LA

Clark, Cindy
La Jolla, CA

Claycomb, William
Imperial Beach, CA

Colgate, John
Santa Barbara, CA

Conner, Mike
Coronado, CA

Corkill, Roberta
Oceanside, CA

Costa, Anthony E.
Washington, DC

Crivetto, Lou & Sandy
San Diego, CA

Curtin, Pete
Chula Vista, CA

Daley, Marsha
Santa Barbara, CA

Daniels, Doug
Avalon, CA

Darlak, Christine
Coronado, CA

Darnell, Ellen
San Diego, CA

de La Rosa, Carlos
Avalon, CA

Deacon, John
Orcutt, CA

DeBeck, Jim
Long Beach, CA

Denny, Sharon
Springfield, CA

Devine, Dennis
Escondido, CA

Deviti, Alfred
Laguna Beach, CA

Dinger, Harlan
La Mesa, CA

Doesburg, Rick
San Clemente, CA

Domlinson, Charlie
Long Beach, CA

Duffy, Walter
Arcata, CA

Eberly, Chris
The Plains, VA

Eckenroth, Dean
Coronado, CA

Elliott, Ted
Bakersfield, CA

English, T. Malcolm
PE9 1XQ, U.K.

Evans, Carol
Oceanside, CA

Everett, William
La Jolla, CA

Farmer, Dave
Los Angeles, CA

Fisher, George
Laguna Hills, CA

Fisher, Robert
San Diego, CA

Fletcher, Bob
San Diego, CA

Ford, Bill
Laguna Beach, CA

Freed, Lynn
Canoga Park, CA

Freireich, Richard
San Diego, CA

Fuentes, Gidget
Carlsbad, CA

Fusaro, Craig
Santa Barbara, CA

Gagosian, Bob
Washington, DC

Gaines, Bill
La Jolla, CA

Galway, Megan
Costa Mesa, CA

Gamble, Lynn
San Diego, CA

Geary, Patty
San Pedro, CA

Glantz, Dale
San Diego, CA

Glassow, Michael
Santa Barbara, CA

Goehring, Vern
Sacramento, CA

Gorss, Marlin
La Jolla, CA

Grader, W.F.
Sausalito, CA

Green, Marsha
Reading, PA

Greenberg, Joel
Los Angeles, CA

Guinther, Eric
Kailua, HI

Guth, John
Vista, CA

Guth, John
Vista, CA

Hall, Albert
Irvine, CA

Halmay, Peter
Lakeside, CA

Hansen, Mike
Dana Point, CA

Hanson, Brian
San Pedro, CA

Hark, Bob
Ventura, CA

Harlowe, Anna
Los Angeles, CA

Harper, Rick
Santa Barbara, CA

Harris, Martha
Los Angeles, CA

Hasbrouck, Bruce G.
Tampa, FL

Heath, Shane
Arcata, CA

Heck, Ronald G
Santa Barbara, CA

Heikkila, Wayne
Redding, CA

Helgren, Richard
Oceanside, CA

Helling, Harry
Dana Point, CA

Hine, Gail
Tustin, CA

Hinman, Ken
Leesburg, VA

Hinton, Mel
San Diego, CA

Hoinkes, Mary Elizabeth
Washington, DC
Holcberg, David
Irvine, CA

Holtel, M.
Vista, CA

Hoogendam, Heather
Solana Beach, CA

Hoover, Carole
Coronado, CA

Hoskins, Gary
Cypress, CA

Howorth, Peter
Santa Barbara, CA

Hunter, Laura
National City, CA

Huntting-Coronel, Charmaine
Escondido, CA

Ininns, Morgan
Dana Point, CA

Jahnkow, Carol
San Diego, CA

James, Kitty
Irvine, CA

Jeffredo, John
Fallbrook, CA

Jeffredo-Warden, Louise
Moss Beach, CA

Jeffrey, Walt
Huntington Beach, CA

Johnson, Tim
Oceanside, CA

Jones, Terry
San Luis Obispo, CA

Jurji, Judith
Seattle, WA

Kanig, Ed
San Diego, CA
Kedis, Angelo
Avalon, CA

Kelly, Fred
Imperial Beach, CA

Kie, John
Fresno, CA

Kingsmill, Jim
San Clemente, CA

Knaster, Alana
Woodland Hills, CA

Knight, Cathy
Santa Monica, CA

Kramer, Rob
Dania Beach, FL

Lang, Valerie
Los Angeles, CA

Lavars, George
Alhambra, CA

Lee, Mike
San Diego, CA

LePore, Paul
Huntington Beach, CA

Lindsay, John
Newport Beach, CA

Lindsey, John
Newport Beach, CA

Lingerfelder, Terry
Solana Beach, CA

Little, Isabelle
Encino, CA

Lowenthal, Alan
Long Beach, CA

Lucasey, Ray
Point Mugu, CA

MacMillan, Adrian
Santa Monica, CA

Mader, Tracey
Petaluma, CA

Marineros, Catalina
Marina Del Rey, CA

Martindell, Chris
San Diego, CA

Martindell, Rich
San Diego, CA

Martus, Carolyn
San Diego, CA

Martz, Patricia
Los Angeles, CA
Mason, Jeff
Santa Barbara, CA

Matson, Lawrence
Cypress, CA

Mautz, William
Hilo, HI

Mazlamian, Bob
Hollywood, CA

McBain, Jim
San Diego, CA

McCall, James L.
Paso Robles, CA

McCorkle, Mike
Summerland, CA

Mcfarland, Chuck
Newport Beach, CA

McGrail, J.
Marina Del Ray, CA

McIntosh, Heather
Patuxent River, MD

McIsaac, Donald O.
Portland, OR

McKeown, John C,
Laguna Beach, CA

McLauren, Jon
San Francisco, CA

Medford, Roberta
Los Angeles, CA

Medina, Nichelle
San Diego, CA

Mello, John
Avalon, CA

Merriam, Clark
Hampton, VA

Millan, Edward J.
Camarillo, CA

Murphy, Richard
Santa Barbara, CA

Murray, Pat
Houston, TX

Myers, Larry
Sacramento, CA
Nowicke, Susan
San Diego CA

Nussman, Mike
Alexandria, VA

Nydegger, David L.
Oceanside, CA

O'Day, Terry
Santa Monica, CA

Olson, Kevin
Montrose, CA

Opdycke, Jeff
San Diego, CA

Owen, Michael
Manhattan Beach, CA

Parenude, Dave
San Diego, CA

Parr, Michael J.
Washington, DC

Pashley, David
The Plains, VA

Patton, Gary A.
Sacramento, CA

Perez, Edgar
San Gabriel, CA

Perleberg, Brian
Longview, WA

Peters, Dennis
Shalimar, FL

Peterson, Jim
San Pedro, CA

Pitcher, Ben
Long Beach, CA

Pivovaroff, Mary
Irvine, CA

Pleschner-Steele, Diane
Buellton, CA

Potorti, Grace
Reno, NV

Raftican, Tom
Irvine, CA

Rassam, Ghassan
Bethesda, MD
Ratican, Tom
Huntington Beach, CA

Rausa, Rosario
Alexandria, VA

Reamer, Jerry
San Diego, CA

Redfern, Chris
San Diego, CA

Reynolds, Joel
Los Angeles, CA

Reznik, Bruce
San Diego, CA

Risser, Art
San Diego, CA

Rocha, Vera
Baldwin Hills, CA

Rodgers, Terry
San Diego, CA

Rogers, Lou
Point Mugu, CA

Rose, Naomi
Washington, D.C.

Roy, Kristina
Washington, D.C.

Royal, Jim
San Diego, CA

Salamunovich, Peter
Avalon, CA

Sanchez, Gerald
Newbury Park, CA

Sandhu, M.S.
Newport Beach, CA

Schillo, Frank
Thousand Oaks, CA

Schroeder, James
Seattle, WA

Schuck, Tony
Rio Vista, CA

Schumann, Kai
San Diego, CA

Scoble, John
San Pedro, CA
Scott, Tom
Riverside, CA

Serden, Bertram
Beverly Hills, CA

Shea, Robert
Campo, CA

Shirey, Jim
Coronado, CA

Simmen, Jeffrey A.
Seattle, WA

Smith, Dennis
San Diego, CA

Smullen, Steve
El Paso, TX

Sobel, Jan
Carlsbad, CA

Sparling, Steven C.
Alexandria, VA

Squibb, Jim
Oceanside, CA

Storsteen, Erik
Redondo Beach, CA

Sullivan, James J.
La Jolla, CA

Sweeting, Richard
Long Beach, CA

Swisher, Ken
Northridge, CA

Talbert, Joe
Coronado, CA

Terrebone, Pamela
Coronado, CA

Thomas, Scott
Irvine, CA

Thompson, Mark
Imperial Beach, CA

Thompson, Michael R.
San Juan Capistrano, CA

Towler, Blake
Washington, DC

Urone, William V
Laguna Niguel, CA

Valdez, Val
Torrence, CA

Vega, Felix
San Pedro, CA

Vincent, Delores
Orange, CA

Vissman, Sandy
Carlsbad, CA

Walker, Greg
Coronado, CA

Walker, Cheryl
San Diego, CA

Walsh, Dan
Encinitas, CA

Walter, Debbie
Solana Beach, CA

Ward, Jack
Long Beach, CA

Warnock, Nils
Stinson Beach, CA

Wauben, Scott
Avalon, CA

Wilson, Darrel
Carpenteria, CA

Wilson, Rick
San Diego, CA

Winegrad, Gerald
Washington, DC

Winter, Jay
Los Angelos, CA

Wise, Chuck
San Francisco, CA

Woodard, Bill
Huntington Beach, CA

Woodard, Robert
San Diego, CA

Woodfield, Helen
Oceanside, CA

Woodfield, Jeff
Oceanside, CA

Woodruff, David S.
La Jolla, CA

Young, Bruce
Coronado, CA

Zechman, Joe
San Diego, CA

Zoggas, Nikos
Escondido, CA

Appendices

This Page Intentionally Left Blank

Appendix A

This Page Intentionally Left Blank

Training and RDT&E Descriptions

This Appendix provides detailed information about Training and Research, Development, Test, and Evaluation (RDT&E) activities that are addressed in this Draft Environmental Impact Statement (EIS) / Overseas Environmental Impact Statement (OEIS) (hereafter referred to as "EIS/OEIS").

Organization of this Appendix

The Appendix contains:

- An overview of each of the Navy's Primary Mission Areas (PMARS),
- A Table listing and briefly describing the 53 types of training and RDT&E events analyzed in the EIS/OEIS, categorized by PMAR, and
- A detailed description of each of the 53 types of training and RDT&E events.

Primary Mission Areas

Anti-Air Warfare (AAW) Training

AAW is the PMAR that addresses combat operations by air and surface forces against hostile aircraft. Navy ships contain an array of modern anti-aircraft weapon systems, including naval guns linked to radar-directed fire-control systems, surface-to-air missile systems, and radar-controlled cannon for close-in point defense. Strike/fighter aircraft carry anti-aircraft weapons, including air-to-air missiles and aircraft cannon. AAW training encompasses events and exercises to train ship and aircraft crews in employment of these weapons systems against simulated threat aircraft or targets. AAW training includes surface-to-air gunnery surface-to-air and air-to-air missile exercises and aircraft force-on-force combat maneuvers

Anti-Submarine Warfare (ASW) Training

ASW involves helicopter and sea control aircraft, ships, and submarines, operating alone or in combination, in operations to locate, track, and neutralize submarines. Controlling the undersea battlespace is a unique naval capability and a vital aspect of sea control. Undersea battlespace dominance requires proficiency in ASW. Every deploying strike group and individual surface combatant must possess this capability.

Various types of active and passive sonars are used by the Navy to determine water depth, locate mines, and identify, track, and target submarines. Passive sonar "listens" for sound waves by using underwater microphones, called hydrophones, which receive, amplify and process underwater sounds. No sound is introduced into the water when using passive sonar. Passive sonar can indicate the presence, character and movement of submarines. However, passive sonar provides only a bearing (direction) to a sound-emitting source; it does not provide an accurate range (distance) to the source. Active sonar is needed to locate objects because active sonar provides both bearing and range to the detected contact (such as an enemy submarine).

Active sonar transmits pulses of sound that travel through the water, reflect off objects and return to a receiver. By knowing the speed of sound in water and the time taken for the sound wave to travel to the object and back, active sonar systems can quickly calculate direction and distance from the sonar platform to the underwater object. There are three types of active sonar.

- High-frequency active sonar, which operates at frequencies greater than 10 kilohertz (kHz). At higher acoustic frequencies, sound rapidly dissipates in the ocean environment, resulting in short detection ranges, typically less than five nm. High-frequency sonar is used primarily for determining water depth, hunting mines and guiding torpedoes.

- Mid-frequency active sonar operates between 1 and 10 kHz, providing an optimal balance of detection range and resolution. Typical mid-frequency sonar detection ranges are up to 10 nautical miles making it the primary tool for conducting anti-submarine warfare.
- Low-frequency sonar operates below 1 kHz and is designed to detect extremely quiet diesel-electric submarines at ranges far beyond the capabilities of mid-frequency active sonars. There are only two ships in use by the U.S. Navy that are equipped with low frequency sonar; both are ocean surveillance vessels operated by Military Sealift Command.

The Navy's ASW training plan, including the use of active sonar in at-sea training scenarios, includes multiple levels of training. Individual-level ASW training addresses basic skills such as detection and classification of contacts, distinguishing discrete acoustic signatures including those of ships, submarines, and marine life, and identifying the characteristics, functions, and effects of controlled jamming and evasion devices.

More advanced, integrated ASW training exercises involving active sonar is conducted in coordinated, at-sea operations during multi-dimensional training events involving submarines, ships, aircraft, and helicopters. This training integrates the full anti-submarine warfare continuum from detecting and tracking a submarine to attacking a target using either exercise torpedoes or simulated weapons. Training events include detection and tracking exercises (TRACKEX) against "enemy" submarine contacts; torpedo employment exercises (TORPEX) against the target; and exercising command and control tasks in a multi-dimensional battlespace.

Anti-Surface Warfare (ASUW) Training

ASUW is a type of naval warfare in which aircraft, surface ships, and submarines employ weapons, sensors, and operations directed against enemy surface ships or boats. Aircraft-to-surface ASUW is conducted by long-range attacks using air-launched cruise missiles or other precision guided munitions, or using aircraft cannon. ASUW also is conducted by warships employing torpedoes, naval guns, and surface-to-surface missiles. Submarines attack surface ships using torpedoes or submarine-launched, anti-ship cruise missiles. Training in ASUW includes surface-to-surface gunnery and missile exercises, air-to-surface gunnery and missile exercises, and submarine missile or torpedo launch events. Training generally involves expenditure of ordnance against a towed target. A sinking exercise (SINKEX) is a specialized training event that provides an opportunity for ship, submarine, and aircraft crews to deliver live ordnance on a deactivated vessel, which is deliberately sunk using multiple weapons systems.

ASUW also encompasses maritime interdiction, that is, the interception of a suspect surface ship by a Navy ship for the purpose of boarding-party inspection or the seizure of the suspect ship. Training in these tasks is conducted in Visit, Board, Search and Seizure exercises.

Amphibious Warfare (AMW) Training

AMW is a type of naval warfare involving the utilization of naval firepower and logistics, and Marine Corps landing forces to project military power ashore. AMW encompasses a broad spectrum of operations involving maneuver from the sea to objectives ashore, ranging from reconnaissance or raid missions involving a small unit, to large-scale amphibious operations involving over one thousand Marines and Sailors, and multiple ships and aircraft embarked in a Strike Group.

AMW training includes tasks at increasing levels of complexity, from individual, crew, and small unit events to large task force exercises. Individual and crew training include the operation of amphibious vehicles and naval gunfire support training. Small-unit training operations include events leading to the certification of a Marine Expeditionary Unit (MEU) as "Special Operations Capable" (SOC). Such training includes shore assaults, boat raids, airfield or port seizures, and reconnaissance. Larger-scale amphibious exercises involve ship-to-shore maneuver, shore bombardment and other naval fire support, and air strike and close air support training.

Electronic Combat (EC) Training

EC is the mission area of naval warfare that aims to control use of the electromagnetic spectrum and to deny its use by an adversary. Typical EC activities include threat avoidance training, signals analysis for intelligence purposes, and use of airborne and surface electronic jamming devices to defeat tracking systems.

Mine Warfare (MIW) Training

MIW is the naval warfare area involving the detection, avoidance, and neutralization of mines to protect Navy ships and submarines, and offensive mine laying in naval operations. A naval mine is a self-contained explosive device placed in water to destroy ships or submarines. Naval mines are deposited and left in place until triggered by the approach of or a contact with an enemy ship, or are destroyed or removed. Naval mines can be laid by purpose-built minelayers, other ships, submarines, or airplanes. MIW training includes Mine Countermeasures (MCM) Exercises and Mine Laying Exercises (MINEX).

Naval Special Warfare (NSW) Training

NSW forces (SEALs and Special Boat Units [SBUs]) train to conduct military operations in five Special Operations mission areas: unconventional warfare, direct action, special reconnaissance, foreign internal defense, and counterterrorism. NSW training involves specialized tactics, techniques, and procedures, employed in training events that include: insertion/extraction operations using parachutes rubber boats, or helicopters; boat-to-shore and boat-to-boat gunnery; demolition training on land or underwater; reconnaissance; and small arms training.

Strike Warfare (STW) Training

STW operations include training of fixed-wing fighter/attack aircraft in delivery of precision guided munitions, non-guided munitions, rockets, and other ordnance against land targets in all weather and light conditions. Training events typically involve a simulated strike mission with a flight of four or more aircraft. The strike mission may simulate attacks on "deep targets" (i.e., those geographically distant from friendly ground forces), or may simulate close air support of targets within close range of friendly ground forces. Laser designators from aircraft or ground personnel may be employed for delivery of precision guided munitions. Some strike missions involve no-drop events in which prosecution of targets is simulated, but video footage is often obtained by onboard sensors.

Combat Search and Rescue (CSAR) is a strike warfare operation with the purpose of training aircrews to locate, protect, and evacuate downed aviation crew members from hostile territory. The operation can include reconnaissance aircraft to find the downed aircrew, helicopters to conduct the rescue, and fighter aircraft to perform close air support to protect both the downed aircrews and the rescue helicopters.

Explosive Ordnance Disposal (EOD) Activities

The EOD mission area involves employment of skills, tactics, and equipment designed to safely render unexploded ordnance (UXO). EOD personnel are highly trained and operate in both tactical and administrative capacities. Tactical missions include safe disposal of improvised explosive devices. Administrative missions include range clearance and ordnance safety in support of operational forces.

U.S. Coast Guard Training

Coast Guard Sector San Diego, a shore command within the Coast Guard 11th District, carries out its mission to serve, protect and defend the American public, maritime infrastructure and the environment. The Sector San Diego Area of Responsibility (AOR) extends southward from the Dana Point harbor to the border with Mexico. Equipment utilized by the Coast Guard includes 25-ft response boats, 41-ft utility boats and 87-ft patrol boats, as well as HH-60 helicopters. Training events include: search and rescue, maritime patrol training, boat handling, and helicopter and surface vessel live-fire training with small arms.

Naval Auxiliary Landing Field (NALF) SCI Airfield Activities

NALF SCI provides opportunities for aviation training and aircraft access to the island. The airfield is restricted to military aircraft and authorized contract flights. There are no permanently assigned aircraft, and aviation support is limited essentially to refueling. NALF SCI has the primary mission of training Naval Air Force Pacific aircrews in Field Carrier Landing Practice (FCLP). FCLP involves landing on a simulated aircraft carrier deck painted on the surface of the runway near its eastern end. Other military activities include visual and instrument approaches and departures, aircraft equipment calibration, survey and photo missions, range support, exercise training, RDT&E test support, medical evacuation, and supply and personnel flights.

RDT&E Events

Space and Naval Warfare Systems Center (SPAWARSYSCEN) conducts RDT&E, engineering, and fleet support for command, control, and communications systems and ocean surveillance. Space and Naval Warfare System's (SPAWAR's) tests on SCI include a wide variety of ocean engineering, missile firings, torpedo testing, manned and unmanned submersibles, Unmanned aerial vehicles (UAVs), EC, and other Navy weapons systems. Specific events include:

- Ship Tracking and Torpedo Tests;
- Unmanned Underwater Vehicle (UUV) Tests;
- Sonobuoy Quality Assurance (QA)/Quality Control (QC) Tests;
- Ocean Engineering Tests;
- Marine Mammal Mine Shape Location and Research; and
- Missile Flight Tests;

The San Diego Division of the Naval Undersea Warfare Center is a Naval Sea Systems Command (NAVSEA) organization supporting the Pacific Fleet. NUWC operates and maintains the SCI Underwater Range (SCIUR). NUWC conducts tests, analysis, and evaluation of submarine USW exercises and test programs. NUWC also provides engineering and technical support for Undersea Warfare (USW) programs and exercises, design cognizance of underwater weapons acoustic and tracking ranges and associated range equipment, and provides proof testing and evaluation for underwater weapons, weapons systems, and components.

Table A-1: Training and RDT&E Activities on the SOCAL Range Complex

Navy Warfare Area	No.	Operation Type	Summary
Anti-Air Warfare	**1**	Aircraft Combat Maneuvers	Trains fighter crews in basic flight maneuvers and advanced air combat tactics. Participants are from two or four aircraft. No weapons are fired.
	2	Air Defense Exercise	Coordinated operations involving surface ships and aircraft, training in radar detection, and simulated airborne and surface firing. No weapons are fired.
	3	Surface-to-Air Missile Exercise	Live-firing event from a surface ship to an aerial target. Weapons employed are Rolling Airframe Missile (RAM) and STANDARD missile. Aerial targets are drones recovered via parachute and small boat.
	4	Surface-to-Air Gunnery Exercise	Surface-to-air live-fire gunnery at aerial target that simulates a threat aircraft or missile. Weapons include the 5-inch naval gun, 76 mm and 20 mm cannon, and 7.62 machine guns.
	5	Air-to-Air Missile Exercise	Fighter/attack aircraft firing against an aerial target that simulates an enemy aircraft. Missiles include AIM-7 SPARROW, AIM-9 SIDEWINDER, and AIM-120 AMRAAM.
Anti-Submarine Warfare	**6**	Antisubmarine Warfare Tracking Exercise - Helicopter	Trains helicopter crews in anti-submarine search, detection, localization, classification and track. Two primary targets: recoverable MK 30 and expendable MK 39. The target simulates a submarine at varying depths and speeds. SH-60 crews drop sonobuoys to detect and localize the target.

Navy Warfare Area	No.	Operation Type	Summary
	7	Antisubmarine Warfare Torpedo Exercise - Helicopter	Trains SH-60 crews in employment of air-launched torpedoes. Aircrew drops an inert, running exercise torpedo or a non-running practice torpedo against ASW targets.
	8	Antisubmarine Warfare Tracking Exercise - Maritime Patrol Aircraft	Trains patrol aircraft crews in anti-submarine search, detection, localization, classification and track. Employs multiple sensor systems against a submarine simulating a threat.
	9	Antisubmarine Warfare Torpedo Exercise - Maritime Patrol Aircraft	Trains patrol aircraft crews in employment of air-launched torpedoes. Aircrew drops an inert, running exercise torpedo or a non-running practice torpedo against ASW targets.
	10	Antisubmarine Warfare EER / IEER sonobuoy employment	Trains patrol aircraft crews in deployment and use of Extended Echo Ranging (EER) and Improved EER (IEER) sonobuoy systems.
	11	Antisubmarine Warfare Tracking Exercise - Surface	Trains ship crews in anti-submarine search, detection, localization, classification, track and attack. ASW targets simulate a submarine at varying depths and speeds. Ships crews and SH-60 helicopter crews employ sensors to detect and localize the target.
	12	Antisubmarine Warfare Torpedo Exercise - Surface	Trains ship crews in anti-submarine search, detection, localization, classification, track and attack. One or more torpedoes are dropped/fired in this exercise. Includes Integrated ASW Phase 2 (IAC II).
	13	Antisubmarine Warfare Tracking Exercise - Submarine	Trains submarine crews in ASW using passive sonar (active sonar use is tactically proscribed), No ordnance expended in this exercise.

Navy Warfare Area	No.	Operation Type	Summary
	14	Antisubmarine Warfare Torpedo Exercise - Submarine	Submarine exercise training Tactical Weapons Proficiency, lasting 1-2 days and multiple firings or exercise torpedoes. Attacking submarines use only passive sonar.
Anti-Surface Warfare	**15**	Visit Board Search and Seizure	Training in interception of a suspect surface craft by a naval ship for the purpose of inspection for illegal activities. Helicopters, surface ships and small boats participate. Small arms may be fired.
	16	Air-Surface Missile Exercise	Ships, helicopters and fighter/attack aircraft expend precision-guided munitions against maneuverable, high-speed, surface targets. The missiles used in this operation are the AGM-114 (Hellfire) and the Harpoon. Small arms are also fired from helicopters.
	17	Air-to-Surface Bombing Exercise	Trains fighter or patrol aircraft crews in delivery of bombs against surface vessels. Involves in-flight arming and releasing of bombs in accordance with appropriate tactics and drop restrictions. These include; Laser-Guided Training Round (LGTR) and Glide Bomb Units (GBUs) 12, 16 and 32i.
	18	Air-to-Surface Gunnery Exercise	Trains helicopter crews in daytime aerial gunnery operations with the GAU-16 (.50 cal) or M-60 (7.62 mm) machine gun.
	19	Surface-to-Surface Gunnery Exercise	Trains surface ship crews in high-speed engagement procedures against mobile seaborne targets, using 5-inch guns, 25 mm cannon, or .50 cal machine guns.
	20	Sink Exercise	Trains ship and aircraft crews in delivering live ordnance on a real, seaborne target, namely a large deactivated vessel, which is deliberately sunk using multiple weapon systems. The ship is cleaned,

Navy Warfare Area	No.	Operation Type	Summary
			environmentally remediated and empty. It is towed to sea and set adrift at the exercise location. The precise duration of a SINKEX is variable, ending when the target sinks, whether after the first weapon impacts or and after multiple impacts.
Amphibious Warfare	**21**	Naval Surface Fire Support	Trains ship crews in naval gunnery against shore targets. Training Naval Gunfire Spotters located ashore to direct the fires of naval guns.
	22	Expeditionary Fires Exercise	USMC field training in integration of close air support, naval gunfire, artillery, and mortars.
	23	Expeditionary Assault - Battalion Landing	Proposed training event for a Marine Corps battalion-sized unit (1,500 personnel). This live-fire exercise would last up to 4 days, employ the full combined arms team of a MEU, and occur up to two times per year. The amphibious forces would land by helicopter (primarily CH-46s) and across the beach. Amphibious landings would use rubber boats, and amphibious crafts and vehicles.
	24	Stinger Firing Exercise	Trains Marine Corps personnel in employment of man-portable air defense systems with the Stinger missile. This is a ground-launched missile firing exercise against a small aerial target.
	25	Amphibious Landings and Raids (on SCI)	Trains Marine Corps forces in small unit live-fire and non-live-fire amphibious operations from the sea onto land areas of SCI.
	26	Amphibious Operations - CPAAA	Trains Marine Corps small units including assault amphibian vehicle units and small boat units in amphibious operations.

Navy Warfare Area	No.	Operation Type	Summary
Electronic Combat	**27**	Electronic Combat Operations	Signal generators on SCI and commercial air services provide air, surface and subsurface units with operating experience in electronic combat, using emitters and electronic and communications jammers to simulate threats.
Mine Warfare	**28**	Mine Countermeasures Exercise	Surface ship uses all organic mine countermeasures, including sonar, to locate and avoid mines. No weapons are fired. Future operations would also use unmanned side-scan sonar systems and be conducted in SWTR Offshore near the Tanner/Cortez Banks.
	29	Mine Neutralization	Training of crews of ships, patrol aircraft, and helicopters crews in mine neutralization
	30	Mine Laying	Training of fighter/attack and patrol aircraft crews in aerial mine laying.
Naval Special Warfare	**31**	NSW Land Demolition	Training of NSW personnel in construction, emplacement and safe detonation of explosives for land breaching and demolition of buildings and other facilities.
	32	Underwater Demolition-Single Point Source Charge	Training of NSW personnel to construct, emplace and safety detonate single charge explosives for underwater obstacle clearance.
	33	Underwater Demolition Multiple Charge - Mat Weave and Obstacle Loading	Training of NSW personnel to construct, emplace and safety detonate multiple charges laid in a pattern for underwater obstacle clearance.
	34	Small Arms Training and GUNEX	Training of NSW personnel in employment of small arms up to 7.62 mm.
	35	Land Navigation	Training of NSW personnel in land navigation techniques.
	36	NSW UAV / UAS Operations	Training of NSW personnel in employment of unmanned aerial vehicles.
	37	Insertion/Extraction	Training of NSW personnel in covert insertion and extraction

Navy Warfare Area	No.	Operation Type	Summary
			into target areas, using boats, aircraft, and parachutes.
	38	NSW Boat Operations	Training of NSW Special Boat Teams in open-ocean operations, and firing from boats, including into land impact areas of SCI.
	39	SEAL Platoon Operations	SEAL Platoon live-fire training in special operations tactics, techniques and procedures
	40	NSW Direct Action	Training of NSW personnel in live-fire events involving insertion, movement to and actions on the objective, and extraction. May engage close air support and NSFS.
Strike	**41**	Bombing Exercise (Land)	Training of fighter/attack crews in bombing of land targets on SCI, using precision guided munitions and unguided munitions. Typical event involves 2-4 aircraft.
	42	Combat Search & Rescue	Training of aircrews, submarine, an NSW forces in rescue of military personnel in a simulated hostile area.
Explosive Ordnance Disposal	**43**	Explosive Ordnance Disposal SCI	Training of EOD teams to locate and neutralize or destroy unexploded ordnance.
U.S. Coast Guard	**44**	Coast Guard Training	Training in SOCAL OPAREA.
Air Operations-Other	**45**	NALF Airfield Activities	Flight training (e.g., landing and takeoff practice) of aircrews utilizing NALF airfield.
RDT&E	**46**	Ship Torpedo Tests	Test event for reliability, maintainability, and performance of torpedoes used in training (REXTORPS and EXTORPS) and operational torpedoes.
	47	Unmanned Underwater Vehicles	Development and operational testing of UUVs.
	48	Sonobuoy QA/QC Testing	Test event for reliability, maintainability, and performance of lots of sonobuoys.
	49	Ocean Engineering	Test event for reliability, maintainability, and performance of marine

Navy Warfare Area	No.	Operation Type	Summary
			designs.
	50	Marine Mammal Mine Shape Location/Research	Events in which marine mammals (primarily porpoises) are trained to locate and mark inert mineshapes.
	51	Missile Flight Tests	Missile testing in which land attack missiles are launched from within SOCAL Range Complex, to impact at SCI or at another range complex outside SOCAL.
	52	NUWC Underwater Acoustics Testing	Test events to evaluate acoustic and non-acoustic ship sensors.
	53	Other Tests	Diverse RDT&E activities.
Major Range Events	**NA**	Major exercises	Comprised of multiple range events, identified above*

Detailed Operations Descriptions

1. Air Combat Maneuvers (ACM)

ACM is the general term used to describe an air-to-air (A-A) event involving two or more strike / fighter aircraft. Aircraft perform intricate flight maneuvers to achieve a gun or missile firing position from which an attack can be made on a threat aircraft with the goal of destroying the adversary aircraft. No ordnance is expended during ACM operations.

ACM training consists of:

- Basic fighter maneuvering, in which two aircraft will engage in offensive and defensive maneuvering practice against each other.
- Intermediate and advanced offensive and defensive counter air training, in which three or more aircraft will engage in offensive and defensive maneuvering. Participating aircraft will be separated at the start by distances up to 50 nm. These exercises which may also occur in the context of major range events, involve high airspeeds (from high subsonic to supersonic) and rapidly changing aircraft altitudes and attitudes.

The preferred ACM training location is on an range located within a Warning Area or Restricted Airspace, instrumented with systems having the capability to precisely track and record the location of aircraft conducting maneuvers on the range.

2. Air Defense Exercise (ADEX)

ADEXs consist of air-to-air and surface-to-air missile training events. These operations are coordinated between surface ships and aircraft. Tasks include radar detection, positioning, maneuver to a simulated airborne of surface firing position, and recovery of aircraft aboard an aircraft carrier. Air-to-air refueling may be included. These operations vary widely in the numbers of ships and aircraft involved and consist of a full array of tactics and procedures that are practiced between air and surface units for defense of the force. No ordnance is expended during ADEX operations.

3. Surface to Air Missile Exercise (MISSILEX (S-A))

The MISSILEX (S-A) is a basic event to train surface ships' crews to engage threat missiles and aircraft with missiles with the goal of disabling or destroying the threat. The threat is simulated by a target towed behind a commercial air services Lear jet, or by a specialized BQM-74 target (a remote controlled target drone, with a parachute to enable recovery at sea). An exercise typically lasts 2 to 3 hours.

Aircraft carrier crews typically will expend one live or telemetered-inert-missile in the course of the MISSILEX (SA). Other ships and their crews typically will not expend ordnance, but will conduct a "detect to engage exercise," simulating firing of a missile.

4. Surface-to-Air Gunnery Exercise (GUNEX (S-A)

The GUNEX (S-A) is a basic event to train surface ships' crews to engage threat missiles and aircraft with gun systems with the goal of disabling or destroying the threat. A target simulating a threat aircraft or missile is deployed on a heading toward the ship. The target tow by a commercial air services Lear jet. Weapons crews practice tracking the target, and also engage the target using main battery guns (5-inch or 76 mm naval guns), or the Close-In Weapon System (CIWS). The exercise lasts about two hours, and typically includes several non-firing tracking runs followed by one or more (up to five) firing runs. The target must maintain an altitude above 500 ft for safety reasons and is not destroyed during the exercise.

Typically six rounds of 5-inch Variable Timed, Non-Fragmentation (VTNF) ammunition and 12 rounds of 76 mm ordnance per gun mount are expended by each main battery gun mount involved in the exercise. CIWS-equipped ships can expend between 900 to 1400 rounds per mount per firing run for each firing run. The CIWS fires a 20 mm inert, projectile made of tungsten. The number of CIWS rounds expended during this exercise varies depending on the ship class, the CIWS model installed, and the available ammunition allowance.

5. Air-to-Air Missile Exercise (MISSILEX (A-A))

The MISSLEX (A-A) is a basic event to strike fighter aircraft crews to attack a simulated threat target aircraft with air-to-air missiles. The target is an unmanned aerial target drone (BQM-34 or BQM-74) or Tactical Air-Launched Decoy (TALD). BQM targets deploy parachutes, float on the surface of the water, and are recovered by boat. TALDs are expended. The exercise lasts about one hour, is conducted in a Warning Area at sea outside of 12 nm at typical altitudes of 15,000 to 25,000 ft. In the exercise, a flight of two aircraft operating at high speeds approach a target from several miles away and, when within missile range, launch live or inert-telemetry missiles against the target. Missiles fired are not recovered.

6. Antisubmarine Warfare Tracking Exercise–Helicopter (ASW TRACKEX-Helo)

ASW TRACKEX-Helo involves helicopters using sonobuoys and dipping sonar to search for, detect, classify, localize, and track a simulated threat submarine with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine.

Sonobuoys are typically employed by a helicopter operating at altitudes below 3,000 ft. Sonobuoys are deployed in specific patterns based on the expected threat submarine and specific water conditions. These patterns will cover many different size areas, depending on these two factors. Both passive and active sonobuoys are employed. For certain sonobuoys, tactical parameters of use may be classified.

The dipping sonar is employed from an altitude of about 50 ft after the search area has been narrowed based on the an sonobuoy search. Both passive and active sonar are employed. As the location of the submarine is further narrowed, a Magnetic Anomaly Device (MAD) is used by the SH-60B to further confirm and localize the target's location.

The target for this exercise is either an Expendable Mobile ASW Training Target (EMATT) or live submarine and may be either non-evading and assigned to a specified track, or fully evasive depending on the state of training of the helicopter. The ASW TRACKEX-Helo usually takes one to two hours. No ordnance is expended. This exercise may involve a single aircraft, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft and/ or ships, including a major range event.

7. Antisubmarine Warfare Torpedo Exercise–Helicopter (ASW TORPEX-Helo)

The ASW TORPEX-Helo involves helicopters using sonobuoys and dipping sonar to search for, detect, classify, localize, and track a simulated threat submarine, as in the ASW TRACKEX-Helo. The TORPEX proceeds to the release of an exercise torpedo against the target, which is typically an EMATT or MK-30 target system.

8. Antisubmarine Warfare Tracking Exercise–Maritime Patrol Aircraft (ASW TRACKEX-MPA)

The ASW TRACKEX-MPA involves fixed-wing maritime patrol aircraft (MPA) employing sonobuoys to search for, detect, classify, localize, and track a simulated threat submarine with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine.

Sonobuoys are typically employed by an MPA operating at altitudes below 3,000 ft. Sonobuoys are deployed in specific patterns based on the expected threat submarine and specific water conditions. These patterns will cover many different size areas, depending on these two factors. Both passive and active sonobuoys are employed. For certain sonobuoys, tactical parameters of use may be classified. A sonobuoy field pattern delivered by an MPA will typically be much larger than a helicopter pattern, as the MPA can carry and deploy more buoys than a helicopter, and can monitor more buoys at one time. The MPA operates at higher altitudes, allowing monitoring the buoys over a larger search pattern area.

The target for this exercise is either an EMATT or live submarine and may be either non-evading and assigned to a specified track, or fully evasive depending on the state of training of the helicopter. The ASW TRACKEX-MPA usually takes two to four hours. No ordnance is expended. This exercise may involve a single aircraft, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft and/ or ships, including a major range event.

9. Antisubmarine Warfare Torpedo Exercise–Maritime Patrol Aircraft (ASW TORPEX-MPA)

The ASW TORPEX-MPA involves patrol aircraft using sonobuoys to search for, detect, classify, localize, and track a simulated threat submarine, as in the ASW TRACKEX-Helo. Additionally, the TORPEX proceeds to the release of an exercise torpedo against the target, which is typically an EMATT or MK-30 target system.

10. Antisubmarine Warfare-Extended Echo Ranging (EER) / Improved EER (IEER) Training

This training event is an at-sea flying exercise designed to train MPA crews in the deployment and use of the Extended Echo Ranging (EER) and Improved EER (IEER) sonobuoy systems. These systems both use the SSQ-110 source. An EER event and an IEER event differ in the number and type of sonobuoys used. The EER event uses the SSQ-77 as the receiver buoy, while the SSQ-101 is the receiver buoy during IEER events. Both use the SSQ-110A sonobuoy as the signal source.

11. Antisubmarine Warfare Tracking Exercise–Surface (ASW TRACKEX-Surface)

The ASW TRACKEX-Surface involves a surface ship employing hull mounted and/or towed array sonar against a target which may be an EMATT or live submarine. The target may be either non-evading and assigned to a specified track or fully evasive depending on the state of training of the ship and crew. Passive and active sonar may be employed depending on the type of threat submarine, the tactical situation, and water conditions that may affect sonar effectiveness. Active sonar transmits at varying power levels, pulse types, and intervals, while passive sonar listens for noise emitted by the threat submarine. Passive sonar is typically employed first for tactical reasons, followed by active sonar to determine an exact target location; however, active sonar may be employed during the initial search phase against an extremely quiet submarine or in situations where the water conditions do not support acceptable passive reception. There is no ordnance expended in this exercise. An ASW TRACKEX-Surface usually lasts two to four hours. This exercise may involve a single ship, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft and/ or ships, including a major range event.

12. Antisubmarine Warfare Torpedo Exercise–Surface (ASW TORPEX-Surface)

The ASW TORPEX-Surface involves a surface ship using hull-mounted and towed sonar arrays to search for, detect, classify, localize, and track a simulated threat submarine, as in the ASW TRACKEX-Surface. Additionally, the TORPEX proceeds to the release of an exercise torpedo against the target, which is typically an EMATT or MK-30 target system.

13. Antisubmarine Warfare Tracking Exercise–Submarine (ASW TRACKEX-Sub)

The ASW TRACKEX-Sub involves a submarine employing hull mounted and/or towed array sonar against a target which may be an EMATT or live submarine. During this event, passive sonar is used almost exclusively; active sonar use is tactically proscribed because it would reveal the tracking submarine’s presence to the target submarine. The preferred range for this exercise is an instrumented underwater training range with the capability to track the locations of submarines and targets, to enhance the after-action learning component of the training. There is no ordnance expended in this exercise. An ASW TRACKEX-Surface usually lasts two to four hours. This exercise may involve a single submarine, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft, ships, and submarines, including a major range event.

14. Antisubmarine Warfare Torpedo Exercise–Submarine (ASW TORPEX-Sub)

The ASW TORPEX-Sub involves a submarine employing hull mounted and/or towed array sonar against a target which may be an EMATT or MK-30 Mobile ASW Target, followed by launch of a MK-48 exercise torpedo. The exercise torpedo is recovered by helicopter or small craft. The preferred range for this exercise is an instrumented underwater range, but it may be conducted in other operating areas depending on training requirements and available assets.

15. Visit, Board, Search, and Seizure (VBSS)

The VBSS involves training of boarding parties delivered by helicopters and surface ships to surface vessels for the purpose of simulating vessel search and seizure operations. Various training scenarios are employed. Small arms with inert blanks may be used. The entire exercise may last two to three hours.

16. Missile Exercise: Air-to-Surface (MISSILEX (A-S))

The MISSILEX (A-S) trains fixed winged aircraft and helicopter crews to launch missiles at surface maritime targets, day and night, with the goal of destroying or disabling enemy ships or boats.

In the typical helicopter event, one or two helicopters approach and acquire an at-sea surface target, which is then designated with a laser to guide the missile to the target. Specially prepared targets with an expendable target area on a stationary floating or remote controlled platform are employed. The missile passes through the expendable target without damaging the platform and explodes near the surface of the water. Live Hellfire missiles are expended.

In the typical fixed-wing event, a flight of two aircraft approach an at-sea surface target from an altitude dictated by the missile parameters. The majority of fixed-wing exercises involve the use of captive carry (inert, no release) training missiles; the aircraft perform all detection, tracking, and targeting requirements without actually releasing a missile. A MISSLEX (A-S) not involving live ordnance may involve a single aircraft, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft, including a major range event. Live ordnance, if employed by a strike fighter aircraft would be either a SLAM-ER or Maverick missile. A patrol aircraft may launch SLAM-ER, Maverick, or Harpoon missiles. A MISSLEX (A-S) involving fixed-wing delivery of live ordnance typically will be carried out in conjunction with a SINKEX (see Event No. 20).

17. Bombing Exercise: Air-to-Surface (BOMBEX (A-S))

BOMBEX (A-S) involve training of strike fighter and MPA in delivery of bombs against surface maritime targets in day or night conditions.

Exercises for strike fighters typically involve a flight of two aircraft delivering unguided or guided munitions that may be either live or inert. Exercises at night will normally be done with captive carry (no drop) simulated guided weapons because of safety considerations. The very large safety footprints of precision guided munitions limit their employment to events at-sea, typically in conjunction with a SINKEX. The following munitions may be employed by strike fighter in the course of the BOMBEX: Unguided munitions: MK-76 and BDU-45 (inert training bombs); MK-80 series (inert or live); MK-20 Cluster Bomb (inert or live). Precision-guided munitions: Laser-guided bombs (LGB) (inert or live); Laser-guided Training Rounds (LGTR) (inert); Joint Direct Attack Munition (JDAM) (inert or live).

MPA use bombs to attack surfaced submarines and surface craft that would not present a major threat to the MPA itself. The MPA is larger and slower than an F/A-18, so its bombing tactics differ markedly. A single MPA approaches the target at a low altitude. MPA have the capability to deliver the following unguided munitions, which may be used in the BOMBEX: BDU-45 inert bomb; MK-82 (500 Lb bomb) (inert or live); MK-20 (Rockeye cluster bomb) (inert or live); CBU-99 (cluster bomb) (inert or live). In most training exercises, it drops inert training munitions, such as the BDU-45 on a MK-58 smoke float used as the target. This exercise may involve a single aircraft (MPA), a flight of two strike fighters, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft and/ or ships, including a major range event or SINKEX.

18. Gunnery Exercise: Air-to-Surface (GUNEX (A-S))

GUNEX (A-S) involves training strike fighter aircraft or helicopters to employ guns to attack surface maritime targets in day or night. Sea targets simulate enemy ships, boats, or floating or near-surface mines. Land targets simulate enemy formations, vehicles or facilities. Exercises involving strike fighter aircraft typically involve a flight of two aircraft firing approximately 250 rounds of inert ammunition against either land (most often) or water targets. Helicopter exercises typically involve a single helicopter flying at an altitude between 50 ft to 100 ft in a racetrack pattern around an at-sea target. Several gunners will each expend about 200 rounds of .50 cal and 800 rounds of 7.62 mm ordnance in each exercise. 40mm grenades fired from hand-held weapons also may be expended. The target is normally a non-instrumented floating object such as an expendable smoke float, steel drum, or cardboard box, but may be a remote controlled speed boat or jet ski type target. Gunners will shoot special target areas or at towed targets when using a remote controlled target to avoid damaging them. The exercise lasts about 1 hour.

19. Gunnery Exercise: Surface-to-Surface, Boat (GUNEX (S-S Boat)

This exercises involves training of crews manning small boats to use a machine guns to attack and disable or destroy a surface target that simulates another ship, boat, floating mine or near shore land targets. A number of different types of boats are used depending on the unit using the boat and their mission. Boats are most used by Naval Special Warfare (NSW) teams and Navy Expeditionary Combat Command (NECC) units with a mission to protect ships in harbors and high value units, such as: aircraft carriers, nuclear submarines, liquid natural gas tankers, etc., while entering and leaving ports, as well as to conduct riverine operations, insertion and extractions, and various naval special warfare operations. The boats used by these units include: Small Unit River Craft (SURC), Combat Rubber Raiding Craft (CRRC), Rigid Hull Inflatable Boats (RHIB), Patrol Craft, and many other versions of these types of boats. These boats use inboard or outboard, diesel or gasoline engines with either propeller or water jet propulsion.

This exercise is usually a live fire exercise, but at times blanks may be used so that the boat crews can practice their ship handling skills for the employment of the weapons without being concerned with the safety requirements involved with live weapons. Boat crews may use high or low speeds to approach and engage targets simulating other boats, swimmers, floating mines, or near shore land targets with .50 cal, 7.62 mm, or 40 mm machine guns (about 200, 800, and 10 rounds respectively). The most common exercise target is a 50 gallon steel drum that is expended during the exercise and not recovered.

20. Gunnery Exercise: Surface-to-Surface, Ship (GUNEX (S-S Ship)

This exercise involves ships' gun crews engaging surface targets at sea with their main battery 5-inch and 76 mm naval guns as well as small arms (25 mm, .50 cal, or 7.62 mm machine guns). There are three types of main battery shipboard guns currently in use: 5-inch/54, 5-inch/62, and 76 mm. Both 5-inch guns use the same types of 5-inch projectiles for training exercises. The difference between the 5-inch guns is the longer range of the 5-inch/62 because of the larger powder propulsion charge. Targets employed include the QST-35 Seaborne Powered Target (SEPTAR), High Speed Maneuverable Surface Target (HSMST), or a specially configured remote controlled water craft.

The exercise proceeds with the target boat approaching from about 10 nm distance. The target is tracked by radar, and when it is within five to nine nm, it is engaged by approximately 60 rounds of 5-inch or 76 mm, (fired with an offset so as not to actually hit the targets) over a period of about 3 hours. After impacting the water, the live rounds are expected to detonate within 3 ft of the surface. Inert rounds and fragments from the live rounds will sink to the bottom of the ocean.

This exercise may involve a single firing ship, or be undertaken in the context of a coordinated larger exercise involving multiple ships, including a major range event.

Ships use machine guns to practice defensive marksmanship, typically against stationary floating targets. The target is typically a 10-foot diameter red balloon tethered by a sea anchor, or a 50 gallon steel drum, or other available target, such as a cardboard box. Targets are expended during the exercise and are not recovered.

bombardment of a target within an impact area on SCI’s Shore Bombardment Area (SHOBA), by one or more ships. The ship is often supported by Navy or Marine spotters ashore, or by spotters embarked in fixed-wing aircraft or helicopters in the air, to call for the fire support from the ship, and to adjust the fall of shot onto the target. Target shapes simulate vehicles, aircraft or personnel on the ground.

The ship positions itself in the NSFS area offshore of SCI about four to six nm from the target area to receive information concerning the target and the type and exact location of the target from the assigned spotter. One or more rounds are fired at the target. The fall of the round is observed by the spotter, who then tells the ship if the target was hit or if the ship needs to adjust where the next round should fall. More shots are fired, and once the rounds are falling on the target, then the spotter will request a larger number of rounds to be fired to effectively destroy the target. Typically five rounds are fired in rapid succession (about one round every five to seven seconds). Ten or more minutes will pass, and then similar missions will be conducted until the allocated number of rounds for the exercise has been expended.

About 70 rounds of 5-inch inert or high explosive ordnance (typically 53% live and 47% inert), in addition to about 5 rounds of illumination are expended during a NSFS FIREX. Portions of the exercise are conducted during both the day and the night to achieve full qualification. A ship will normally conduct three FIREXs at different levels of complexity over several months to become fully qualified.

A Shore Fire Control Party (SFCP) may consist of about 10 personnel who supply target information to the ship. From positions on the ground, the Navy, Marine, or NSW personnel who make up the SFCP provide the target coordinates at which the ship’s crew directs its fire. As the rounds fall, the SFCP records where the rounds falls and provide adjustments to the fall of shot, as necessary, to ensure the target is "destroyed."

This exercise may involve a single ship, or be undertaken in the context of a coordinated larger exercise involving multiple ships, aircraft conducting BOMBEX or CAS missions in support of troops on the ground, and / or artillery located ashore on SCI including a major range event.

The locations and opportunities for live-fire from a ship at sea to targets ashore are very limited, and often the training range area is not adequate to establish and maintain surface fire support proficiency. A technology solution has been developed to precisely determine the impact of rounds fired at a simulated or virtual land area containing virtual targets located in the ocean, which enables ships to complete NSFS training in the absence of a land target or impact area. The current training system is called the VAST, which is supported by the Integrated Maritime Portable Acoustic Scoring and Simulation System (IMPASS). VAST is an onboard computer system that provides a realistic presentation, such as a land mass with topography, to the ship's systems. The scoring system is deployed by the firing ship and consists of five sonobuoys set in a pentagon-shaped arrangement at 1.3 km intervals. Within the ship’s combat system, VAST creates a virtual land mass that overlays the array and simulates land targets. The ship fires its ordnance into this target area; the sonobuoys detect the bearing to the acoustic noise resulting from the impact of a high explosive or inert round landing in the water then transmit their GPS position and their bearing information to the ship. From the impact location data collected, the VAST computer triangulates the exact point of impact of the round, and, from that data, the exercise may be conducted as if the ship were firing at an actual land target. When the training is complete, the IMPASS buoy system is recovered by the ship.

The FIREX (VAST) exercise is conducted very similarity to the FIREX (Land) exercise from the ship perspective, even though the exercise is conducted completely at sea. Approximately 5 to 70 rounds of 5-inch inert or high explosive ordnance and five rounds of illumination are expended per exercise over several hours. All exercises are conducted in daylight and outside of 12 nm from land in order to have sufficient sea space to maneuver the ship and lay out the IMPASS sonobuoy pattern.

22. Expeditionary Fires Exercise (EFEX)/Supporting Arms Coordination Exercise (SACEX)

The EFEX/SACEX is a major training exercise oriented around NSFS and Marine artillery fires in support of ground amphibious operations. The mission of the exercises is to achieve effective integration of Naval gunfire, close air support, and artillery fire support. EFEX/SACEX is typically eight days long, during which the ESG commander runs a schedule-of-operations driven exercise. NSFS ships must have completed NSFS certification (see NSFS FIREX [#21] above) prior to commencement of the exercise.

An EFEX/SACEX is the final evaluation of amphibious warfare, conventional warfare, and special operations capability and serves as the formal pre-deployment coordination exercise of the supporting arms capabilities of Expeditionary Strike Group (ESG). This exercise involves employment of live ordnance by an artillery battery (six howitzers), 81 mm mortars (eight mortars), four AH-1Ws attack helicopters, six fixed wing strike fighter or attack aircraft, two NSFS ships, and associated spotting teams, controllers, and liaison personnel. Additional support elements can include an additional artillery battery for simulated naval gunfire and additional aircraft from a carrier air wing.

23. Infantry Battalion-Sized Amphibious Landing

Battalion landing operations are proposed for SCI because the island's challenging terrain, high plateaus, and shallow beaches provide the a superior littoral training environment, and the only range area in the U.S. inventory at which live NSFS may be coordinated with amphibious landing operations. Proposed operations would employ a Marine Air Ground Task Force of approximately 1,500 personnel including infantry, armored vehicle, logistics, command and control, and aviation personnel and their aircraft, vehicles, and other weapons systems. This exercise would last up to 4 days and occur up to two times per year. The amphibious forces would land by helicopter and across the beach by amphibious landing craft and amphibious vehicles This exercise may involve a single ship, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft and/ or ships, including a major range event.

The concept of operations around which the Battalion Landing is being analyzed includes the following:

Day 1. An opposition force of one infantry company would land by helicopter at VC-3 and take up positions to defend the airfield. The company of about 140 would bivouac in the field, remaining within the Infantry Operations Area. A small reconnaissance unit (12 Marines) would land by rubber boat at Eel Cove and proceed on foot in tactical formation, across open country, not using established roadways.

Day 2. Multiple company-sized units embarked in boats, landing craft, or vehicles would land at Northwest Harbor, West Cove, Wilson Cove, and Horse Beach. These units would execute a coordinated attack on a designated objective such as VC-3, using the Infantry Operations Area as the boundary of their operation. Tanks, EFVs and other amphibious assault vehicles would remain in the AVMC. The size (width) of the AVMC is a critical factor in providing a realistic training venue for armored vehicles.

Day 3. Operations would continue across SCI in accordance with exercise objectives.

Day 4. Forces would redeploy off the island.

Aircraft would support all phases of the operation. Live-fire training operations would take place in day and night.

24. Stinger Missile Firing

The Stinger missile is a portable, shoulder fired weapon that also may be mounted on and fired from a vehicle. Stinger firing has occurred in the past; however not for several years. Proposed stinger training would be conducted from positions on-shore in SHOBA, toward the ocean, not over land, at target drones, either Ballistic Aerial Targets (BATs) or Remotely Piloted Vehicles (RPVs). The BAT is a solid-rocket, ground-launched glider target that is destroyed upon impact with the water and is not recovered. The RPV is a small, gasoline-powered aircraft and is remote controlled. The RPV can be used repeatedly, if not damaged by the missile. RPVs would land in SHOBA after the firing exercise. Training would occur predominantly in the daytime.

25. Amphibious Landings and Raids by Small Units

SCI supports training of small units of Marines or NSW personnel in the conduct of amphibious operations using small boats, amphibious craft or assault amphibian vehicles. Training includes both live-fire and non-live-fire events, including reconnaissance missions, raids, tactical recovery of aircraft and personnel (TRAP) exercises, assault amphibian vehicle landing events. These events typically involve units of from 12 to 40 personnel, and may be conducted across beaches at Wilson Cove, Horse Beach Cove, Northwest Harbor, and Eel Point, and in any of various training areas designated on SCI.

Amphibious Operations-Camp Pendleton Amphibious Assault Area (CPAAA)

The ocean area adjacent to Camp Pendleton is designated as the CPAAA. This area is utilized extensively for amphibious training by units of the 1st Marine Expeditionary Force, 1st Marine Division, and 1st Marine Logistics Group. Training events conducted by these operating forces in this area include: reconnaissance unit training, small boat unit training, assault amphibian vehicle crew and unit training, and Marine Expeditionary Unit (Special Operations Capable) events, and ESG training. Initial training to qualify marines to operate amphibian vehicles is conducted by the Assault Amphibian School Battalion in the CPAAA. Naval Beach Groups, which operate Landing Craft, Air Cushioned (LCAC) vehicles utilize the CPAAA for training. The Amphibian Vehicle Test Branch conducts RDT&E of vehicles including EFVs in the CPAAA. Events conducted in the CPAAA include:

- amphibious demonstrations
- amphibious raids
- amphibious assaults
- amphibious withdrawals
- basic amphibious training
- amphibious support training
- parachute operations
- submarine operations (wet deck/dry deck)
- diving operations
- scout swimmer training
- Tactical Recovery of Aircraft and Personnel (TRAP)

27. Electronic Combat (EC) Operations

These events train aircraft, surface ship, and submarine crews to control critical portions of the electromagnetic spectrum used by threat radars, communications equipment, and electronic detection equipment. EC operations can be active or passive, offensive or defensive.

Active EC uses radio frequency (RF) transmissions in the 2-12 gigahertz frequency spectrum to conduct jamming of threat equipment and deception through generation of false targets.

Passive EC uses the enemy's electromagnetic transmissions to obtain intelligence about their operations and to recognize and categorize enemy threats.

Offensive EC uses active or passive installed EC systems against enemy search, EC, and weapons systems.

Defensive EC uses active or passive installed EC systems in reaction to enemy threat systems. Missile, gun or search radar signals are common threat signals that can initiate an automatic response, including dispersion of chaff (very thin metal strips) and flares as decoys.

Navy units can conduct EC training in stand-alone events, involving few aircraft, or single ships or submarines, however EC operations typically are conducted in the context of a coordinated larger exercise involving multiple aircraft, ships, and submarines, including a major range event.

28 / 29. Mine Countermeasures (MCM) Training

MCM consists of mine avoidance training (#28) and mine neutralization training (#29). These events trains surface ships and aircraft to detect and either avoid or neutralize mines. Training utilizes simulated minefields constructed of moored or bottom mines, or instrumented mines that can record effectiveness of mine detection efforts. Mine or small object avoidance training for surface ships involves use of mid-frequency active sonar systems to detect mines. Submarines also have the capability to detect mines utilizing organic sonar; however, use of active sonar is tactically proscribed for submarines as it allows detection. Therefore, MCM training is primarily conducted by surface ships. Ship or submarine-mounted MFAS systems employed are:

- AN/SQS-53
- AN/SQS-56
- AN/SQQ-32
- AN/BQQ-5 or 10

Helicopters engage in airborne MCM training, utilizing specialized equipment including:

- AN/AQS-20 Mine Hunting System (employing side-looking sonar)
- AN/AES-1 Airborne Laser Mine Detection System
- AN/ALQ-220 Organic Airborne Surface Influence Sweep

MCM exercises typically last one or two hours for surface ships and helicopters, and may last up to 15 hours for specially configured MCM ships. Navy units typically conduct MCM training in stand-alone events, involving few aircraft, or single ships or submarines, however MCM training may occur in the context of a coordinated larger exercise involving multiple aircraft, ships, and submarines, including a major range event.

30. Mine Laying

Fixed-winged aircraft and submarines lay offensive or defensive mines to create a tactical advantage for friendly forces. Offensive mines prevent enemy shipping from leaving an enemy port or area, or supplies from entering an enemy port or area. Defensive mines protect friendly forces and facilities by preventing enemy forces from entering the friendly port or area.

At the basic level of training, fixed winged aircraft use precise navigation to lay a minefield pattern for a specific tactical situation. A flight of two strike fighter aircraft or a single MPA attempt to fly undetected to the area where the mines will be laid and use either a low or high altitude tactic to lay the mines. The aircrew typically drops a series of four inert training shapes (MK-76, BDU-45, or BDU-48), making multiple passes in the same flight pattern, and dropping one or more shapes each time. The shapes are scored for accuracy as they enter the water, and the aircrew is later debriefed on their performance. Advanced training scenarios involve multiple aircraft to evaluate the ability of an entire squadron to plan, load, and execute a mine-laying mission. The aircraft drop their shapes in a pre-determined pattern and return to the carrier or base. Since the final location of each mine shape is of tactical importance, the drops are scored and the shapes are recovered.

Submarine mine laying operations are typically "virtual" with no expenditure of any mine shape or any range requirements.

31. Land Demolitions

NSW or EOD personnel train in use of explosive charges to destroy land mines, explosives such as improvised explosive devices, unexploded ordnance, structures, or other items as required. The size of an explosive charge is defined in terms of net explosive weight (NEW). Charge sizes typically employed range from 1 to 20 pounds NEW.

32 / 33. Underwater Demolitions

NSW or EOD personnel use small explosive charges to destroy obstacles or other structures in an underwater area that could cause interference with friendly or neutral forces and planned operations. Underwater demolitions training involves either a single charge (#32) or multiple charges laid in a pattern. In atypical training scenario, NSW or EOD personnel locate barriers or obstacles designed to block amphibious vehicle access to beach areas, then use small explosive charges to destroy them. These training events typically use less than five pounds NEW of explosives which are detonated near the shoreline in water less than 21 ft deep.

34. Small Arms Training

Navy personnel training in the use small arms and small unit tactics to defend unit positions or attack simulated enemy positions. Small arms training exercises may include use of 9 mm pistols, 12-gauge shotguns, 5.56 mm automatic rifles, .50 caliber, 7.62 mm, 5.56 mm machine guns, and 40 mm grenades. Training involving live-fire of small arms may be conducted on marksmanship training ranges with fixed firing points and fixed targets, or may occur in free-play training events with firing positions dictated by the training scenario and use of mobile or pop-up targets. While small arms training events typically occur on designated ranges ashore on SCI, training of personnel also is conducted aboard surface ships at sea firing into the sea.

35. Land Navigation

Training in land navigation is conducted on SCI by individuals and small units on foot utilizing maps, compasses, and other navigation aids on established courses.

36. Unmanned Aerial Vehicle (UAV) Operations

Unmanned Aerial Vehicles (UAV) obtain information about the activities of an enemy or potential enemy or tactical area of operations by use of various onboard surveillance systems including: visual, aural, electronic, photographic, or other means. There are currently numerous types of UAVs employed to obtain intelligence data on threats. UAVs are typically flown at altitudes well above 3,000 ft in patterns to best collect the required data, yet remain beyond the reach threat weapon systems. The UAVs may be controlled by a pilot at a remote location, just as if the pilot were onboard, or may fly a preplanned, preprogrammed route from start to finish. Missions will typically last four to six hours, but will vary depending on the scheduled mission training. Training occurs in restricted airspace on and above SCI.

37. NSW Insertion / Extraction

NSW and other personnel train to approach or depart an objective area using various transportation methods and tactics. These operations train forces to insert and extract personnel and equipment day or night. Tactics and techniques employed include insertion from aircraft by parachute, by rope, or from low, slow-flying helicopters from which personnel jump into the water. Parachute training is required to be conducted on surveyed drop zones to enhance safety. Insertion and extraction methods also employ submarine deliver of personnel into the water, and small inflatable boats.

Insertion and extraction training typically is conducted in the context of additional related exercises, and such as direct action training of NSW personnel, live-fire small arms training, and NSFS spotter training.

38. NSW Boat Operations

NSW personnel assigned to Special Boat Units conduct training in open ocean and littoral operations, including in the vicinity of SCI. Training events include firing of crew-served machine guns and hand held weapons into land impact areas of SHOBA.

39. NSW SEAL Platoon Operations

NSW SEAL platoons perform special operations using tactics that are applicable to the specific tactical situations where the NSW personnel are employed. They are specially trained, equipped, and organized to conduct special operations in maritime, littoral, and riverine environments. SCI is a principal training venue for SEAL platoons and other NSW personnel. NSW training is continually evolving to meet the tactical requirements and special weapons required to complete the mission assigned. NSW personnel train to move covertly or overtly, by sea, air, or land, to an area of operation as the tactical situation demands and perform those tasks required to capture a site, destroy a target, rescue personnel, or perform a multitude of operations against hostile forces, using weapons required by the tactical situation. Opposing forces and targets within training range areas are utilized for realism. Typically, NSW personnel employ a variety of live fire or blank small arms and explosive ordnance in the course of training. SEAL platoon training may be conducted in isolation, or may occur in the context of larger-scale events and exercises, including major range events.

40. Direct Action

Direct action training is a specialized NSW event involving a squad or platoon size force of personnel inserted into and later extracted from a hostile area by helicopter, small boat or other means to conduct live-fire offensive actions against simulated hostile forces or targets. These offensive actions can include: raids, ambushes, standoff attacks, designating or illuminating targets for precision-guided munitions, providing support for cover and deception operations, and sabotage. Small arms such as 7.62 mm, 5.56 mm, 9 mm, 12-gauge, 40 mm grenades, laser illuminators, and other squad or platoon weapons are typically employed.

41. Bombing Exercise (Air-to-Ground) (BOMBEX (A-G))

BOMBEX (A-G) involves training of strike fighter aircraft or helicopter delivery of ordnance against land targets in day or night conditions. The BOMBEX may involve Close Air Support

(CAS) training in direct support of and in close proximity to forces on the ground, such as NSW or marine forces engaged in training exercises on SCI.

For strike fighter aircraft, in a typical exercise at the basic level, a flight of two aircraft will approach the target from an altitude of between 15,000 ft to less than 3,000 ft and, when on an established range, will usually establish a racetrack pattern around the target. The pattern is established in a predetermined horizontal and vertical position relative to the target to ensure that all participating aircraft follow the same flight path during their target ingress, ordnance delivery, target egress, and “downwind” profiles. This type of pattern is designed to ensure that only one aircraft will be releasing ordnance at any given time. The typical bomb release altitude is below 3,000 ft and within a range of 1,000 yards for unguided munitions; above 15,000 ft and may be in excess of 10 nm for precision-guided munitions. Exercises at night will normally be done with captive carry (no drop) weapons because of safety considerations. Laser designators from the aircraft dropping the bomb, a support aircraft, or ground support personnel are used to illuminate certified targets for use with lasers when using laser guided weapons.

Advanced-level training events for strike fighters typically involve a flight of four or more aircraft, with or without a designated opposition force. Participating aircraft attack the target using tactics which may require that several aircraft approach the target and deliver their ordnance simultaneously from different altitudes and/or directions. An E-2 aircraft is typically involved in this exercise from a command and control perspective, and an EA-18G aircraft may provide electronic combat support in major range events.

The following munitions may be employed by strike fighters in the course of the BOMBEX: Unguided munitions: MK-76 and BDU-45 (inert training bombs); MK-80 series (inert or live); MK-20 Cluster Bomb (inert or live). Precision-guided munitions: Laser-guided bombs (LGB) (inert or live); Laser-guided Training Rounds (LGTR) (inert); Joint Direct Attack Munition (JDAM) (inert or live). Rockets: 5-inch Zuni rockets.

Helicopter training involves one or two helicopters approaching an assigned target. The target is attacked with guns, Zuni rockets, or a Hellfire missile. A laser is used to guide a Hellfire missile to the target. The laser designator is either the one of the attacking aircraft or a designator team (typically NSW or Marine forces) on the ground. The helicopter launches one live missile per exercise from an altitude of about 300 ft while in forward flight or in a hover, against a specially prepared target. The target can be a stationary target or a remote controlled vehicle whose infrared signature has been augmented with a heat source to better represent a typical threat vehicle.

42. Combat Search and Rescue (CSAR)

CSAR training involves fixed-winged aircraft, helicopters and / or submarines using tactical procedures to rescue military personnel within a hostile area of operation. In a helicopter training scenario, helicopters fly below 3,000 ft the target area. Machine guns (7.62 mm or 5.56 mm) are mounted in the side door, and blank ammunition is normally used in this exercise. Chaff and flares may be expended if a surface-to-air or air-to-air threat or opposing force is employed to provide additional complexity. NSW personnel may be embarked during this exercise to act as the rescue party. This NSW squad would debark from the helicopter, "rescue" the personnel to be recovered, and return to the helicopter to be removed from the area. This basic exercise would last about one and a half hours. More advanced training would involve command and control aircraft and strike fighter aircraft in a role as a combat air patrol. In a submarine training scenario, the submarine proceeds to a specified location near land, locates the persons to be rescued, and surfaces to embark them. This exercise may involve a single helicopter or submarine, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft and/ or ships, including a major range event.

43. Explosive Ordnance Disposal (EOD)

EOD personnel train to gain and maintain qualification and proficiency in locating, neutralizing or destroying unexploded ordnance (UXO) and conducting other hazardous range clearance activities. Removal of UXO is important for personnel safety and environmental sustainability of ranges. Operations are conducted in impact areas on SCI. These EOD activities are similar in nature to the activities described under the heading Land Demolition (# 31), the difference being that EOD range clearance actions are not undertaken in a tactical training environment, but are administrative in nature.

44. Coast Guard Training

Coast Guard Sector San Diego is a command within the Coast Guard 11th District. The Sector San Diego Area Of Responsibility (AOR) extends from the border with Mexico north to Dana Point. Coast Guard personnel regularly train in maritime rescue and patrol activities in the SOCAL Range Complex, using a variety of boats, small ships, and helicopters.

45. Naval Auxiliary Landing Field (NALF)

The NALF on SCI supports aviation events, including training and logistics activities. The primary training activity conducted at the NALF is Field Carrier Landing Practice (FCLP), which are characterized by touch-and-go practice in day and night conditions on a simulated aircraft carrier outline marked on the landing field. NALF also supports regular resupply and personnel transport aircraft runs between SCI and mainland bases.

46. Ship Torpedo Tests

This is a test event for reliability, maintainability, and performance of EXTORPS and REXTORPS. Events include torpedo firing.

47. Unmanned Underwater Vehicle Tests

These are in-water events for the development and operational testing of advanced designs of underwater vehicles, conducted in the vicinity of NOTS Pier.

48. Sonobuoy Quality Assurance and Quality Control Tests

This testing event evaluates random lots of sonobuoys and determine the quality of the set. The sonobuoys are dropped from an aircraft into the SCIUR area east of SCI. Defective buoys are recovered. All non-defective buoys are scuttled.

49. Ocean Engineering

Ocean engineering tests determine the characteristics, reliability, maintainability and endurance of various pieces of marine design. The items to be tested are left in the water off NOTS Pier for an extended period, and are monitored by Navy personnel.

50. Marine Mammal Mine Shape Location / Research

In this series of events, trained marine mammals are taught to locate and mark inert mine shapes. The marine mammals, most of which are porpoises, are penned and cared for at Naval Base Point Loma, and transported to SCI for mine location and applied research.

51. Missile Flight Tests

Missile flight test events confirm performance, reliability, maintainability and suitability for operational use of various missiles in the Navy inventory. Tests involve launches from operational ships and aircraft from within either the Point Mugu Sea Range or the SOCAL Range Complex against airborne targets in W-291, or land targets in the Missile Impact Range on SCI

52. Underwater Acoustic Sensor Tests

These tests are conducted to evaluate the accuracy of several acoustic and nonacoustic ship sensors. Tests occur at SCIUR.

53. Other Tests

The SOCAL Range Complex supports diverse tests including surface warfare tests against fast-moving, small boats, mine countermeasures, naval gunfire, electronic combat and combat systems verification. Testing is conducted primarily in the waters west of SCI.

1-42. Integrated Training and Major Range Events

A major range event is comprised of several "unit level" range operations conducted by several units operating together while commanded and controlled by a single commander. These exercises typically employ an exercise scenario developed to train and evaluate the Strike Group / Force in required naval tactical tasks. In a major range event, most of the operations and activities being directed and coordinated by the Strike Group commander are identical in nature to the operations conducted in the course in individual, crew, and smaller-unit training events. In a major range event, however, these disparate training tasks are conducted in concert, rather than in isolation.

Major range events include:

- Composite Training Unit Exercise (COMPTUEX). The COMPTUEX is an Integration Phase, at-sea, major range event. For the CSG, this exercise integrates the aircraft carrier and carrier air wing with surface and submarine units in a challenging operational environment. For the ESG, this exercise integrates amphibious ships with their associated air wing, surface ships, submarines, and MEU. Live-fire operations that may take place during COMPTUEX include long-range air strikes, Naval Surface Fire Support (NSFS), and surface-to-air, surface-to-surface, and air-to-surface missile exercises. The MEU also conducts realistic training based on anticipated operational requirements and to further develop the required coordination between Navy and Marine Corps forces. Special Operations training may also be integrated with the exercise scenario. The COMPTUEX is typically 21 days in length. The exercise is conducted in accordance with a schedule of events, which may include two 1-day, scenario-driven, “mini” battle problems, culminating with a scenario-driven 3-day Final Battle Problem. COMPTUEX occurs three to four times per year.
- JTFEX. The JTFEX is a dynamic and complex major range event that is the culminating exercise in the Sustainment Phase training for the CSGs and ESGs. For an ESG, the exercise incorporates an Amphibious Ready Group (ARG) Certification Exercise (ARG CERT) for the amphibious ships and a Special Operations Capable Certification (SOCCERT) for the MEU. When schedules align, the JTFEX may be conducted concurrently for an ESG and CSG. JTFEX emphasizes mission planning and effective execution by all primary and support warfare commanders, including command and control, surveillance, intelligence, logistics support, and the integration of tactical fires. JTFEXs are complex scenario-driven exercises that evaluate a strike group in all warfare areas. JTFEX is normally 10 days long, not including a 3-day in-port Force Protection Exercise, and is the final at-sea exercise for the CSG or ESG prior to deployment. JTFEX occurs three to four times per year.

Integrated unit-level training events, which pursue tailored training objectives for components of a Strike Group, are complex exercises of lesser scope than Major Range Events. This type of training includes:

- Ship ASW Readiness and Evaluation Measuring (SHAREM). SHAREM is a Chief of Naval Operations (CNO) chartered program with the overall objective to collect and analyze high-quality data to quantitatively "assess" surface ship ASW readiness and effectiveness. The SHAREM will typically involve multiple ships, submarines, and aircraft in several coordinated events over a period of a week or less. A SHAREM may take place once per year in SOCAL.

- Sustainment Exercise. Included in the FRTP is a requirement to conduct post-deployment training, and maintenance. This ensures that the components of a Strike Group maintain an acceptable level of readiness after returning from deployment. A sustainment exercise is an exercise designed to challenge the strike group in all warfare areas. This exercise is similar to a COMPTUEX but of shorter duration. One to two sustainment exercises may occur each year in SOCAL.
- Integrated ASW Course (IAC) Phase II. IAC exercises are combined aircraft and surface ship events. The IAC Phase II consists of two 12-hour events conducted primarily on SOAR over a 2-day period. The typical participants include four helicopters, two P-3 aircraft, two adversary submarines, and two Mk 30 or Mk 39 targets. Frequently, IACs include the introduction of an off-range Mk 30 target. Four IAC Phase II exercises may occur per year.

Appendix B

This Page Intentionally Left Blank

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[I.D. 121506A]

Endangered and Threatened Species; Initiation of a Status Review under the Endangered Species Act for the Atlantic White Marlin

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice of initiation of a status review under the Endangered Species Act (ESA); request for information.

SUMMARY: We, NMFS, announce the initiation of a status review for the Atlantic white marlin (*Tetrapturus albidus*), and we solicit information on the status of and threats to the species.

DATES: Information regarding the status of and threats to the Atlantic white marlin must be received by February 20, 2007.

ADDRESSES: You may submit information on the Atlantic white marlin by any one of the following methods:

- Fax: 727–824–5309, Attention: Dr. Stephania Bolden
- Mail: Information on paper, disk or CD-ROM should be addressed to the Assistant Regional Administrator for Protected Resources, NMFS Southeast Regional Office, 263 13th Avenue South, St. Petersburg, FL 33701
- E-mail: *whitemarlin.info@noaa.gov*. Include in the subject line the following identifier: white marlin review

FOR FURTHER INFORMATION CONTACT: Dr. Stephania Bolden, NMFS, Southeast Regional Office (727) 824–5312, or Ms. Marta Nammack, NMFS, Office of Protected Resources (301) 713–1401.

SUPPLEMENTARY INFORMATION:

Background

We conducted a status review of the Atlantic white marlin under the ESA and published a 12-month determination that listing was not warranted (67 FR 57204; September 9, 2002). As a result of subsequent litigation and a settlement agreement with the Center for Biological Diversity, we agreed to initiate a status review following the 2006 stock assessment by the International Commission for the Conservation of Atlantic Tunas (ICCAT); the 2006 ICCAT white marlin stock assessment can be found at *www.iccat.int*. Atlantic white marlin are billfish (Family: Istiophoridae) found throughout tropical and temperate waters of the Atlantic Ocean and adjacent seas. White marlin, along with other billfish and tunas, are managed internationally by the member nations of the ICCAT. At this time we announce commencement of a new status review for the Atlantic white marlin, and request information regarding the status of and threats to the species, pursuant to the terms of the aforementioned settlement agreement.

Request for Information

To support this status review, we are soliciting information relevant to the status of and threats to the species, including, but not limited to, information on the following topics: (1) historical and current abundance and distribution of the species and congeners throughout the species range; (2) potential factors for the species' decline throughout the species range; (3) rates of capture and release of the species from both recreational and commercial fisheries; (4) post-release mortality; (5) life history information (size/age at maturity, growth rates, fecundity, reproductive rate/success, etc.); (6) morphological and molecular information to assist in determining taxonomy of this species and congeners; (7) threats to the species, particularly: (a) present or threatened destruction, modification, or curtailment of habitat or range; (b) over-utilization for commercial, recreational, scientific, or educational purposes; (c) disease or predation, (d) inadequacy of existing regulatory mechanisms, or (e) other natural or manmade factors affecting its continued existence; and (8) any ongoing conservation efforts for the species. See **DATES** and **ADDRESSES** for guidance on and deadlines for submitting information.

Authority: 16 U.S.C. 1531 *et seq.*

Dated: December 18, 2006.

Donna Wieting,

Deputy Director, Office of Protected Resources, National Marine Fisheries Service.

[FR Doc. 06–9812 Filed 12–18–06; 2:45 pm]

BILLING CODE 3510–22–S

DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Intent To Prepare an Environmental Impact Statement/ Overseas Environmental Impact Statement for the Southern California Range Complex (including the San Clemente Island Range Complex) and To Announce Public Scoping Meetings

AGENCY: Department of the Navy, DoD.

ACTION: Notice.

SUMMARY: Pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969, as implemented by the Council on Environmental Quality regulations (40 CFR parts 1500–1508), and Presidential Executive Order 12114 (Environmental Effects Abroad of Major Federal Actions), the Department of the Navy (DON) announces its intent to prepare an Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to evaluate the potential environmental effects associated with conducting naval readiness activities in the Southern California (SOCAL) Range Complex (to include the San Clemente Island (SCI) Range Complex). DON proposes to support current, emerging, and future military activities in the SOCAL and SCI Range Complexes as necessary to achieve and sustain Fleet readiness, including military training; research, development, testing, and evaluation (RDT&E) of systems, weapons, and platforms; and investment in range resources and range infrastructure, all in furtherance of our statutory obligations under Title 10 of the United States Code governing the roles and responsibilities of the DON.

On August 17, 1999, DON initiated the NEPA process for an EIS/OEIS evaluating the impacts of DON activities at the SCI Range Complex by publishing a Notice of Intent in the **Federal Register** (64 FR 44716–44717). DON has determined that it is appropriate to include within the scope of the SOCAL Range Complex EIS/OEIS the previously announced environmental analysis of military activities on the SCI Range. Therefore, this Notice of Intent supersedes and withdraws the August 17, 1999, notice of the DON's intent to prepare an EIS/OEIS for the SCI Range Complex.

Dates and Addresses: Three public scoping meetings will be held to receive oral and written comments on environmental concerns that should be addressed in the EIS/OEIS. Public scoping meetings will be held on the following dates, at the times and locations specified:

1. Wednesday, January 29, 2007, 6 p.m.–8 p.m., Cabrillo Marine Aquarium Library, 3720 Stephen M. White Drive, San Pedro, CA.
2. Tuesday, January 30, 2007, 6 p.m.–8 p.m., Oceanside Civic Center Library, 330 North Coast Highway, Oceanside, CA.
3. Wednesday, January 31, 2007, 6 p.m.–8 p.m., Coronado Public Library, 640 Orange Avenue, Coronado, CA.

Each meeting will consist of an information session staffed by DON representatives, to be followed by a presentation describing the proposed action and alternatives. Written comments from interested parties are encouraged to ensure that the full range of relevant issues is identified. Members of the public can contribute oral or written comments at the scoping meetings, or written comments by mail or fax, subsequent to the meetings. Additional information concerning the scoping meetings is available at: *http://www.SocalRangeComplexEIS.com.*

FOR FURTHER INFORMATION CONTACT: Ms. Diori Kreske, Naval Facilities Engineering Command Southwest, 2585 Callaghan Hwy., San Diego, CA 92136–5198; telephone 619–556–8706.

SUPPLEMENTARY INFORMATION: The SOCAL Range Complex is a suite of land ranges and training areas, surface and subsurface ocean ranges and operating areas, and military airspace that is centrally managed and controlled by DON agencies. The complex geographically encompasses near-shore and offshore surface ocean operating areas and extensive military Special Use Airspace generally located between Marine Corp Base Camp Pendleton to the north and San Diego to the south. It extends more than 600 miles to the southwest in the Pacific Ocean covering approximately 120,000 square nautical miles of ocean area. The SCI Range Complex is geographically encompassed by the SOCAL Range Complex. The SCI Range Complex consists of land ranges and training areas on San Clemente Island and certain near-island ocean operating areas and ranges.

Collectively, the components of the SOCAL Range Complex provide the space and resources needed to execute training events across the training continuum, from individual skills training to complex joint exercises. The mission of the SOCAL Range Complex is to support DON, Marine Corps, and joint (multi-service) training by maintaining and operating range facilities and by providing range services and support to the Pacific Fleet, U.S. Marine Corps Forces Pacific, and other forces and military activities. The Commander, Fleet Forces Command and Commander, U.S. Pacific Fleet are responsible for operations, maintenance, training, and support of this national training asset.

Naval transformation initiatives determine current, emerging, and future requirements for training access to the SOCAL Range Complex. Moreover, recent world events have placed the U.S. military on heightened alert in the defense of the U.S., and in defense of allied nations. At this time, the U.S. military, and specifically the U.S. Navy, is actively engaged in anti-terrorism efforts around the globe. Title 10 U.S. Code Section 5062 directs the Chief of Naval Operations to maintain, train, and equip all naval forces for combat so that they are capable of winning wars, deterring aggression, and maintaining freedom of the seas. To achieve this level of readiness, naval forces must have access to ranges, operating areas (OPAREAs), and airspace where they can develop and maintain skills for wartime missions and conduct RDT&E of naval weapons systems. As such, DON ranges, OPAREAs, and airspace must be maintained and/or enhanced to accommodate necessary training and testing activities in support of national security objectives.

The proposed action, therefore, responds to DON's need to: (1) Maintain baseline operations at current levels; (2) accommodate future increases in operational training tempo in the SOCAL and SCI Range Complexes as necessary to support the deployment of naval forces; (3) achieve and sustain readiness in ships and squadrons so that the DON can quickly surge significant combat power in the event of a national crisis or contingency operation and consistent with Fleet Readiness Training Plan; (4) support the acquisition, testing, training, and introduction into the Fleet of advanced platforms and weapons systems; and, (5) implement investments to optimize range capabilities required to adequately support required training. DON will meet these needs and maintain the long-term viability of the SOCAL Range Complex, while protecting human health and the environment.

Three alternatives will be evaluated in the EIS/OEIS, including: (1) The No Action Alternative, comprised of baseline operations and support of existing range capabilities; (2) Alternative 1 comprised of the No Action Alternative plus additional operations on upgraded/-modernized existing ranges; and (3) Alternative 1 plus new ranges, new dedicated capabilities, additional increased tempo (beyond Alternative 1) to optimize training in support of future contingencies. The analysis will address potentially significant direct, indirect, and cumulative impacts on biological resources, land use, air quality, water quality, water resources, and socioeconomics, as well as other environmental issues that could occur with the implementation of the DON's proposed actions and alternatives.

The DON is initiating the scoping process to identify community concerns and local issues to be addressed in the EIS/OEIS. Federal, State, and local agencies, and interested parties are encouraged to provide oral and/or written comments to the DON that identify specific issues or topics of environmental concern that should be addressed in the EIS/OEIS. Written comments must be postmarked by February 8, 2007, and should be mailed to: Naval Facilities Engineering Command Southwest, 2585 Callaghan Hwy., San Diego, CA 92136–5198; Attention: Ms. Diori Kreske, telephone 619–556–8706.

Dated: December 13, 2006.

M.A. Harvison,

Lieutenant Commander, Judge Advocate General's Corps, Federal Legislative Liaison Officer.

[FR Doc. E6–21802 Filed 12–20–06; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF EDUCATION

Notice of Proposed Information Collection Requests

AGENCY: Department of Education.

ACTION: Notice of proposed information collection requests.

SUMMARY: The IC Clearance Official, Regulatory Information Management Services, Office of Management, invites comments on the proposed information collection requests as required by the Paperwork Reduction Act of 1995.

DATES: An emergency review has been requested in accordance with the Act (44 U.S.C. Chapter 3507 (j)), since public harm is reasonably likely to result if normal clearance procedures are followed. Approval by the Office of Management and Budget (OMB) has been requested by January 22, 2007. A regular clearance process is also beginning. Interested persons are invited to submit comments on or before February 20, 2007.

ADDRESSES: Written comments regarding the emergency review should be addressed to the Office of Information and Regulatory Affairs, Attention: Rachael Potter, Desk Officer, Department of Education, Office of Management and Budget; 725 17th Street, NW., Room 10222, New Executive Office Building, Washington, DC 20503 or faxed to (202) 395–6974.

SUPPLEMENTARY INFORMATION: Section 3506 of the Paperwork Reduction Act of 1995 (44 U.S.C. Chapter 35) requires that the Director of OMB provide interested Federal agencies and the

Appendix C

This Page Intentionally Left Blank

AIR QUALITY ANALYSIS
SUPPORTING DATA

This Appendix provides supporting data for the analysis contained in Section 3.2 (Air Quality).

Table C-1 Surface Ship Air Emissions – No Action Alternative
Table C-2 Surface Ship Air Emissions – Alternative 1
Table C-3 Surface Ship Air Emissions – Alternative 2

Tables provide estimates of emissions from combustion of fuel by marine vessels during SOCAL Range operations. Each table includes a listing of individual training operations from the SOCAL Operations Data Book, number of each type of marine vessel participating in the operations for the No Action Alternative and Alternatives 1 and 2, and hours on range for each training operation. Percentage of time within 0 to 3 nm of shore, 3 to 12 nm from shore, and > 12 nm from shore for both SCI and the SDAB are based on the SOCAL Operations Data Book. Emission factors are provided by JJMA in terms of lbs/hour. Emissions are then calculated for each area as follows:

Lbs/year per operation = No. of marine vessels in each category x hours per operation x percentage of time at the specified distance from shore x emission factor (lbs/hour).

Table C-4 Aircraft Air Emissions – No Action Alternative
Table C-5 Aircraft Air Emissions – Alternative 1
Table C-6 Aircraft Air Emissions – Alternative 2

Tables provide estimates of emissions from combustion of fuel by aircraft during SOCAL Range operations. Each table includes a listing of individual training operations from the SOCAL Operations Data Book, number of each type of aircraft participating in the operations for each alternative, and hours on range for each operation. Emissions below 3,000 ft above ground level are not counted in the emission calculations as they are not assumed to affect ambient air quality. Percentage of time below 3,000 feet, and within 0 to 3 nm of shore, 3 to 12 nm from shore, and > 12 nm from shore for both SCI and the SDAB are based on the SOCAL Operations Data Book. Fuel flow in lbs/hour and emission factors in terms of lbs/1000 lbs/ fuel are provided by AESO for each type of aircraft and each type of operation. Aircraft is generally assumed to operate in cruise mode unless otherwise specified. Emissions are then calculated for each area as follows:

Lbs/year per operation = No. of aircraft in each category x hours per operation x percentage of time below 3,000 feet AGL x percentage of time at the specified distance from shore x fuel flow (lbs/hour) emission factor (lbs/1,000 lbs fuel).

Table C-7 Takeoffs/Landings from NALF – No Action Alternative
Table C-8 Takeoffs/Landings from NALF – Alternative 1
Table C-9 Takeoffs/Landings from NALF – Alternative 2

Tables provide estimates of emissions from combustion of fuel during takeoffs/landings at the NALF. Numbers of takeoffs/landings per aircraft type were provided by the Navy. Different types of operations (i.e., takeoff, arrival, touch and go, etc.) were identified for each aircraft type. Emissions were estimated based on data from AESO for each operation. AESO provided emission factors in lbs/operation. Emissions are then calculated for each area as follows:

Lbs/year per operation = No. of aircraft in each category x number of operations x lbs/operation.

Table C-10 SOCAL Ordnance Expenditures – No Action Alternative
Table C-11 SOCAL Ordnance Expenditures – Alternative 1
Table C-12 SOCAL Ordnance Expenditures – Alternative 2

Tables provide estimates of emissions from ordnance used in SOCAL Range operations. Estimates of total ordnance use by category were obtained from the SOCAL Operations Data Book. Total ordnance use for each alternative was summed by ordnance type. Emissions by ordnance type were estimated based on emission factors from the EPA's AP-42 document. Emissions were calculated as follows:

Lbs/year per ordnance type = Amount of ordnance by type x emission factor (lbs/ordnance used or weight of explosives).

Table C-13 Ground Vehicle Operations – No Action Alternative
Table C-14 Ground Vehicles Operations – Alternative 1
Table C-15 Ground Vehicles Operations – Alternative 2

Tables provide estimates of emissions from ground vehicles used in SOCAL Range operations. Each table includes a listing of individual training operations from the SOCAL Operations Data Book, number of each type of ground vehicle participating in the operations for each alternative, and hours on range for each operation. Emission factors were obtained either from the Navy or from the ARB's EMFAC2007 model, which provides emission estimates in grams/VMT; vehicle speeds were estimated to be 5 mph during training exercises to estimate emissions in lbs/hour. Emissions are then calculated for each area as follows:

Lbs/year per operation = No. of ground vehicles in each category x hours per operation x emission factor (lbs/hour).

Table C-16 Total Emissions with 3 nm – SOCAL Conformity

Table presents a summary of emissions within 3 nm of shore and onshore for the purpose of demonstrating conformity with

Table C-1. Surface Ship Air Emissions—No Action Alternative

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs)	Percent at Each Power Level	Total Time on Range (hrs)	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10	Emissions 0-3 nm Offshore (lbs) CO	Nox	HC	Sox	PM	Emissions 3-12 nm Offshore - US Territory (lbs) CO	Nox	HC	Sox	PM	Emissions >12 nm Offshore - Outside US Territory: Offshore San Diego CO	Nox	HC	Sox	PM	Offshore Mexico CO	Nox	HC	Sox	PM
							Hours	%	Hours	Percent			Hours																											
Training Exercises																																								
1	Air Combat Maneuvers	0																																						
2	Air Defense Exercise	107		CG	Cruiser	CG-2	1.0	100%	107.0	0%	0%	100%	0.0	0.0	107.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11532.5	5041.8	943.7	2249.1	281.4					
		214		DDG	Guided Missile Destroyer	DDG-2	1.0	100%	214.0	0%	0%	100%	0.0	0.0	214.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22253.9	10464.6	1718.4	3839.2	526.4					
		22		CVN	Nuclear Carrier (No emissions)					0%	0%	100%																												
		4		FFG	Guided Missile Frigate	FFG-2	3.7	100%	14.8	0%	0%	100%	0.0	0.0	14.8	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	988.9	1002.3	115.6	171.2	48.1					
3	S-A Missiles	1		CVN	Nuclear Carrier (No emissions)					0%	0%	100%																												
		1		TRB	Torpedo Retrieval Boats	TRB-3	4.0	100%	4.0	1%	2%	97%	0.0	0.1	3.9	6.47	56.2	1.6	7.4	1.2	0.3	2.2	0.1	0.3	0.0	0.5	4.5	0.1	0.6	0.1	25.1	218.1	6.0	28.7	4.6					
4	S-A Gunnery Exercise	17		CVN						0%	0%	100%																												
		33		CG	Cruiser	CG-2	1.5	100%	49.5	0%	0%	100%	0.0	0.0	49.5	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						5335.1	2332.4	436.6	1040.5	130.2
		68		DDG	Guided Missile Destroyer	DDG-2	1.5	100%	102.0	0%	0%	100%	0.0	0.0	102.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						10607.0	4987.8	819.1	1829.9	250.9
		41		FFG	Guided Missile Frigate	FFG-2	1.5	100%	61.5	0%	0%	100%	0.0	0.0	61.5	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						4109.4	4164.8	480.3	711.6	199.9
		10		LHA	Amphib. Assault Ship - Tarawa	LHA-1	1.5	100%	15.0	0%	0%	100%	0.0	0.0	15.0	7.38	43.5	5.5	131.0	26.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						110.7	653.0	83.0	1964.6	394.4
		11		LDH	Large Helicopter-dock Ships	LHD-1	1.5	100%	16.5	0%	0%	100%	0.0	0.0	16.5	5.89	34.8	4.4	104.6	21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						97.2	573.7	72.9	1725.9	346.3
		16		LPD	Amphibious Transport Dock - Wasp	LPD-1	1.5	100%	24.0	0%	0%	100%	0.0	0.0	24.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						44.3	261.3	33.2	786.1	157.8
		18		LSD	Landing Ship Dock	LPD-1	1.5	100%	27.0	0%	0%	100%	0.0	0.0	27.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						49.8	294.0	37.4	884.4	177.5
		28		USCGS	US Coast Guard	USCG	1.5	100%	42.0	0%	0%	100%	0.0	0.0	42.0	5.74	57.9	0.9	11.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						241.1	2432.2	37.0	485.1	8.8
		20		Other Ship	Coastal Patrol-Independent Low Speed (	PC-1	1.5	100%	30.0	0%	0%	100%	0.0	0.0	30.0	6.5	12.5	1.1	2.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						195.0	373.8	31.5	75.3	10.5
5	A-A Missiles	1		TRB	Torpedo Retrieval Boats	TRB-3	4.0	100%	4.0	1%	2%	97%	0.0	0.1	3.9	6.47	56.2	1.6	7.4	1.2	0.3	2.2	0.1	0.3	0.0	0.5	4.5	0.1	0.6	0.1						25.1	218.1	6.0	28.7	4.6
6	Helicopter ASW TRACKEX	9		CG	Cruiser	CG-3	3.6	100%	32.4	1%	10%	89%	0.3	3.2	28.8	114.75	65.2	7.7	33.6	3.4	37.2	21.1	2.5	10.9	1.1	371.8	211.3	24.9	108.7	11.1	3308.9	1880.7	221.2	967.4	99.2					
		23		DDG	Guided Missile Destroyer	DDG-3	3.6	100%	82.8	1%	10%	89%	0.8	8.3	73.7	106.67	53.8	7.8	21.2	2.8	88.3	44.6	6.5	17.6	2.3	883.2	445.8	64.9	175.7	23.2	7860.7	3967.6	577.7	1563.7	206.3					
		14		TRB	Torpedo Retrieval Boats	TRB-3	3.6	100%	50.4	1%	10%	89%	0.5	5.0	44.9	6.47	56.2	1.6	7.4	1.2	3.3	28.3	0.8	3.7	0.6	32.6	283.3	7.8	37.3	5.9	290.2	2521.8	69.5	331.9	52.9					
7	Helicopter ASW TORPEX	21		CG	Cruiser	CG-3	3.6	100%	75.6	1%	10%	89%	0.8	7.6	67.3	114.75	65.2	7.7	33.6	3.4	86.8	49.3	5.8	25.4	2.6	867.5	493.1	58.0	253.6	26.0	7720.8	4388.3	516.1	2257.4	231.5					
		57		DDG	Guided Missile Destroyer	DDG-3	3.6	100%	205.2	1%	10%	89%	2.1	20.5	182.6	106.67	53.8	7.8	21.2	2.8	218.9	110.5	16.1	43.5	5.7	2188.9	1104.8	160.9	435.4	57.5	19480.9	9832.7	1431.8	3875.4	511.4					
		55		TRB	Torpedo Retrieval Boats	TRB-3	3.6	100%	198.0	1%	10%	89%	2.0	19.8	176.2	6.47	56.2	1.6	7.4	1.2	12.8	111.3	3.1	14.7	2.3	128.1	1113.2	30.7	146.5	23.4	1140.1	9907.1	273.1	1304.0	207.9					
8	MPA ASW TRACKEX																																							
9	MPA ASW TORPEX	2		CG	Cruiser	CG-3	2.0	100%	4.0	5%	10%	85%	0.2	0.4	3.4	114.75	65.2	7.7	33.6	3.4	23.0	13.0	1.5	6.7	0.7	45.9	26.1	3.1	13.4	1.4	390.2	221.7	26.1	114.1	11.7					
		4		DDG	Guided Missile Destroyer	DDG-3	2.0	100%	8.0	5%	10%	85%	0.4	0.8	6.8	106.67	53.8	7.8	21.2	2.8	42.7	21.5	3.1	8.5	1.1	85.3	43.1	6.3	17.0	2.2	725.4	366.1	53.3	144.3	19.0					
		3		FFG	Guided Missile Frigate	FFG-3	2.0	100%	6.0	5%	10%	85%	0.3	0.6	5.1	120.04	78.1	11.6	16.1	4.3	36.0	23.4	3.5	4.8	1.3	72.0	46.9	7.0	9.6	2.6	612.2	398.4	59.4	82.0	21.9					
		13		TRB	Torpedo Retrieval Boats	TRB-3	2.0	100%	26.0	5%	10%	85%	1.3	2.6	22.1	6.47	56.2	1.6	7.4	1.2	8.4	73.1	2.0	9.6	1.5	16.8	146.2	4.0	19.2	3.1	143.0	1242.5	34.3	163.5	26.1					
10	EER/IEER ASW																																							
11	Surface Ship ASW TRACKEX	228		CG	Cruiser	CG-3	2.0	100%	456.0	1%	10%	89%	4.6	45.6	405.8	114.75	65.2	7.7	33.6	3.4	523.3	297.4	35.0	153.0	15.7	5232.6	2974.0	349.8	1529.9	156.9	46570.1	26468.9	3112.8	13615.9	1396.1					
		450		DDG	Guided Missile Destroyer	DDG-3	2.0	100%	900.0	1%	10%	89%	9.0	90.0	801.0	106.67	53.8	7.8	21.2	2.8	960.0	484.6	70.6	191.0	25.2	9600.3	4845.6	705.6	1909.8	252.0	85442.7	43125.8	6279.8	16997.2	2242.8					
		169		FFG	Guided Missile Frigate	FFG-3	2.0	100%	338.0	1%	10%	89%	3.4	33.8	300.8	120.04	78.1	11.6	16.1	4.3	405.7	264.0	39.3	54.4	14.5	4057.4	2640.1	393.4	543.5	145.3	36110.4	23497.1	3501.5	4837.2	1293.5					
		0		Support	Torpedo Retrieval Boats	TRB-3	2.0	100%	0.0	1%	10%	89%	0.0	0.0	0.0	6.47	56.2	1.6	7.4	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
12	Surface Ship ASW TORPEX	6		CG	Cruiser	CG-3	3.7	100%	22.2	1%	10%	89%	0.2	2.2	19.8	114.75	65.2	7.7	33.6	3.4	25.5	14.5	1.7	7.4	0.8	254.7	144.8	17.0	74.5	7.6	2267.2	1288.6	151.5	662.9	68.0					
		10		DDG	Guided Missile Destroyer	DDG-3	3.7	100%	37.0	1%	10%	89%	0.4	3.7	32.9	106.67	53.8	7.8	21.2	2.8	39.5	19.9	2.9	7.9	1.0	394.7	199.2	29.0	78.5	10.4	3512.6	1773.0	258.2	698.8	92.2					
		5		FFG	Guided Missile Frigate	FFG-3	3.7	100%	18.5	1%	10%	89%	0.2	1.9	16.5	120.04	78.1	11.6	16.1	4.3	22.2	14.5	2.2	3.0	0.8	222.1	144.5	21.5	29.7	8.0	1976.5	1286.1	191.7	264.8	70.8					
		10		TRB	Torpedo Retrieval Boats	TRB-3	3.7	100%	37.0	1%	10%	89%	0.4	3.7	32.9	6.47	56.2	1.6	7.4	1.2	2.4	20.8	0.6	2.7	0.4	23.9	208.0	5.7	27.4	4.4	213.1	1851.3	51.0	243.7	38.9					
13	Sub ASW Trackex	45		SSN	Submarines (No emissions)																																			
		14		TRB	Torpedo Retrieval Boats	TRB-3	12.8	100%	179.2	1%	2%	97%	1.8	3.6	173.8	6.47	56.2	1.6	7.4	1.2	11.6	100.7	2.8	13.3	2.1	23.2	201.5	5.6	26.5	4.2	1124.6	9772.4	269.4	1286.3	205.1					
14	Sub ASW TORPEX	18		SSN	Submarines (No emissions)																																			
		18		TRB	Torpedo Retrieval Boats	TRB-3	11.7	100%	210.6	1%	2%	97%	2.1	4.2	204.3	6.47	56.2	1.6	7.4	1.2	13.6	118.4	3.3	15.6	2.5	27.3	236.8	6.5	31.2	5.0	1321.7	11484.7	316.6	1511.7	241.1					
15	VBSS	13		CG	Cruiser	CG-2	4.0	100%	52.0	0%	0%	100%	0.0	0.0	52.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5604.6	2450.2	458.6	1093.0	136.8					
		26		DDG	Guided Missile Destroyer	DDG-2	4.0	100%	104.0	0%	0%	100%	0.0	0.0	104.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10815.0	5085.6	835.1	1865.8	255.8					
		5		FFG	Guided Missile Frigate	FFG-2	4.0	100%	20.0	0%	0%	100%	0.0	0.0	20.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1336.4	1354.4	156.2	231.4	65.0					
		2		LPD	Amphibious Transport Dock - Wasp	LPD-1	4.0	100%	8.0	0%	0%	100%	0.0	0.0	8.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.8	87.1	11.1	262.0	52.6					
		5		LSD		LPD-1	4.0	100%	20.0	0%	0%	100%	0.0	0.0	20.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.9	217.8	27.7	655.1	131.5					
16	ASUW MISSILEX	30		TRB	Torpedo Retrieval Boats	TRB-2	7.0	100%	210.0	5%	28%	67%	10.5	58.8	140.7	7.64	33.1	0.6	3.4	1.2	80.2	347.4	6.2	35.6	12.2	449.2	1945.7	34.7	199.3	68.2	1074.9	4655.8	83.0	477.0	163.2					
		2		CG	Cruiser	CG-2	4.0	100%	8.0	0%	0%	100%	0.0	0.0	8.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	862.2	377.0	70.6	168.2	21.0					
		2		DDG	Guided Missile Destroyer	DDG-2	4.0	100%	8.0	0%	0%	100%	0.0	0.0	8.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	831.9	391.2	64.2	143.5	19.7					
17	A-S BOMBEX	0																																						
18	A-S GUNEX	0																																						

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs)	Percent at Each Power Level	Total Time on Range (hrs)	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10	Emissions 0-3 nm Offshore (lbs) CO	Nox	HC	Sox	PM	Emissions 3-12 nm Offshore - US Territory (lbs) CO	Nox	HC	Sox	PM	Emissions >12 nm Offshore - Outside US Territory: Offshore San Diego CO	Nox	HC	Sox	PM	Offshore Mexico CO	Nox	HC	Sox	PM
19	S-S GUNEX	1		CVN	Nuclear Carrier (No emissions)																																			
		64		CG	Cruiser	CG-1	2.5	100%	160.0	0%	28%	72%	0.0	44.8	115.2	102.58	40.6	9.2	17.7	2.1	0.0	0.0	0.0	0.0	0.0	4595.6	1819.3	413.1	793.4	95.0						11817.2	4678.3	1062.1	2040.2	244.2
		132		DDG	Guided Missile Destroyer	DDG-1	2.5	100%	330.0	0%	28%	72%	0.0	92.4	237.6	102.98	47.3	8.1	17.0	2.4	0.0	0.0	0.0	0.0	0.0	9515.4	4374.2	748.4	1574.5	217.1						24468.0	11248.0	1924.6	4048.7	558.4
		44		FFG	Guided Missile Frigate	FFG-1	2.5	100%	110.0	0%	28%	72%	0.0	30.8	79.2	65.75	66.4	7.9	10.9	3.1	0.0	0.0	0.0	0.0	0.0	2025.1	2043.6	243.0	335.4	96.7						5207.4	5254.9	624.9	862.5	248.7
		2		LPD	Amphibious Transport Dock - Wasp	LPD-1	2.5	100%	5.0	0%	28%	72%	0.0	1.4	3.6	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	2.6	15.2	1.9	45.9	9.2						6.6	39.2	5.0	117.9	23.7
		1		LSD	Landing Ship Dock	LPD-1	2.5	100%	2.5	0%	28%	72%	0.0	0.7	1.8	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	1.3	7.6	1.0	22.9	4.6						3.3	19.6	2.5	59.0	11.8
		1		LHD	Large Helicopter-dock Ships	LHD-2	2.5	100%	2.5	0%	28%	72%	0.0	0.7	1.8	6.8	40.1	5.1	120.7	24.2	0.0	0.0	0.0	0.0	0.0	4.8	28.1	3.6	84.5	17.0						12.2	72.2	9.2	217.3	43.6
		16		Unknown	Other	PC-2	2.5	100%	40.0	0%	28%	72%	0.0	11.2	28.8	17.21	38.1	2.9	8.2	0.9	0.0	0.0	0.0	0.0	0.0	192.8	427.2	32.9	92.2	10.3						495.6	1098.4	84.7	237.0	26.5
		36		USCG	US Coast Guard	USCG	2.5	100%	90.0	0%	28%	72%	0.0	25.2	64.8	5.74	57.9	0.9	11.6	0.2	0.0	0.0	0.0	0.0	0.0	144.6	1459.3	22.2	291.1	5.3						372.0	3752.6	57.0	748.4	13.6
20	SINKEX	4		CG	Cruiser	CG-2	16.0	100%	64.0	0%	0%	100%	0.0	0.0	64.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						6897.9	3015.7	564.5	1345.3	168.3
		4		DDG	Guided Missile Destroyer	DDG-2	16.0	100%	64.0	0%	0%	100%	0.0	0.0	64.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						6655.4	3129.6	513.9	1148.2	157.4
		4		DD	Destroyer	DDG-2	16.0	100%	64.0	0%	0%	100%	0.0	0.0	64.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						6655.4	3129.6	513.9	1148.2	157.4
		4		FFG	Guided Missile Frigate	FFG-2	16.0	100%	64.0	0%	0%	100%	0.0	0.0	64.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						4276.5	4334.1	499.8	740.5	208.0
		2		SSN	Submarines (No emissions)																																			
21	NSFS	15		CG	Cruiser	CG-2	9.0	100%	135.0	0%	30%	70%	0.0	40.5	94.5	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	4365.1	1908.4	357.2	851.3	106.5	10185.2	4452.8	833.5	1986.4	248.5					
		32		DDG	Guided Missile Destroyer	DDG-2	9.0	100%	288.0	0%	30%	70%	0.0	86.4	201.6	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	8984.7	4225.0	693.8	1550.0	212.5	20964.4	9858.2	1618.8	3616.7	495.9					
		4		FFG	Guided Missile Frigate	FFG-2	9.0	100%	36.0	0%	30%	70%	0.0	10.8	25.2	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	721.7	731.4	84.3	125.0	35.1	1683.9	1706.5	196.8	291.6	81.9					
22	EFEX	2		CG	Cruiser	CG-2	72.0	100%	144.0	0%	100%	0%	0.0	144.0	0.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	15520.3	6785.3	1270.1	3026.9	378.7	0.0	0.0	0.0	0.0	0.0					
		2		DDG	Guided Missile Destroyer	DDG-2	72.0	100%	144.0	0%	100%	0%	0.0	144.0	0.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	14974.6	7041.6	1156.3	2583.4	354.2	0.0	0.0	0.0	0.0	0.0					
23	Battalion Landing	0		LHA	Amphib. Assault Ship - Tarawa	LHA-1	6.0	100%	0.0	10%	30%	60%	0.0	0.0	0.0	7.38	131.0	26.3	7.4	43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		LCU	Landing Craft Utility	LCU	3.0	100%	0.0	10%	30%	60%	0.0	0.0	0.0	36.21	3.1	1.6	36.2	45.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		AAV/EFV	Amphibious Assault Vehicle	AAV-2	6.0	100%	0.0	10%	30%	60%	0.0	0.0	0.0	0.633674	3.8	0.2	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		LCAC	Landing Craft Air Cushioned	LCAC	3.0	100%	0.0	10%	30%	60%	0.0	0.0	0.0	25.41	43.3	3.9	25.4	55.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		CRRC	Combat Raiding Rubber Craft	CRRC-4	6.0	100%	0.0	10%	30%	60%	0.0	0.0	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
24	USMC Stinger	0																																						
25	Amphibious Landings & Raids																																							
25A	Recon Mission	0																																						
25B	Helicopter Assault	0		LHD	Large Helicopter-dock Ships	LHD-2	6.0	100%	0.0	0%	0%	100%	0.0	0.0	0.0	6.8	40.1	5.1	120.7	24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		LHA	Amphib. Assault Ship - Tarawa	LHA-1	6.0	100%	0.0	0%	0%	100%	0.0	0.0	0.0	7.38	131.0	26.3	7.4	43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
25C	Armored Operations	0		LHD	Large Helicopter-dock Ships	LHD-2	12.0	100%	0.0	33%	33%	33%	0.0	0.0	0.0	6.8	40.1	5.1	120.7	24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		LHA	Amphib. Assault Ship - Tarawa	LHA-1	12.0	100%	0.0	33%	33%	33%	0.0	0.0	0.0	7.38	131.0	26.3	7.4	43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		LCAC	Landing Craft Air Cushioned	LCAC	12.0	100%	0.0	33%	33%	33%	0.0	0.0	0.0	25.41	43.3	3.9	25.4	55.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		LCU	Landing Craft Utility	LCU	12.0	100%	0.0	33%	33%	33%	0.0	0.0	0.0	36.21	3.1	1.6	36.2	45.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
25D	Artillery Operations	2		LHD	Large Helicopter-dock Ships	LHD-2	24.0	100%	48.0	100%	0%	0%	48.0	0.0	0.0	6.8	40.1	5.1	120.7	24.2	326.4	1925.8	244.8	5793.6	1163.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		1		LHA	Amphib. Assault Ship - Tarawa	LHA-1	24.0	100%	24.0	20%	40%	40%	4.8	9.6	9.6	7.38	43.5	5.5	131.0	26.3	35.4	208.9	26.5	628.7	126.2	70.8	417.9	53.1	1257.3	252.4	70.8	417.9	53.1	1257.3	252.4					
		4		LCAC	Landing Craft Air Cushion	LCAC	24.0	100%	96.0	100%	0%	0%	96.0	0.0	0.0	25.41	55.3	0.7	43.3	3.9	2439.4	5310.7	69.1	4156.8	373.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		4		LCU	Landing Craft Utility	LCU	24.0	100%	96.0	100%	0%	0%	96.0	0.0	0.0	36.21	45.0	0.5	3.1	1.6	3476.2	4315.2	49.9	298.6	150.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
25E	Amphibious Assault	0		LHD	Large Helicopter-dock Ships	LHD-2	8.0	100%	0.0	38%	38%	25%	0.0	0.0	0.0	6.8	40.1	5.1	120.7	24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					

Table C-1. Surface Ship Air Emissions—No Action Alternative

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs)	Percent at Each Power Level	Total Time on Range (hrs)	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Emissions Factors (lb/hr)					Emissions: Emissions 0-3 nm Offshore (lbs)					Emissions 3-12 nm Offshore - US Territory (lbs)					Emissions >12 nm Offshore - Outside US Territory									
							Hours	%	Hours	Percent			Hours			CO	NOx	HC	SOx	PM10	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM
		0		LHA	Amphib. Assault Ship - Tarawa	LHA-1	8.0	100%	0.0	38%	38%	25%	0.0	0.0	0.0	7.38	43.5	5.5	131.0	26.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		LPD	Amphibious Transport Dock - Wasp	LPD-1	8.0	100%	0.0	38%	38%	25%	0.0	0.0	0.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		LCAC	Landing Craft Air Cushioned	LCAC	8.0	100%	0.0	38%	38%	25%	0.0	0.0	0.0	25.41	43.3	3.9	25.4	55.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		LCU	Landing Craft Utility	LCU	8.0	100%	0.0	38%	38%	25%	0.0	0.0	0.0	36.21	3.1	1.6	36.2	45.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
25F	Combat Engineer Ops	0		LHA	Amphib. Assault Ship - Tarawa	LHA-1	6.0	100%	0.0	33%	33%	33%	0.0	0.0	0.0	7.38	131.0	26.3	7.4	43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		LCU	Landing Craft Utility	LCU	6.0	100%	0.0	33%	33%	33%	0.0	0.0	0.0	36.21	3.1	1.6	36.2	45.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
25G	Amphibious Assault Vehicle Ops	0		LHA	Amphib. Assault Ship - Tarawa	LHA-1	8.0	100%	0.0	25%	25%	50%	0.0	0.0	0.0	7.38	131.0	26.3	7.4	43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		EFV	Expeditionary Fighting Vessel	EFV-1	8.0	100%	0.0	25%	25%	50%	0.0	0.0	0.0	2.0611	4.17	0.72	0.06	0.3211	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
25H	EFV	0		LPD	Amphibious Transport Dock - Wasp	LPD-1	8.0	100%	0.0	25%	25%	50%	0.0	0.0	0.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		LCAC	Landing Craft Air Cushioned	LCAC	8.0	100%	0.0	25%	25%	50%	0.0	0.0	0.0	25.41	43.3	3.9	25.4	55.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		EFV	Expeditionary Fighting Vessel	EFV-1	8.0	100%	0.0	25%	25%	50%	0.0	0.0	0.0	2.0611	4.17	0.72	0.06	0.3211	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
25I	Assault Amphibian School	0		LCAC	Landing Craft Air Cushioned	LCAC	8.0	100%	0.0	0%	0%	100%	0.0	0.0	0.0	25.41	43.3	3.9	25.4	55.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		LCU	Landing Craft Utility	LCU	8.0	100%	0.0	0%	0%	100%	0.0	0.0	0.0	36.21	3.1	1.6	36.2	45.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		0		EFV	Amphibious Assault Vehicle	EFV-1	8.0	100%	0.0	0%	0%	100%	0.0	0.0	0.0	2.0611	4.17	0.72	0.06	0.3211	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
26	Ambphibious Operations CPAAA																																							
26A	Amphibious Operations	1530		AAV/EFV	Amphibious Assault Vehicle	AAV-1	16.8	20%	25704.0	100%	0%	0%	25704.0	0.0	0.0	0.444918	1.0	0.2	0.1	0.2	11436.2	26631.2	4474.8	1323.2	4604.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
				AAV/EFV	Amphibious Assault Vehicle	AAV-2	16.8	80%	0.0	100%	0%	0%	0.0	0.0	0.0	0.633674	3.8	0.2	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		6		LCAC	Landing Craft Air Cushion	LCAC	16.8	100%	100.8	100%	0%	0%	100.8	0.0	0.0	25.41	55.3	0.7	43.3	3.9	2561.3	5576.3	72.6	4364.6	392.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
26B	Amphibious Ops	4		LHD	Large Helicopter-dock Ships	LHD-1	4.2	90%	15.2	0%	0%	100%	0.0	0.0	15.2	5.89	34.8	4.4	104.6	21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	89.3	527.0	67.0	1585.3	318.1					
				LHD	Large Helicopter-dock Ships	LHD-2	4.2	10%	1.7	0%	0%	100%	0.0	0.0	1.7	6.8	40.1	5.1	120.7	24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.5	67.6	8.6	203.3	40.8					
		4		LCAC	Landing Craft Air Cushion	LCAC	4.2	100%	16.8	0%	0%	100%	0.0	0.0	16.8	25.41	55.3	0.7	43.3	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	427.9	931.6	12.1	729.2	65.5					
		60		CRRC	Combat Raiding Rubber Craft	CRRC-1	4.2	22%	55.6	28%	36%	36%	15.6	20.0	20.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.4					
				CRRC	Combat Raiding Rubber Craft	CRRC-4	4.2	27%	55.6	28%	36%	36%	15.6	20.0	20.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	2.6					
				CRRC	Combat Raiding Rubber Craft	CRRC-5	4.2	51%	128.8	28%	36%	36%	36.1	46.4	46.4	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.0	6.9	0.0	0.0	0.0	0.0	6.9					
		4		LCU	Landing Craft Utility	LCU	4.2	100%	16.8	32%	0%	68%	5.4	0.0	11.5	36.21	45.0	0.5	3.1	1.6	195.1	242.2	2.8	16.8	8.5	0.0	0.0	0.0	0.0	0.0	414.6	514.7	6.0	35.6	18.0					
26C	Amphibious Ops	130		AAV/EFV	Amphibious Assault Vehicle	AAV-1	15.0	10%	195.0	100%	0%	0%	195.0	0.0	0.0	0.444918	1.0	0.2	0.1	0.2	86.8	202.0	33.9	10.0	34.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						AAV-2	15.0	90%	1755.0	100%	0%	0%	1755.0	0.0	0.0	0.633674	3.8	0.2	0.1	0.3	1112.1	6596.0	300.9	184.8	516.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
26D	Amphibious Ops	5		AAV	Amphibious Assault Vehicle	AAV-1	2.4	20%	2.4	100%	0%	0%	2.4	0.0	0.0	0.444918	1.0	0.2	0.1	0.2	1.0	2.4	0.4	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						AAV-2	2.4	80%	9.4	100%	0%	0%	9.4	0.0	0.0	0.633674	3.8	0.2	0.1	0.3	6.0	35.3	1.6	1.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		1502		EFV	Amphibious Assault Vehicle	EFV-1	2.4	33%	1176.4	28%	70%	2%	329.4	823.5	23.5	2.0611	4.17	0.72	0.06	0.3211	678.9	1372.6	237.5	20.8	105.8	1697.3	3431.6	593.8	52.0	264.4	48.5	98.0	17.0	1.5	7.6					
						EFV-2	2.4	67%	2353.3	28%	70%	2%	658.9	1647.3	47.1	2.0611	4.17	0.72	0.06	0.3211	1358.1	2745.7	475.1	41.6	211.6	3395.2	6864.2	1187.9	104.1	528.9	97.0	196.1	33.9	3.0	15.1					
		2268		RIB	Rigid Inflatable	RIB-1	2.4	7%	355.5	28%	70%	2%	99.5	248.8	7.1	0.04	1.6	0.0	0.2	0.0	4.0	158.3	1.0	16.9	2.0	10.0	395.7	2.5	42.3	5.0	0.3	11.3	0.1	1.2	0.1					
						RIB-3		13%	708.9	28%	70%	2%	198.5	496.2	14.2	0.08	3.0	0.0	0.4	0.0	15.9	595.4	2.0	71.5	7.9	39.7	1488.6	5.0	178.6	19.8	1.1	42.5	0.1	5.1	0.6					
						RIB-4		80%	4263.8	28%	70%	2%	1193.9	2984.7	85.3	0.34	9.1	0.1	1.4	0.2	405.9	10912.0	71.6	1719.2	179.1	1014.8	27280.0	179.1	4298.0	447.7	29.0	779.4	5.1	122.8	12.8					
		756		Support	Coastal Patrol-Independent Low Speed (	PC-1	2.4	20%	355.3	28%	70%	2%	99.5	248.7	7.1	6.5	12.5	1.1	2.5	0.4	646.7	1239.6	104.5	249.7	34.8	1616.7	3099.1	261.2	624.3	87.1	46.2	88.5	7.5	17.8	2.5					
					Dynamic Maneuvering	PC-3		80%	1421.3	28%	70%	2%	398.0	994.9	28.4	59.93	187.6	9.3	47.1	4.8	23849.6	74661.0	3709.0	18751.8	1898.3	59624.1	186652.4	9272.4	46879.5	4745.7	1703.5	5332.9	264.9	1339.4	135.6					
26E	Amphibious Ops	348		AAV	Amphibious Assault Vehicle	AAV-1	13.2	20%	918.7	100%	0%	0%	918.7	0.0	0.0	0.444918	1.0	0.2	0.1	0.2	408.8	951.9	159.9	47.3	164.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						AAV-2	13.2	80%	3674.9	100%	0%	0%	3674.9	0.0	0.0	0.633674	3.8	0.2	0.1	0.3	2328.7	13811.7	630.1	387.0	1081.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		156		CRRC	Combat Raiding Rubber Craft	CRRC-1	13.2	28%	566.3	70%	30%	0%	396.4	169.9	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-4	13.2	18%	360.4	70%	30%	0%	252.3	108.1	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-5	13.2	55%	1132.6	70%	30%	0%	792.8	339.8	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	117.8	0.0	0.0	0.0	0.0	50.5	0.0	0.0	0.0	0.0	0.0					
26F	Amphibious Warfare	964		LCAC	Landing Craft Air Cushion	LCAC	8.5	100%	8194.0	16%	55%	29%	1311.0	4506.7	2376.3	25.41	55.3	0.7	43.3	3.9	33313.5	72526.7	943.9	56768.0	5099.9	114515.2	249310.6	3244.8	195140.1	17531.1	60380.8	131454.7	1710.9	102892.1	9243.7					
		221		LCU	Landing Craft Utility	LCU	8.5	100%	1878.5	75%	5%	20%	1408.9	93.9	375.7	36.21	45.0	0.5	3.1	1.6	51015.4	63328.9	732.6	4381.6	2211.9	3401.0	4221.9	48.8	292.1	147.5	13604.1	16887.7	195.4	1168.4	589.8					
		72		Support	Coastal Patrol-Independent Low Speed (	PC-2	8.5	100%	612.0	100%	0%	0%	612.0	0.0	0.0	17.21	38.1	2.9	8.2	0.9	10532.5	23341.7	1799.3	5036.8	563.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		72		LCM-8		LCU	8.5	100%	612.0	100%	0%	0%	612.0	0.0	0.0	36.21	45.0	0.5	3.1	1.6	22160.5	27509.4	318.2	1903.3	960.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		30		LARC		LCU	8.5	100%	255.0	100%	0%	0%	255.0	0.0	0.0	36.21	45.0	0.5	3.1	1.6	9233.6	11462.3	132.6	793.1	400.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		36		SLWT	SLWT (assume LPD)	LPD-2	8.5	20%	61.2	95%	5%	0%	58.1	3.1	0.0	2.935967	17.3	2.2	52.1	10.5	170.7	1007.1	128.0	3029.9	608.1	9.0	53.0	6.7	159.5	32.0	0.0	0.0	0.0	0.0	0.0					
						LPD-3	8.5	80%	244.8	95%	5%	0%	232.6	12.2	0.0	6.549492	38.6	4.9	116.3	23.3	1523.1	8986.6	1142.4	27035.9	5426.2	80.2	473.0	60.1	1422.9	285.6	0.0	0.0	0.0	0.0	0.0					
		36		SLWT	SLWT (assume LPD)	LPD-2	8.5	20%	61.2	95%	5%	0%	58.1	3.1	0.0	2.935967	17.3	2.2	52.1	10.5	170.7	1007.1	128.0	3029.9	608.1	9.0	53.0	6.7	159.5	32.0	0.0	0.0	0.0	0.0	0.0					
						LPD-3	8.5	80%	244.8	95%	5%	0%	232.6	12.2	0.0	6.549492	38.6	4.9	116.3	23.3	1523.1	8986.6	1142.4	27035.9	5426.2	80.2	473.0	60.1	1422.9	285.6	0.0	0.0	0.0	0.0	0.0					
		18		BW	Boston Whaler	BW-2	8.5	20%	30.6	95%	5%	0%	29.1	1.5	0.0	0	0.1	9.0	0.0	0.0	0.0	2.6	262.1	0.0	0.0	0.0	0.1	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						BW-3	8.5	80%	122.4	95%	5%	0%	116.3	6.1	0.0	0	0.3	26.3	0.0	0.0	0.0	30.7	3058.2	0.0	0.0	0.0	1.6	161.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
26G	Amphibious Ops	614		CRRC	Combat Raiding Rubber Craft	CRRC-1	6.2	28%	1038.4	80%	20%	0%	830.7	207.7	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.5	0.0	0.0	0.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-4	6.2	18%	660.8	80%	20%	0%	528.7	132.2	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	69.8	0.0	0.0	0.0	0.0	17.5	0.0	0.0	0.0	0.0	0.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-5	6.2	55%	2076.9	80%	20%	0%	1661.5	415.4	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	246.8	0.0	0.0	0.0	0.0	61.7	0.0	0.0	0.0	0.0	0.0					
27	Elec Combat	314		CVN	Nuclear Carrier (No emissions)																																			
		741		CG	Cruiser	CG-2	4.9	100%	3630.9	0%	3%	97%	0.0	108.9	3522.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	11740.2	5132.6	960.7	2289.6	286.5	379598.2	165955.4	31063.8	74031.9	9262.8					
		635		DDG	Guided Missile Destroyer	DDG-2	4.9	100%	3111.5	0%	3%	97%	0.0	93.3	3018.2	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	9706.9	4564.6	749.6	1674.6	229.6	313857.9	147587.8	24235.8	54145.7	7424.7					
		23		DD	Destroyer	DDG-2	4.9	100%	112.7	0%	3%	97%	0.0	3.4	109.3	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	351.6	165.3	27.1	60.7	8.3	11368.1	5345.7	877.8	1961.2	268.9					
		18		FFG	Guided Missile Frigate	FFG-2	4.9	100%	88.2	0%	3%	97%	0.0	2.6	85.6	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	176.8	179.2	20.7	30.6	8.6	5716.7	5793.7	668.2	989.9	278.1					
		5		FFH	Canadian Frigate	FFG-2	4.9	100%	24.5	0%	3%	97%	0.0	0.7	23.8	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	49.1	49.8	5.7	8.5	2.4	1588.0	1609.4	185.6	275.0	77.2					
		5		AOE	Logistics/Support	AOE-1	4.9	100%	24.5	0%	3%	97%	0.0	0.7	23.8	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	2.7	16.2	2.1	48.6	9.8	88.6	522.6	66.3	1571.8	315.6					
		2		MHC		PC-1	4.9	100%	9.8	0%	3%	97%	0.0	0.3	9.5	6.5	12.5	1.1	2.5	0.4	0.0	0.0	0.0	0.0	0.0	1.9	3.7	0.3	0.7	0.1	61.8	118.4	10.0	23.9	3.3					
		16		LPD	Amphibious Transport Dock - Wasp	LPD-1	4.9	100%	78.4	0%	3%	97%	0.0	2.4	76.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	4.3	25.6	3.3	77.0	15.5	140.3	828.0	105.3	2491.0	500.0					
		230		LHD	Large Helicopter-dock Ships	LHD-1	4.9	100%	1127.0	0%	3%	97%	0.0	33.8	1093.2	5.89	34.8	4.4	104.6	21.0	0.0	0.0	0.0	0.0	0.0	199.1	1175.6	149.4	3536.5	709.7	6438.9	38010.2	4831.9	114347.7	22946.1					
		15		LSD	Landing Ship Dock	LPD-1	4.9	100%	73.5	0%	3%	97%	0.0	2.2	71.3	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	4.1	24.0	3.1	72.2	14.5	131.6	776.2	98.7	2335.3	468.7					
		175		LHA	Amphib. Assault Ship - Tarawa	LHA-1	4.9	100%	857.5	0%	3%	97%	0.0	25.7	831.8	7.38	43.5	5.5	131.0	26.3	0.0	0.0	0.0	0.0	0.0	189.9	1119.8	142.3	3369.2	676.3	6138.5	36207.2	4599.7	108937.6	21867.4					
		1		AGF		LPD-1	4.9	100%	4.9	0%	3%	97%	0.0	0.1	4.8	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.3	1.6	0.2	4.8	1.0	8.8	51.7	6.6	155.7	31.2					
		4		WHEC	US Coast Guard	USCG	4.9	100%	19.6	0%	3%	97%	0.0	0.6	19.0	5.74	57.9	0.9	11.6	0.2	0.0	0.0	0.0	0.0	0.0	3.4	34.1	0.5	6.8	0.1	109.1	1101.0	16.7	219.6	4.0					
		144		Unknown		PC-1	4.9	100%	705.6	0%	3%	97%	0.0	21.2	684.4	6.5	12.5	1.1	2.5	0.4	0.0	0.0	0.0	0.0	0.0	137.6	263.8	22.2	53.1	7.4	4448.8	8528.0	718.7	1717.9	239.6					
		10		SSN	Submarines (No emissions)																																			
		2		SSBN	Submarines (No emissions)																																			
28A	Sm Obj Avoidance	8		CG	Cruiser	CG-2	1.8	100%	14.0	100%	0%	0%	14.0	0.0	0.0	107.78	47.1	8.8	21.0	2.6	1508.9	659.7	123.5	294.3	36.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		13		DDG	Guided Missile Destroyer	DDG-2	1.8	100%	22.8	100%	0%	0%	22.8	0.0	0.0	103.99	48.9	8.0	17.9	2.5	2365.8	1112.5	182.7	408.1	56.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		10		FFG	Guided Missile Frigate	FFG-2	1.8	100%	17.5	100%	0%	0%	17.5	0.0	0.0	66.82	67.7	7.8	11.6	3.3	1169.4	1185.1	136.7	202.5	56.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		15		MCM		USCG	1.8	100%	26.3	100%	0%	0%	26.3	0.0	0.0	5.74	57.9	0.9	11.6	0.2	150.7	1520.1	23.1	303.2	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		21		MHC		USCG	1.8	100%	36.8	100%	0%	0%	36.8	0.0	0.0	5.74	57.9	0.9	11.6	0.2	210.9	2128.2	32.3	424.5	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
29	Mine Neutralization	0																																						
30	Mining Exercise	2		MHC		USCG	0.5	100%	1.0	50%	40%	10%	0.5	0.4	0.1	5.74	57.9	0.9	11.6	0.2	2.9	29.0	0.4	5.8	0.1	2.3	23.2	0.4	4.6	0.1	0.6	5.8	0.1	1.2	0.0					
31	NSWC Land Demolition	3		CRRC		CRRC-2	4.0	90%	10.8	100%	0%	0%	10.8	0.0	0.0	0	0.0	2.3	0.0	0.0	0.0	0.3	24.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						CRRC-3		10%	1.2	100%	0%	0%	1.2	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	0.1	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
32	NSWC UW Demo	72		CRRC		CRRC-2	6.0	90%	388.8	100%	0%	0%	388.8	0.0	0.0	0	0.0	2.3	0.0	0.0	0.0	10.3	891.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						CRRC-3		10%	43.2	100%	0%	0%	43.2	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	3.1	272.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
33	Mat Weave	28		CRRC		CRRC-2	4.0	90%	100.8	100%	0%	0%	100.8	0.0	0.0	0	0.0	2.3	0.0	0.0	0.0	2.7	231.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						CRRC-3		10%	11.2	100%	0%	0%	11.2	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	0.8	70.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
34	NSWC Small Arms	20		CRRC		CRRC-2	6.0	90%	108.0	100%	0%	0%	108.0	0.0	0.0	0	0.0	2.3	0.0	0.0	0.0	2.9	247.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						CRRC-3		10%	12.0	100%	0%	0%	12.0	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	0.9	75.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
35	NSWC Land Nav	0																																						
36	NSW UAV Operationa	0																																						
37	Insertion/Extraction	0																																						
38	NSW Boat Operations	220		MK V	MK V	MK-1	10.0	50%	1100.0	5%	42%	53%	55.0	462.0	583.0	1.94	14.8	0.5	2.4	0.2	106.7	815.7	27.5	131.5	11.0	896.3	6851.5	231.0	1104.2	92.4	1131.0	8645.9	291.5	1393.4	116.6					
						MK-3		50%	1100.0	5%	42%	53%	55.0	462.0	583.0	13.22	71.5	1.1	15.7	1.2	727.1	3931.4	57.8	860.8	63.3	6107.6	33023.8	485.1	7230.3	531.3	7707.3	41672.8	612.2	9124.0	670.5					
		67		RIB	Rigid Inflatable	RIB-3	10.0	50%	335.0	5%	42%	53%	16.8	140.7	177.6	0.08	3.0	0.0	0.4	0.0	1.3	50.3	0.2	6.0	0.7	11.3	422.1	1.4	50.7	5.6	14.2	532.7	1.8	63.9	7.1					
						RIB-4		50%	335.0	5%	42%	53%	16.8	140.7	177.6	0.34	9.1	0.1	1.4	0.2	5.7	153.1	1.0	24.1	2.5	47.8	1286.0	8.4	202.6	21.1	60.4	1622.8	10.7	255.7	26.6					

Table C-1. Surface Ship Air Emissions—No Action Alternative

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs)	Percent at Each Power Level	Total Time on Range (hrs)	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10
							Hours	%	Hours	Percent			Hours			CO	NOx	HC	SOx	PM10
39	NSWG-1 Platoon Ops	2		PC	Coastal Patrol-Independent Low Speed (	PC-3	4.0	100%	8.0	20%	30%	50%	1.6	2.4	4.0	59.93	187.6	9.3	47.1	4.8
		25		CRRC		CRRC-5	0.5	100%	12.5	100%	0%	0%	12.5	0.0	0.0	0	0.1	12.9	0.0	0.0
		42		SOW	MK V	MK-3	0.5	100%	21.0	100%	0%	0%	21.0	0.0	0.0	13.22	71.5	1.1	15.7	1.2
40	Direct Action	2		PC	Coastal Patrol-Independent Low Speed (	PC-2	8.0	80%	12.8	30%	20%	50%	3.8	2.6	6.4	17.21	38.1	2.9	8.2	0.9
					Dynamic Maneuvering	PC-3		20%	3.2	30%	20%	50%	1.0	0.6	1.6	59.93	187.6	9.3	47.1	4.8
		3		SOW	MK V	MK-1	4.0	80%	9.6	30%	25%	45%	2.9	2.4	4.3	1.94	14.8	0.5	2.4	0.2
						MK-3		20%	2.4	30%	25%	45%	0.7	0.6	1.1	13.22	71.5	1.1	15.7	1.2
		1		LCAC	Landing Craft Air Cushion	LCAC	1.0	100%	1.0	100%	0%	0%	1.0	0.0	0.0	25.41	55.3	0.7	43.3	3.9
		10		CRRC	Combat Rubber Raiding Craft	CRRC-3	1.0	100%	10.0	100%	0%	0%	10.0	0.0	0.0	0	0.1	6.3	0.0	0.0
		10		SDV	Combat Rubber Raiding Craft	CRRC-3	1.0	100%	10.0	100%	0%	0%	10.0	0.0	0.0	0	0.1	6.3	0.0	0.0
41	Bombing Exercise - Land	0																		
42	CSAR	0																		
43	EOD Outside SHOBA	0																		
44	USCG Ops	149		Response	Coastal Patrol-Independent Low Speed (	PC-1	3.2	2%	9.5	80%	20%	0%	7.6	1.9	0.0	6.5	12.5	1.1	2.5	0.4
						PC-2		2%	9.5	80%	20%	0%	7.6	1.9	0.0	17.21	38.1	2.9	8.2	0.9
				Utility	Dynamic Maneuvering	PC-3		96%	457.7	80%	20%	0%	366.2	91.5	0.0	59.93	187.6	9.3	47.1	4.8
		149		Utility	Coastal Patrol-Independent Low Speed (	PC-1	3.2	15%	71.5	80%	20%	0%	57.2	14.3	0.0	6.5	12.5	1.1	2.5	0.4
						PC-2		60%	286.1	80%	20%	0%	228.9	57.2	0.0	17.21	38.1	2.9	8.2	0.9
					Dynamic Maneuvering	PC-3		25%	119.2	80%	20%	0%	95.4	23.8	0.0	59.93	187.6	9.3	47.1	4.8
		100		Cutter	US Coast Guard	USCG	3.2	100%	320.0	20%	20%	60%	64.0	64.0	192.0	5.74	57.9	0.9	11.6	0.2
		49		Cutter	US Coast Guard	USCG	3.2	100%	156.8	5%	5%	90%	7.8	7.8	141.1	5.74	57.9	0.9	11.6	0.2
45	NALF Airfield	0																		
46	Ship Torpedo Test	2		DDG	Guided Missile Destroyer	DDG-3	6.5	100%	13.0	0%	23%	77%	0.0	3.0	10.0	106.67	53.8	7.8	21.2	2.8
		2		DDH	Japanese Destroye Helo Deck (FMS)	CG-3	6.5	100%	13.0	0%	23%	77%	0.0	3.0	10.0	114.75	65.2	7.7	33.6	3.4
		2		DD	Japanese Destroyer (FMS)	CG-3	6.5	100%	13.0	0%	23%	77%	0.0	3.0	10.0	114.75	65.2	7.7	33.6	3.4
		7		FFH	Helicopter Frigate (Canadian)	FFG-3	6.5	100%	45.5	0%	23%	77%	0.0	10.6	34.9	120.04	78.1	11.6	16.1	4.3
47	UUV	10		BW	Boston Whalers	BW-1	10.0	100%	100.0	100%	0%	0%	100.0	0.0	0.0	0	0.1	7.5	0.0	0.0
		10		HS	Harbor Security	RIB-2	10.0	100%	100.0	100%	0%	0%	100.0	0.0	0.0	0.04	1.6	0.0	0.2	0.0
		20			Phanton DS4 (no emissions)					100%	0%	0%								
48	Sonobuoy QA/QC	60		AE	Acoustic Explorer	AE-2	4.0	100%	240.0	50%	30%	20%	120.0	72.0	48.0	20.17	20.9	1.0	6.0	1.6
49	Ocean Engineering	65		BW	Boston Whaler	BW-2	3.0	100%	195.0	100%	0%	0%	195.0	0.0	0.0	0	0.1	9.0	0.0	0.0
50	MM Mine Location	1		AE	Acoustic Explorer	AE-1	12.0	100%	12.0	100%	0%	0%	12.0	0.0	0.0	7.31	8.5	0.4	2.1	0.6
		5		BW	Boston Whaler	BW-2	12.0	100%	60.0	100%	0%	0%	60.0	0.0	0.0	0	0.1	9.0	0.0	0.0
51	Missile Flight Test	3		CG		CG-2	4.0	100%	12.0	0%	0%	100%	0.0	0.0	12.0	107.78	47.1	8.8	21.0	2.6
		6		DDG	Guided Missile Destroyer	DDG-2	4.0	100%	24.0	0%	0%	100%	0.0	0.0	24.0	103.99	48.9	8.0	17.9	2.5
52	NUWC UW Acoustic	44		FFG	Guided Missile Frigate	FFG-2	4.0	100%	176.0	0%	0%	100%	0.0	0.0	176.0	66.82	67.7	7.8	11.6	3.3
		12		AE	Acoustic Explorer	AE-1	4.0	100%	48.0	0%	0%	100%	0.0	0.0	48.0	7.31	8.5	0.4	2.1	0.6
		44		BW	Boston Whaler	BW-2	4.0	100%	176.0	0%	0%	100%	0.0	0.0	176.0	0	0.1	9.0	0.0	0.0
53	Other Tests (MCM, ASUW, FIREX)	6		CG	Cruiser	CG-2	4.0	100%	24.0	0%	0%	100%	0.0	0.0	24.0	107.78	47.1	8.8	21.0	2.6
		18		DDG	Guided Missile Destroyer	DDG-2	4.0	100%	72.0	0%	0%	100%	0.0	0.0	72.0	103.99	48.9	8.0	17.9	2.5
		19		FFH	Helicopter Frigate (Canadian)	FFG-2	4.0	100%	76.0	0%	0%	100%	0.0	0.0	76.0	66.82	67.7	7.8	11.6	3.3
		1		DD	Japanese Destroyer (FMS)	CG-2	4.0	100%	4.0	0%	0%	100%	0.0	0.0	4.0	107.78	47.1	8.8	21.02	2.6
		4		AOR	Canadian	AOE-1	4.0	100%	16.0	0%	0%	100%	0.0	0.0	16.0	3.73	22.0	2.8	66.1	13.3
	Total	####																		

Emissions

Scenario / Nomenclature / Vessel Mode	Emissions 0-3 nm Offshore (lbs) CO	Nox	HC	Sox	PM	Emissions 3-12 nm Offshore - US Territory (lbs) CO	Nox	HC	Sox	PM	Emissions >12 nm Offshore - Outside US Territory CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM
39 PC PC-3	95.9	300.2	14.9	75.4	7.6	143.8	450.3	22.4	113.1	11.4	239.7	750.4	37.3	188.5	19.1					
39 CRRC CRRC-5	0.0	1.9	161.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
39 SOW MK-3	277.6	1501.1	22.1	328.7	24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
40 PC PC-2	66.1	146.5	11.3	31.6	3.5	44.1	97.6	7.5	21.1	2.4	110.1	244.1	18.8	52.7	5.9					
40 PC-3	57.5	180.1	8.9	45.2	4.6	38.4	120.1	6.0	30.2	3.1	95.9	300.2	14.9	75.4	7.6					
40 SOW MK-1	5.6	42.7	1.4	6.9	0.6	4.7	35.6	1.2	5.7	0.5	8.4	64.1	2.2	10.3	0.9					
40 MK-3	9.5	51.5	0.8	11.3	0.8	7.9	42.9	0.6	9.4	0.7	14.3	77.2	1.1	16.9	1.2					
40 LCAC LCAC	25.4	55.3	0.7	43.3	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
40 CRRC CRRC-3	0.0	0.7	63.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
40 SDV CRRC-3	0.0	0.7	63.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
44 Response PC-1	49.6	95.1	8.0	19.1	2.7	12.4	23.8	2.0	4.8	0.7	0.0	0.0	0.0	0.0	0.0					
44 PC-2	131.3	291.0	22.4	62.8	7.0	32.8	72.7	5.6	15.7	1.8	0.0	0.0	0.0	0.0	0.0					
44 Utility PC-3	21945.3	68699.5	3412.8	17254.5	1746.7	5486.3	17174.9	853.2	4313.6	436.7	0.0	0.0	0.0	0.0	0.0					
44 Utility PC-1	371.9	712.9	60.1	143.6	20.0	93.0	178.2	15.0	35.9	5.0	0.0	0.0	0.0	0.0	0.0					
44 PC-2	3938.7	8728.9	672.9	1883.6	210.6	984.7	2182.2	168.2	470.9	52.6	0.0	0.0	0.0	0.0	0.0					
44 PC-3	5714.9	17890.5	888.8	4493.4	454.9	1428.7	4472.6	222.2	1123.3	113.7	0.0	0.0	0.0	0.0	0.0					
44 Cutter USCG (100)	367.4	3706.2	56.3	739.2	13.4	367.4	3706.2	56.3	739.2	13.4	1102.1	11118.7	169.0	2217.6	40.3					
44 Cutter USCG (49)	45.0	454.0	6.9	90.6	1.6	45.0	454.0	6.9	90.6	1.6	810.0	8172.3	124.2	1629.9	29.6					
46 DDG DDG-3	0.0	0.0	0.0	0.0	0.0	321.7	162.4	23.6	64.0	8.4	1065.0	537.5	78.3	211.9	28.0					
46 DDH CG-3	0.0	0.0	0.0	0.0	0.0	346.1	196.7	23.1	101.2	10.4	1145.7	651.2	76.6	335.0	34.3					
46 DD CG-3	0.0	0.0	0.0	0.0	0.0	346.1	196.7	23.1	101.2	10.4	1145.7	651.2	76.6	335.0	34.3					
46 FFH FFG-3	0.0	0.0	0.0	0.0	0.0	1267.1	824.5	122.9	169.7	45.4	4194.7	2729.5	406.7	561.9	150.3					
47 BW BW-1	0.0	7.6	751.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
47 HS RIB-2	4.0	159.0	1.0	17.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
48 AE AE-2	2420.4	2511.6	118.8	716.4	188.4	1452.2	1507.0	71.3	429.8	113.0	968.2	1004.6	47.5	286.6	75.4					
49 BW BW-2	0.0	17.7	1758.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
50 AE AE-1	87.7	101.5	4.6	25.4	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
50 BW BW-2	0.0	5.4	541.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
51 CG CG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1293.4	565.4	105.8	252.2	31.6					
51 DDG DDG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2495.8	1173.6	192.7	430.6	59.0					
52 FFG FFG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11760.3	11918.7	1374.6	2036.3	572.0					
52 AE AE-1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	350.9	406.1	18.2	101.8	26.4					
52 BW BW-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0	1587.1	0.0	0.0					
53 CG CG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2586.7	1130.9	211.7	504.5	63.1					
53 DDG DDG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7487.3	3520.8	578.2	1291.7	177.1					
53 FFH FFG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5078.3	5146.7	593.6	879.3	247.0					
53 DD CG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	431.1	188.5	35.3	84.1	10.5					
53 AOR AOE-1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	59.7	351.8	44.6	1058.2	212.5					
Total Emissions (SCI) tons	**8.69**	**12.84**	**3.22**	**7.22**	**1.16**	**56.32**	**32.58**	**4.70**	**15.29**	**2.39**	**583.20**	**437.81**	**50.56**	**281.98**	**43.31**	**43.84**	**28.03**	**3.95**	**11.12**	**1.77**
Total Emissions (SD) tons	**104.07**	**234.73**	**12.64**	**90.96**	**16.79**	**100.50**	**276.82**	**8.58**	**133.08**	**12.92**										
Total Emissions within US Territory (SCI)	**65.01**	**45.42**	**7.92**	**22.52**	**3.55**															
Total Emissions within US Territory (SD)	**204.57**	**511.55**	**21.22**	**224.04**	**29.72**															

56768.0

Date: 13-May-2007

Notes: 1 - Ship nomenclature highlighted in yellow signifies no specific AQ Emissions data for that vessel.
For vessels without AQ emissions data, the following data was used:

Support (for USW)	TRB	AGF	LPD
Support (for Surf Firing)	PC	WHEC	USCG
MCM	USCG	Unknown (for Elec Combat)	PC
MHC	USCG	SOW	MKV
LSD	LPD	EFV	AAV
Unknown (for VBSS)	PC	DDH	CG
DD	CG	HS	RIB
FFH	FFG	AOR	AOE

Table C-2. Surface Ship Air Emissions—Alternative 1

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs)	Percent at Each Power Level	Total Time on Range (hrs)	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Emissions Factors (lb/hr)					Emissions: Emissions 0-3 nm Offshore (lbs)					Emissions 3-12 nm Offshore - US Territory (lbs)					Emissions >12 nm Offshore - Outside US Territory									
							Hours	%	Hours	Percent			Hours			CO	NOx	HC	SOx	PM10	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM
Training Exercises																															Offshore San Diego					Offshore Mexico				
1	Air Combat Maneuvers	0																																						
2	Air Defense Exercise	111		CG	Cruiser	CG-2	1.0	100%	111.0	0%	0%	100%	0.0	0.0	111.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11963.6	5230.3	979.0	2333.2	291.9					
		221		DDG	Guided Missile Destroyer	DDG-2	1.0	100%	221.0	0%	0%	100%	0.0	0.0	221.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22981.8	10806.9	1774.6	3964.7	543.7					
		23		CVN	Nuclear Carrier (No emissions)					0%	0%	100%																												
		4		FFG	Guided Missile Frigate	FFG-2	3.7	100%	14.8	0%	0%	100%	0.0	0.0	14.8	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	988.9	1002.3	115.6	171.2	48.1					
3	S-A Missiles	4		CVN	Nuclear Carrier (No emissions)					0%	0%	100%																												
		4		TRB	Torpedo Retrieval Boats	TRB-3	4.0	100%	16.0	1%	2%	97%	0.2	0.3	15.5	6.47	56.2	1.6	7.4	1.2	1.0	9.0	0.2	1.2	0.2	2.1	18.0	0.5	2.4	0.4	100.4	872.5	24.1	114.8	18.3					
4	S-A Gunnery Exercise	23		CVN						0%	0%	100%																												
		44		CG	Cruiser	CG-2	1.5	100%	66.0	0%	0%	100%	0.0	0.0	66.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						7113.5	3109.9	582.1	1387.3	173.6
		91		DDG	Guided Missile Destroyer	DDG-2	1.5	100%	136.5	0%	0%	100%	0.0	0.0	136.5	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						14194.6	6674.9	1096.1	2448.8	335.8
		55		FFG	Guided Missile Frigate	FFG-2	1.5	100%	82.5	0%	0%	100%	0.0	0.0	82.5	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						5512.7	5586.9	644.3	954.5	268.1
		13		LHA	Amphib. Assault Ship - Tarawa	LHA-1	1.5	100%	19.5	0%	0%	100%	0.0	0.0	19.5	7.38	43.5	5.5	131.0	26.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						143.9	848.8	107.8	2553.9	512.7
		15		LDH	Large Helicopter-dock Ships	LHD-1	1.5	100%	22.5	0%	0%	100%	0.0	0.0	22.5	5.89	34.8	4.4	104.6	21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						132.5	782.3	99.5	2353.5	472.3
		21		LPD	Amphibious Transport Dock - Wasp	LPD-1	1.5	100%	31.5	0%	0%	100%	0.0	0.0	31.5	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						58.1	343.0	43.6	1031.8	207.1
		24		LSD	Landing Ship Dock	LPD-1	1.5	100%	36.0	0%	0%	100%	0.0	0.0	36.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						66.4	392.0	49.8	1179.2	236.7
		37		USCGS	US Coast Guard	USCG	1.5	100%	55.5	0%	0%	100%	0.0	0.0	55.5	5.74	57.9	0.9	11.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						318.6	3214.0	48.8	641.0	11.7
		27		Other Ship	Coastal Patrol-Independent Low Speed (	PC-1	1.5	100%	40.5	0%	0%	100%	0.0	0.0	40.5	6.5	12.5	1.1	2.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						263.3	504.6	42.5	101.7	14.2
5	A-A Missiles	1		TRB	Torpedo Retrieval Boats	TRB-3	4.0	100%	4.0	1%	2%	97%	0.0	0.1	3.9	6.47	56.2	1.6	7.4	1.2	0.3	2.2	0.1	0.3	0.0	0.5	4.5	0.1	0.6	0.1						25.1	218.1	6.0	28.7	4.6
6	Helicopter ASW TRACKEX	28		CG	Cruiser	CG-3	3.6	100%	100.8	1%	10%	89%	1.0	10.1	89.7	114.75	65.2	7.7	33.6	3.4	115.7	65.7	7.7	33.8	3.5	1156.7	657.4	77.3	338.2	34.7	10294.5	5851.0	688.1	3009.8	308.6					
		71		DDG	Guided Missile Destroyer	DDG-3	3.6	100%	255.6	1%	10%	89%	2.6	25.6	227.5	106.67	53.8	7.8	21.2	2.8	272.6	137.6	20.0	54.2	7.2	2726.5	1376.2	200.4	542.4	71.6	24265.7	12247.7	1783.5	4827.2	637.0					
		43		TRB	Torpedo Retrieval Boats	TRB-3	3.6	100%	154.8	1%	10%	89%	1.5	15.5	137.8	6.47	56.2	1.6	7.4	1.2	10.0	87.0	2.4	11.5	1.8	100.2	870.3	24.0	114.6	18.3	891.4	7745.5	213.5	1019.5	162.6					
7	Helicopter ASW TORPEX	28		CG	Cruiser	CG-3	3.6	100%	100.8	1%	10%	89%	1.0	10.1	89.7	114.75	65.2	7.7	33.6	3.4	115.7	65.7	7.7	33.8	3.5	1156.7	657.4	77.3	338.2	34.7	10294.5	5851.0	688.1	3009.8	308.6					
		75		DDG	Guided Missile Destroyer	DDG-3	3.6	100%	270.0	1%	10%	89%	2.7	27.0	240.3	106.67	53.8	7.8	21.2	2.8	288.0	145.4	21.2	57.3	7.6	2880.1	1453.7	211.7	572.9	75.6	25632.8	12937.8	1884.0	5099.2	672.8					
		72		TRB	Torpedo Retrieval Boats	TRB-3	3.6	100%	259.2	1%	10%	89%	2.6	25.9	230.7	6.47	56.2	1.6	7.4	1.2	16.8	145.7	4.0	19.2	3.1	167.7	1457.2	40.2	191.8	30.6	1492.6	12969.3	357.6	1707.1	272.2					
8	MPA ASW TRACKEX																																							
9	MPA ASW TORPEX	2		CG	Cruiser	CG-3	2.0	100%	4.0	5%	10%	85%	0.2	0.4	3.4	114.75	65.2	7.7	33.6	3.4	23.0	13.0	1.5	6.7	0.7	45.9	26.1	3.1	13.4	1.4	390.2	221.7	26.1	114.1	11.7					
		4		DDG	Guided Missile Destroyer	DDG-3	2.0	100%	8.0	5%	10%	85%	0.4	0.8	6.8	106.67	53.8	7.8	21.2	2.8	42.7	21.5	3.1	8.5	1.1	85.3	43.1	6.3	17.0	2.2	725.4	366.1	53.3	144.3	19.0					
		3		FFG	Guided Missile Frigate	FFG-3	2.0	100%	6.0	5%	10%	85%	0.3	0.6	5.1	120.04	78.1	11.6	16.1	4.3	36.0	23.4	3.5	4.8	1.3	72.0	46.9	7.0	9.6	2.6	612.2	398.4	59.4	82.0	21.9					
		14		TRB	Torpedo Retrieval Boats	TRB-3	2.0	100%	28.0	5%	10%	85%	1.4	2.8	23.8	6.47	56.2	1.6	7.4	1.2	9.1	78.7	2.2	10.4	1.7	18.1	157.4	4.3	20.7	3.3	154.0	1338.0	36.9	176.1	28.1					
																																			0.0					
10	EER/IEER ASW																																							
11	Surface Ship ASW TRACKEX	225		CG	Cruiser	CG-3	2.0	100%	450.0	1%	10%	89%	4.5	45.0	400.5	114.75	65.2	7.7	33.6	3.4	516.4	293.5	34.5	151.0	15.5	5163.8	2934.9	345.2	1509.8	154.8	45957.4	26120.6	3071.8	13436.8	1377.7					
		450		DDG	Guided Missile Destroyer	DDG-3	2.0	100%	900.0	1%	10%	89%	9.0	90.0	801.0	106.67	53.8	7.8	21.2	2.8	960.0	484.6	70.6	191.0	25.2	9600.3	4845.6	705.6	1909.8	252.0	85442.7	43125.8	6279.8	16997.2	2242.8					
		225		FFG	Guided Missile Frigate	FFG-3	2.0	100%	450.0	1%	10%	89%	4.5	45.0	400.5	120.04	78.1	11.6	16.1	4.3	540.2	351.5	52.4	72.4	19.4	5401.8	3515.0	523.8	723.6	193.5	48076.0	31283.1	4661.8	6440.0	1722.2					
		0		Support	Torpedo Retrieval Boats	TRB-3	2.0	100%	0.0	1%	10%	89%	0.0	0.0	0.0	6.47	56.2	1.6	7.4	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
12	Surface Ship ASW TORPEX	8		CG	Cruiser	CG-3	3.7	100%	29.6	1%	10%	89%	0.3	3.0	26.3	114.75	65.2	7.7	33.6	3.4	34.0	19.3	2.3	9.9	1.0	339.7	193.1	22.7	99.3	10.2	3023.0	1718.2	202.1	883.8	90.6					
		12		DDG	Guided Missile Destroyer	DDG-3	3.7	100%	44.4	1%	10%	89%	0.4	4.4	39.5	106.67	53.8	7.8	21.2	2.8	47.4	23.9	3.5	9.4	1.2	473.6	239.0	34.8	94.2	12.4	4215.2	2127.5	309.8	838.5	110.6					
		6		FFG	Guided Missile Frigate	FFG-3	3.7	100%	22.2	1%	10%	89%	0.2	2.2	19.8	120.04	78.1	11.6	16.1	4.3	26.6	17.3	2.6	3.6	1.0	266.5	173.4	25.8	35.7	9.5	2371.8	1543.3	230.0	317.7	85.0					
		12		TRB	Torpedo Retrieval Boats	TRB-3	3.7	100%	44.4	1%	10%	89%	0.4	4.4	39.5	6.47	56.2	1.6	7.4	1.2	2.9	25.0	0.7	3.3	0.5	28.7	249.6	6.9	32.9	5.2	255.7	2221.6	61.2	292.4	46.6					
13	Sub ASW Trackex	53		SSN	Submarines (No emissions)																																			
		16		TRB	Torpedo Retrieval Boats	TRB-3	12.8	100%	204.8	1%	2%	97%	2.0	4.1	198.7	6.47	56.2	1.6	7.4	1.2	13.3	115.1	3.2	15.2	2.4	26.5	230.3	6.3	30.3	4.8	1285.3	11168.4	307.9	1470.1	234.4					
14	Sub ASW TORPEX	22		SSN	Submarines (No emissions)																																			
		22		TRB	Torpedo Retrieval Boats	TRB-3	11.7	100%	257.4	1%	2%	97%	2.6	5.1	249.7	6.47	56.2	1.6	7.4	1.2	16.7	144.7	4.0	19.0	3.0	33.3	289.4	8.0	38.1	6.1	1615.4	14036.9	387.0	1847.6	294.6					
15	VBSS	18		CG	Cruiser	CG-2	4.0	100%	72.0	0%	0%	100%	0.0	0.0	72.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7760.2	3392.6	635.0	1513.4	189.4					
		36		DDG	Guided Missile Destroyer	DDG-2	4.0	100%	144.0	0%	0%	100%	0.0	0.0	144.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14974.6	7041.6	1156.3	2583.4	354.2					
		7		FFG	Guided Missile Frigate	FFG-2	4.0	100%	28.0	0%	0%	100%	0.0	0.0	28.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1871.0	1896.2	218.7	324.0	91.0					
		3		LPD	Amphibious Transport Dock - Wasp	LPD-1	4.0	100%	12.0	0%	0%	100%	0.0	0.0	12.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.1	130.7	16.6	393.1	78.9					
		7		LSD		LPD-1	4.0	100%	28.0	0%	0%	100%	0.0	0.0	28.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.7	304.9	38.8	917.2	184.1					
																																			0.0					
16	ASUW MISSILEX	32		TRB	Torpedo Retrieval Boats	TRB-2	7.0	100%	224.0	5%	28%	67%	11.2	62.7	150.1	7.64	33.1	0.6	3.4	1.2	85.6	370.6	6.6	38.0	13.0	479.2	2075.4	37.0	212.6	72.8	1146.6	4966.1	88.5	508.8	174.1					
		2		CG	Cruiser	CG-2	4.0	100%	8.0	0%	0%	100%	0.0	0.0	8.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	862.2	377.0	70.6	168.2	21.0					
		2		DDG	Guided Missile Destroyer	DDG-2	4.0	100%	8.0	0%	0%	100%	0.0	0.0	8.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	831.9	391.2	64.2	143.5	19.7					
17	A-S BOMBEX	0																																						
18	A-S GUNEX	0																																						
19	S-S GUNEX	1		CVN	Nuclear Carrier (No emissions)																																			
		71		CG	Cruiser	CG-1	2.5	100%	177.5	0%	28%	72%	0.0	49.7	127.8	102.58	40.6	9.2	17.7	2.1	0.0	0.0	0.0	0.0	0.0	5098.2	2018.3	458.2	880.2	105.4						13109.7	5190.0	1178.3	2263.3	270.9
		147		DDG	Guided Missile Destroyer	DDG-1	2.5	100%	367.5	0%	28%	72%	0.0	102.9	264.6	102.98	47.3	8.1	17.0	2.4	0.0	0.0	0.0	0.0	0.0	10596.6	4871.3	833.5	1753.4	241.8						27248.5	12526.2	2143.3	4508.8	621.8
		49		FFG	Guided Missile Frigate	FFG-1	2.5	100%	122.5	0%	28%	72%	0.0	34.3	88.2	65.75	66.4	7.9	10.9	3.1	0.0	0.0	0.0	0.0	0.0	2255.2	2275.8	270.6	373.5	107.7						5799.2	5852.1	695.9	960.5	276.9
		2		LPD	Amphibious Transport Dock - Wasp	LPD-1	2.5	100%	5.0	0%	28%	72%	0.0	1.4	3.6	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	2.6	15.2	1.9	45.9	9.2						6.6	39.2	5.0	117.9	23.7
		1		LSD	Landing Ship Dock	LPD-1	2.5	100%	2.5	0%	28%	72%	0.0	0.7	1.8	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	1.3	7.6	1.0	22.9	4.6						3.3	19.6	2.5	59.0	11.8
		1		LHD	Large Helicopter-dock Ships	LHD-2	2.5	100%	2.5	0%	28%	72%	0.0	0.7	1.8	6.8	40.1	5.1	120.7	24.2	0.0	0.0	0.0	0.0	0.0	4.8	28.1	3.6	84.5	17.0						12.2	72.2	9.2	217.3	43.6
		18		Unknown	Other	PC-2	2.5	100%	45.0	0%	28%	72%	0.0	12.6	32.4	17.21	38.1	2.9	8.2	0.9	0.0	0.0	0.0	0.0	0.0	216.8	480.6	37.0	103.7	11.6						557.6	1235.7	95.3	266.7	29.8
		40		USCG	US Coast Guard	USCG	2.5	100%	100.0	0%	28%	72%	0.0	28.0	72.0	5.74	57.9	0.9	11.6	0.2	0.0	0.0	0.0	0.0	0.0	160.7	1621.5	24.6	323.4	5.9						413.3	4169.5	63.4	831.6	15.1
20	SINKEX	4		CG	Cruiser	CG-2	16.0	100%	64.0	0%	0%	100%	0.0	0.0	64.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						6897.9	3015.7	564.5	1345.3	168.3
		8		DDG	Guided Missile Destroyer	DDG-2	16.0	100%	128.0	0%	0%	100%	0.0	0.0	128.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						13310.7	6259.2	1027.8	2296.3	314.9
		0		DD	Destroyer	DDG-2	16.0	100%	0.0	0%	0%	100%	0.0	0.0	0.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0	0.0	0.0	0.0	0.0
		4		FFG	Guided Missile Frigate	FFG-2	16.0	100%	64.0	0%	0%	100%	0.0	0.0	64.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						4276.5	4334.1	499.8	740.5	208.0
		2		SSN	Submarines (No emissions)																																			
21	NSFS	16		CG	Cruiser	CG-2	9.0	100%	144.0	0%	30%	70%	0.0	43.2	100.8	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	4656.1	2035.6	381.0	908.1	113.6	10864.2	4749.7	889.1	2118.8	265.1					
		34		DDG	Guided Missile Destroyer	DDG-2	9.0	100%	306.0	0%	30%	70%	0.0	91.8	214.2	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	9546.3	4489.0	737.2	1646.9	225.8	22274.7	10474.4	1720.0	3842.7	526.9					
		4		FFG	Guided Missile Frigate	FFG-2	9.0	100%	36.0	0%	30%	70%	0.0	10.8	25.2	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	721.7	731.4	84.3	125.0	35.1	1683.9	1706.5	196.8	291.6	81.9					
22	EFEX	2		CG	Cruiser	CG-2	72.0	100%	144.0	0%	100%	0%	0.0	144.0	0.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	15520.3	6785.3	1270.1	3026.9	378.7	0.0	0.0	0.0	0.0	0.0					
		2		DDG	Guided Missile Destroyer	DDG-2	72.0	100%	144.0	0%	100%	0%	0.0	144.0	0.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	14974.6	7041.6	1156.3	2583.4	354.2	0.0	0.0	0.0	0.0	0.0					
23	Battalion Landing	1		LHA	Amphib. Assault Ship - Tarawa	LHA-1	6.0	100%	6.0	10%	30%	60%	0.6	1.8	3.6	7.38	131.0	26.3	7.4	43.5	4.4	78.6	15.8	4.4	26.1	13.3	235.7	47.3	13.3	78.4	26.6	471.5	94.6	26.6	156.7					
		1		LHD	Large Helicopter-dock Ships	LHD-2	2.5	100%	2.5	10%	30%	60%	0.3	0.8	1.5	6.8	40.1	5.1	120.7	24.2	1.7	10.0	1.3	30.2	6.1	5.1	30.1	3.8	90.5	18.2	10.2	60.2	7.7	181.1	36.3					
		1		LPD	Amphibious Transport Dock - Wasp	LPD-1	2.5	100%	2.5	10%	30%	60%	0.3	0.8	1.5	1.845393	10.9	1.4	32.8	6.6	0.5	2.7	0.3	8.2	1.6	1.4	8.2	1.0	24.6	4.9	2.8	16.3	2.1	49.1	9.9					
		6		LCU	Landing Craft Utility	LCU	3.0	100%	18.0	10%	30%	60%	1.8	5.4	10.8	36.21	3.1	1.6	36.2	45.0	65.2	5.6	2.8	65.2	80.9	195.5	16.8	8.5	195.5	242.7	391.1	33.6	17.0	391.1	485.5					
		14		AAV/EFV	Amphibious Assault Vehicle	EFV-2	6.0	100%	84.0	10%	30%	60%	8.4	25.2	50.4	2.0611	4.17	0.72	0.06	0.3211	17.3	35.0	6.1	0.5	2.7	51.9	105.0	18.2	1.6	8.1	103.9	210.0	36.3	3.2	16.2					
		5		LCAC	Landing Craft Air Cushioned	LCAC	3.0	100%	15.0	10%	30%	60%	1.5	4.5	9.0	25.41	43.3	3.9	25.4	55.3	38.1	65.0	5.8	38.1	83.0	114.3	194.9	17.5	114.3	248.9	228.7	389.7	35.0	228.7	497.9					
		0		CRRC	Combat Raiding Rubber Craft	CRRC-4	6.0	100%	0.0	10%	30%	60%	0.0	0.0	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
24	USMC Stinger	0																																						
25	Amphibious Landings & Raids																																							
25A	Recon Mission	8		LPD	Amphibious Transport Dock - Wasp	LPD-1	4.0	100%	32.0	0%	0%	100%	0.0	0.0	32.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	59.1	348.4	44.3	1048.2	210.4					
25B	Helicopter Assault	4		LHD	Large Helicopter-dock Ships	LHD-2	6.0	100%	24.0	0%	0%	100%	0.0	0.0	24.0	6.8	40.1	5.1	120.7	24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	163.2	962.9	122.4	2896.8	581.5					
		4		LHA	Amphib. Assault Ship - Tarawa	LHA-1	6.0	100%	24.0	0%	0%	100%	0.0	0.0	24.0	7.38	131.0	26.3	7.4	43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	177.1	3143.3	631.0	177.1	1044.7					
25C	Armored Operations	3		LHD	Large Helicopter-dock Ships	LHD-2	12.0	100%	36.0	33%	33%	33%	12.0	12.0	12.0	6.8	40.1	5.1	120.7	24.2	81.5	481.0	61.1	1447.0	290.5	81.5	481.0	61.1	1447.0	290.5	81.5	481.0	61.1	1447.0	290.5					
		3		LHA	Amphib. Assault Ship - Tarawa	LHA-1	12.0	100%	36.0	33%	33%	33%	12.0	12.0	12.0	7.38	131.0	26.3	7.4	43.5	88.5	1570.1	315.2	88.5	521.8	88.5	1570.1	315.2	88.5	521.8	88.5	1570.1	315.2	88.5	521.8					
		6		LCAC	Landing Craft Air Cushioned	LCAC	12.0	100%	72.0	33%	33%	33%	24.0	24.0	24.0	25.41	43.3	3.9	25.4	55.3	609.2	1038.2	93.3	609.2	1326.4	609.2	1038.2	93.3	609.2	1326.4	609.2	1038.2	93.3	609.2	1326.4					
		6		LCU	Landing Craft Utility	LCU	12.0	100%	72.0	33%	33%	33%	24.0	24.0	24.0	36.21	3.1	1.6	36.2	45.0	868.2	74.6	37.6	868.2	1077.7	868.2	74.6	37.6	868.2	1077.7	868.2	74.6	37.6	868.2	1077.7					
25D	Artillery Operations	2		LHD	Large Helicopter-dock Ships	LHD-2	24.0	100%	48.0	100%	0%	0%	48.0	0.0	0.0	6.8	40.1	5.1	120.7	24.2	326.4	1925.8	244.8	5793.6	1163.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		1		LHA	Amphib. Assault Ship - Tarawa	LHA-1	24.0	100%	24.0	20%	40%	40%	4.8	9.6	9.6	7.38	43.5	5.5	131.0	26.3	35.4	208.9	26.5	628.7	126.2	70.8	417.9	53.1	1257.3	252.4	70.8	417.9	53.1	1257.3	252.4					
		4		LCAC	Landing Craft Air Cushion	LCAC	24.0	100%	96.0	100%	0%	0%	96.0	0.0	0.0	25.41	55.3	0.7	43.3	3.9	2439.4	5310.7	69.1	4156.8	373.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		4		LCU	Landing Craft Utility	LCU	24.0	100%	96.0	100%	0%	0%	96.0	0.0	0.0	36.21	45.0	0.5	3.1	1.6	3476.2	4315.2	49.9	298.6	150.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					

Table C-2. Surface Ship Air Emissions—Alternative 1

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs)	Percent at Each Power Level	Total Time on Range (hrs)	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Emissions Factors (lb/hr)					Emissions: Emissions 0-3 nm Offshore (lbs)					Emissions 3-12 nm Offshore - US Territory (lbs)					Emissions >12 nm Offshore - Outside US Territory									
							Hours	%	Hours	Percent			Hours			CO	NOx	HC	SOx	PM10	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM
25E	Amphibious Assault	2		LHD	Large Helicopter-dock Ships	LHD-2	8.0	100%	16.0	38%	38%	25%	6.0	6.0	4.0	6.8	40.1	5.1	120.7	24.2	40.8	240.7	30.6	724.2	145.4	40.8	240.7	30.6	724.2	145.4	27.2	160.5	20.4	482.8	96.9					
		1		LHA	Amphib. Assault Ship - Tarawa	LHA-1	8.0	100%	8.0	38%	38%	25%	3.0	3.0	2.0	7.38	43.5	5.5	131.0	26.3	22.1	130.6	16.6	392.9	78.9	22.1	130.6	16.6	392.9	78.9	14.8	87.1	11.1	261.9	52.6					
		3		LPD	Amphibious Transport Dock - Wasp	LPD-1	8.0	100%	24.0	38%	38%	25%	9.0	9.0	6.0	1.845393	10.9	1.4	32.8	6.6	16.6	98.0	12.5	294.8	59.2	16.6	98.0	12.5	294.8	59.2	11.1	65.3	8.3	196.5	39.4					
		4		LCAC	Landing Craft Air Cushioned	LCAC	8.0	100%	32.0	38%	38%	25%	12.0	12.0	8.0	25.41	43.3	3.9	25.4	55.3	304.9	519.6	46.7	304.9	663.8	304.9	519.6	46.7	304.9	663.8	203.3	346.4	31.1	203.3	442.6					
		4		LCU	Landing Craft Utility	LCU	8.0	100%	32.0	38%	38%	25%	12.0	12.0	8.0	36.21	3.1	1.6	36.2	45.0	434.5	37.3	18.8	434.5	539.4	434.5	37.3	18.8	434.5	539.4	289.7	24.9	12.6	289.7	359.6					
25F	Combat Engineer Ops	1		LHA	Amphib. Assault Ship - Tarawa	LHA-1	6.0	100%	6.0	33%	33%	33%	2.0	2.0	2.0	7.38	131.0	26.3	7.4	43.5	14.7	261.7	52.5	14.7	87.0	14.7	261.7	52.5	14.7	87.0	14.7	261.7	52.5	14.7	87.0					
		2		LCU	Landing Craft Utility	LCU	6.0	100%	12.0	33%	33%	33%	4.0	4.0	4.0	36.21	3.1	1.6	36.2	45.0	144.7	12.4	6.3	144.7	179.6	144.7	12.4	6.3	144.7	179.6	144.7	12.4	6.3	144.7	179.6					
25G	Amphibious Assault Vehicle Ops	6		LHA	Amphib. Assault Ship - Tarawa	LHA-1	8.0	100%	48.0	25%	25%	50%	12.0	12.0	24.0	7.38	131.0	26.3	7.4	43.5	88.6	1571.6	315.5	88.6	522.4	88.6	1571.6	315.5	88.6	522.4	177.1	3143.3	631.0	177.1	1044.7					
		36		EFV	Expeditionary Fighting Vessel	EFV-1	8.0	100%	288.0	25%	25%	50%	72.0	72.0	144.0	2.0611	4.17	0.72	0.06	0.3211	148.4	300.0	51.9	4.6	23.1	148.4	300.0	51.9	4.6	23.1	296.8	600.0	103.8	9.1	46.2					
25H	EFV	2		LPD	Amphibious Transport Dock - Wasp	LPD-1	8.0	100%	16.0	25%	25%	50%	4.0	4.0	8.0	1.845393	10.9	1.4	32.8	6.6	7.4	43.6	5.5	131.0	26.3	7.4	43.6	5.5	131.0	26.3	14.8	87.1	11.1	262.0	52.6					
		1		LCAC	Landing Craft Air Cushioned	LCAC	8.0	100%	8.0	25%	25%	50%	2.0	2.0	4.0	25.41	43.3	3.9	25.4	55.3	50.8	86.6	7.8	50.8	110.6	50.8	86.6	7.8	50.8	110.6	101.6	173.2	15.6	101.6	221.3					
		46		EFV	Expeditionary Fighting Vessel	EFV-1	8.0	100%	368.0	25%	25%	50%	92.0	92.0	184.0	2.0611	4.17	0.72	0.06	0.3211	189.6	383.4	66.3	5.8	29.5	189.6	383.4	66.3	5.8	29.5	379.2	766.7	132.7	11.6	59.1					
25I	Assault Amphibian School	80		LCAC	Landing Craft Air Cushioned	LCAC	8.0	100%	640.0	0%	0%	100%	0.0	0.0	640.0	25.41	43.3	3.9	25.4	55.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16262.4	27712.0	2489.6	16262.4	35404.8					
		40		LCU	Landing Craft Utility	LCU	8.0	100%	320.0	0%	0%	100%	0.0	0.0	320.0	36.21	3.1	1.6	36.2	45.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11587.2	995.2	502.4	11587.2	14384.0					
		60		EFV	Amphibious Assault Vehicle	EFV-1	8.0	100%	480.0	0%	0%	100%	0.0	0.0	480.0	2.0611	4.17	0.72	0.06	0.3211	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	989.3	2000.2	346.1	30.3	154.1					
26	Ambphibious Operations CPAAA																																							
26A	Amphibious Operations	1688		AAV/EFV	Amphibious Assault Vehicle	EFV-1	16.8	20%	5671.7	28%	70%	2%	1588.1	3970.2	113.4	2.0611	4.17	0.72	0.06	0.3211	3273.2	6617.5	1145.2	100.4	509.9	8182.9	16543.7	2862.9	250.9	1274.8	233.8	472.7	81.8	7.2	36.4					
				AAV/EFV	Amphibious Assault Vehicle	EFV-2	16.8	80%	22686.7	28%	70%	2%	6352.3	15880.7	453.7	2.0611	4.17	0.72	0.06	0.3211	13092.7	26470.0	4580.6	401.5	2039.7	32731.7	66174.9	11451.6	1003.7	5099.3	935.2	1890.7	327.2	28.7	145.7					
		6		LCAC	Landing Craft Air Cushion	LCAC	16.8	100%	100.8	100%	0%	0%	100.8	0.0	0.0	25.41	55.3	0.7	43.3	3.9	2561.3	5576.3	72.6	4364.6	392.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
26B	Amphibious Ops	5		LHD	Large Helicopter-dock Ships	LHD-1	4.2	90%	18.9	0%	0%	100%	0.0	0.0	18.9	5.89	34.8	4.4	104.6	21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.6	658.7	83.7	1981.6	397.7					
				LHD	Large Helicopter-dock Ships	LHD-2	4.2	10%	2.1	0%	0%	100%	0.0	0.0	2.1	6.8	40.1	5.1	120.7	24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	84.5	10.7	254.1	51.0					
		5		LCAC	Landing Craft Air Cushion	LCAC	4.2	100%	21.1	0%	0%	100%	0.0	0.0	21.1	25.41	55.3	0.7	43.3	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	534.9	1164.5	15.2	911.5	81.9					
		69		CRRC	Combat Raiding Rubber Craft	CRRC-1	4.2	22%	63.9	28%	36%	36%	17.9	23.0	23.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.5					
				CRRC	Combat Raiding Rubber Craft	CRRC-4	4.2	27%	78.4	28%	36%	36%	22.0	28.2	28.2	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	3.7					
				CRRC	Combat Raiding Rubber Craft	CRRC-5	4.2	51%	148.1	28%	36%	36%	41.5	53.3	53.3	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	7.9					
		5		LCU	Landing Craft Utility	LCU	4.2	100%	21.1	32%	0%	68%	6.7	0.0	14.3	36.21	45.0	0.5	3.1	1.6	243.9	302.8	3.5	20.9	10.6	0.0	0.0	0.0	0.0	0.0	518.3	643.4	7.4	44.5	22.5					
26C	Amphibious Ops	143		AAV/EFV	Amphibious Assault Vehicle	EFV-1	2.4	33%	112.0	28%	70%	2%	31.4	78.4	2.2	2.0611	4.17	0.72	0.06	0.3211	64.6	130.7	22.6	2.0	10.1	161.6	326.7	56.5	5.0	25.2	4.6	9.3	1.6	0.1	0.7					
						EFV-2	2.4	67%	224.0	28%	70%	2%	62.7	156.8	4.5	2.0611	4.17	0.72	0.06	0.3211	129.3	261.4	45.2	4.0	20.1	323.2	653.5	113.1	9.9	50.4	9.2	18.7	3.2	0.3	1.4					
26D	Amphibious Ops	5		AAV	Amphibious Assault Vehicle	AAV-1	2.4	20%	2.4	100%	0%	0%	2.4	0.0	0.0	0.444918	1.0	0.2	0.1	0.2	1.0	2.4	0.4	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						AAV-2	2.4	80%	9.4	100%	0%	0%	9.4	0.0	0.0	0.633674	3.8	0.2	0.1	0.3	6.0	35.3	1.6	1.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		2258		EFV	Amphibious Assault Vehicle	EFV-1	2.4	33%	1768.6	28%	70%	2%	495.2	1238.0	35.4	2.0611	4.17	0.72	0.06	0.3211	1020.7	2063.5	357.1	31.3	159.0	2551.7	5158.8	892.7	78.2	397.5	72.9	147.4	25.5	2.2	11.4					
						EFV-2	2.4	67%	3537.7	28%	70%	2%	990.6	2476.4	70.8	2.0611	4.17	0.72	0.06	0.3211	2041.6	4127.7	714.3	62.6	318.1	5104.1	10319.1	1785.7	156.5	795.2	145.8	294.8	51.0	4.5	22.7					
		2268		RIB	Rigid Inflatable	RIB-1	2.4	7%	355.5	28%	70%	2%	99.5	248.8	7.1	0.04	1.6	0.0	0.2	0.0	4.0	158.3	1.0	16.9	2.0	10.0	395.7	2.5	42.3	5.0	0.3	11.3	0.1	1.2	0.1					
						RIB-3		13%	708.9	28%	70%	2%	198.5	496.2	14.2	0.08	3.0	0.0	0.4	0.0	15.9	595.4	2.0	71.5	7.9	39.7	1488.6	5.0	178.6	19.8	1.1	42.5	0.1	5.1	0.6					
						RIB-4		80%	4263.8	28%	70%	2%	1193.9	2984.7	85.3	0.34	9.1	0.1	1.4	0.2	405.9	10912.0	71.6	1719.2	179.1	1014.8	27280.0	179.1	4298.0	447.7	29.0	779.4	5.1	122.8	12.8					
		756		Support	Coastal Patrol-Independent Low Speed (	PC-1	2.4	20%	355.3	28%	70%	2%	99.5	248.7	7.1	6.5	12.5	1.1	2.5	0.4	646.7	1239.6	104.5	249.7	34.8	1616.7	3099.1	261.2	624.3	87.1	46.2	88.5	7.5	17.8	2.5					
					Dynamic Maneuvering	PC-3		80%	1421.3	28%	70%	2%	398.0	994.9	28.4	59.93	187.6	9.3	47.1	4.8	23849.6	74661.0	3709.0	18751.8	1898.3	59624.1	186652.4	9272.4	46879.5	4745.7	1703.5	5332.9	264.9	1339.4	135.6					
26E	Amphibious Ops	386		AAV	Amphibious Assault Vehicle	AAV-1	13.2	20%	1019.0	100%	0%	0%	1019.0	0.0	0.0	0.444918	1.0	0.2	0.1	0.2	453.4	1055.8	177.4	52.5	182.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						AAV-2	13.2	80%	4076.2	100%	0%	0%	4076.2	0.0	0.0	0.633674	3.8	0.2	0.1	0.3	2583.0	15319.8	698.9	429.2	1199.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		173		CRRC	Combat Raiding Rubber Craft	CRRC-1	13.2	28%	628.0	70%	30%	0%	439.6	188.4	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.7	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-4	13.2	18%	399.6	70%	30%	0%	279.7	119.9	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	36.9	0.0	0.0	0.0	0.0	15.8	0.0	0.0	0.0	0.0	0.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-5	13.2	55%	1256.0	70%	30%	0%	879.2	376.8	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	130.6	0.0	0.0	0.0	0.0	56.0	0.0	0.0	0.0	0.0	0.0					
26F	Amphibious Warfare	964		LCAC	Landing Craft Air Cushion	LCAC	8.5	100%	8194.0	16%	55%	29%	1311.0	4506.7	2376.3	25.41	55.3	0.7	43.3	3.9	33313.5	72526.7	943.9	56768.0	5099.9	114515.2	249310.6	3244.8	195140.1	17531.1	60380.8	131454.7	1710.9	102892.1	9243.7					
		221		LCU	Landing Craft Utility	LCU	8.5	100%	1878.5	75%	5%	20%	1408.9	93.9	375.7	36.21	45.0	0.5	3.1	1.6	51015.4	63328.9	732.6	4381.6	2211.9	3401.0	4221.9	48.8	292.1	147.5	13604.1	16887.7	195.4	1168.4	589.8					
		72		Support	Coastal Patrol-Independent Low Speed (	PC-2	8.5	100%	612.0	100%	0%	0%	612.0	0.0	0.0	17.21	38.1	2.9	8.2	0.9	10532.5	23341.7	1799.3	5036.8	563.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		72		LCM-8		LCU	8.5	100%	612.0	100%	0%	0%	612.0	0.0	0.0	36.21	45.0	0.5	3.1	1.6	22160.5	27509.4	318.2	1903.3	960.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		30		LARC		LCU	8.5	100%	255.0	100%	0%	0%	255.0	0.0	0.0	36.21	45.0	0.5	3.1	1.6	9233.6	11462.3	132.6	793.1	400.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		36		SLWT	SLWT (assume LPD)	LPD-2	8.5	20%	61.2	95%	5%	0%	58.1	3.1	0.0	2.935967	17.3	2.2	52.1	10.5	170.7	1007.1	128.0	3029.9	608.1	9.0	53.0	6.7	159.5	32.0	0.0	0.0	0.0	0.0	0.0					
						LPD-3	8.5	80%	244.8	95%	5%	0%	232.6	12.2	0.0	6.549492	38.6	4.9	116.3	23.3	1523.1	8986.6	1142.4	27035.9	5426.2	80.2	473.0	60.1	1422.9	285.6	0.0	0.0	0.0	0.0	0.0					
		36		SLWT	SLWT (assume LPD)	LPD-2	8.5	20%	61.2	95%	5%	0%	58.1	3.1	0.0	2.935967	17.3	2.2	52.1	10.5	170.7	1007.1	128.0	3029.9	608.1	9.0	53.0	6.7	159.5	32.0	0.0	0.0	0.0	0.0	0.0					
						LPD-3	8.5	80%	244.8	95%	5%	0%	232.6	12.2	0.0	6.549492	38.6	4.9	116.3	23.3	1523.1	8986.6	1142.4	27035.9	5426.2	80.2	473.0	60.1	1422.9	285.6	0.0	0.0	0.0	0.0	0.0					
		18		BW	Boston Whaler	BW-2	8.5	20%	30.6	95%	5%	0%	29.1	1.5	0.0	0	0.1	9.0	0.0	0.0	0.0	2.6	262.1	0.0	0.0	0.0	0.1	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						BW-3	8.5	80%	122.4	95%	5%	0%	116.3	6.1	0.0	0	0.3	26.3	0.0	0.0	0.0	30.7	3058.2	0.0	0.0	0.0	1.6	161.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
26G	Amphibious Ops	675		CRRC	Combat Raiding Rubber Craft	CRRC-1	6.2	28%	1141.6	80%	20%	0%	913.3	228.3	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.1	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-4	6.2	18%	726.5	80%	20%	0%	581.2	145.3	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	76.7	0.0	0.0	0.0	0.0	19.2	0.0	0.0	0.0	0.0	0.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-5	6.2	55%	2283.2	80%	20%	0%	1826.6	456.6	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	271.3	0.0	0.0	0.0	0.0	67.8	0.0	0.0	0.0	0.0	0.0					
27	Elec Combat	317		CVN	Nuclear Carrier (No emissions)																																			
		748		CG	Cruiser	CG-2	4.9	100%	3665.2	0%	3%	97%	0.0	110.0	3555.2	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	11851.1	5181.1	969.8	2311.3	289.2	383184.2	167523.1	31357.3	74731.2	9350.3					
		641		DDG	Guided Missile Destroyer	DDG-2	4.9	100%	3140.9	0%	3%	97%	0.0	94.2	3046.7	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	9798.7	4607.7	756.6	1690.4	231.8	316823.5	148982.3	24464.8	54657.3	7494.8					
		23		DD	Destroyer	DDG-2	4.9	100%	112.7	0%	3%	97%	0.0	3.4	109.3	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	351.6	165.3	27.1	60.7	8.3	11368.1	5345.7	877.8	1961.2	268.9					
		18		FFG	Guided Missile Frigate	FFG-2	4.9	100%	88.2	0%	3%	97%	0.0	2.6	85.6	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	176.8	179.2	20.7	30.6	8.6	5716.7	5793.7	668.2	989.9	278.1					
		5		FFH	Canadian Frigate	FFG-2	4.9	100%	24.5	0%	3%	97%	0.0	0.7	23.8	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	49.1	49.8	5.7	8.5	2.4	1588.0	1609.4	185.6	275.0	77.2					
		5		AOE	Logistics/Support	AOE-1	4.9	100%	24.5	0%	3%	97%	0.0	0.7	23.8	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	2.7	16.2	2.1	48.6	9.8	88.6	522.6	66.3	1571.8	315.6					
		2		MHC		PC-1	4.9	100%	9.8	0%	3%	97%	0.0	0.3	9.5	6.5	12.5	1.1	2.5	0.4	0.0	0.0	0.0	0.0	0.0	1.9	3.7	0.3	0.7	0.1	61.8	118.4	10.0	23.9	3.3					
		16		LPD	Amphibious Transport Dock - Wasp	LPD-1	4.9	100%	78.4	0%	3%	97%	0.0	2.4	76.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	4.3	25.6	3.3	77.0	15.5	140.3	828.0	105.3	2491.0	500.0					
		232		LHD	Large Helicopter-dock Ships	LHD-1	4.9	100%	1136.8	0%	3%	97%	0.0	34.1	1102.7	5.89	34.8	4.4	104.6	21.0	0.0	0.0	0.0	0.0	0.0	200.9	1185.8	150.7	3567.3	715.8	6494.9	38340.7	4873.9	115342.0	23145.6					
		15		LSD	Landing Ship Dock	LPD-1	4.9	100%	73.5	0%	3%	97%	0.0	2.2	71.3	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	4.1	24.0	3.1	72.2	14.5	131.6	776.2	98.7	2335.3	468.7					
		177		LHA	Amphib. Assault Ship - Tarawa	LHA-1	4.9	100%	867.3	0%	3%	97%	0.0	26.0	841.3	7.38	43.5	5.5	131.0	26.3	0.0	0.0	0.0	0.0	0.0	192.0	1132.6	143.9	3407.7	684.0	6208.7	36621.0	4652.3	110182.6	22117.3					
		1		AGF		LPD-1	4.9	100%	4.9	0%	3%	97%	0.0	0.1	4.8	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.3	1.6	0.2	4.8	1.0	8.8	51.7	6.6	155.7	31.2					
		4		WHEC	US Coast Guard	USCG	4.9	100%	19.6	0%	3%	97%	0.0	0.6	19.0	5.74	57.9	0.9	11.6	0.2	0.0	0.0	0.0	0.0	0.0	3.4	34.1	0.5	6.8	0.1	109.1	1101.0	16.7	219.6	4.0					
		145		Unknown		PC-1	4.9	100%	710.5	0%	3%	97%	0.0	21.3	689.2	6.5	12.5	1.1	2.5	0.4	0.0	0.0	0.0	0.0	0.0	138.5	265.6	22.4	53.5	7.5	4479.7	8587.2	723.6	1729.9	241.2					
		204		SSN	Submarines (No emissions)																																			
		41		SSBN	Submarines (No emissions)																																			
28A	Sm Obj Avoidance	8		CG	Cruiser	CG-2	1.8	100%	14.0	100%	0%	0%	14.0	0.0	0.0	107.78	47.1	8.8	21.0	2.6	1508.9	659.7	123.5	294.3	36.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		14		DDG	Guided Missile Destroyer	DDG-2	1.8	100%	24.5	100%	0%	0%	24.5	0.0	0.0	103.99	48.9	8.0	17.9	2.5	2547.8	1198.1	196.7	439.5	60.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		10		FFG	Guided Missile Frigate	FFG-2	1.8	100%	17.5	100%	0%	0%	17.5	0.0	0.0	66.82	67.7	7.8	11.6	3.3	1169.4	1185.1	136.7	202.5	56.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		16		MCM		USCG	1.8	100%	28.0	100%	0%	0%	28.0	0.0	0.0	5.74	57.9	0.9	11.6	0.2	160.7	1621.5	24.6	323.4	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		22		MHC		USCG	1.8	100%	38.5	100%	0%	0%	38.5	0.0	0.0	5.74	57.9	0.9	11.6	0.2	221.0	2229.5	33.9	444.7	8.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
29	Mine Neutralization	0																																						
30	Mining Exercise	2		MHC		USCG	0.5	100%	1.0	50%	40%	10%	0.5	0.4	0.1	5.74	57.9	0.9	11.6	0.2	2.9	29.0	0.4	5.8	0.1	2.3	23.2	0.4	4.6	0.1	0.6	5.8	0.1	1.2	0.0					
31	NSWC Land Demolition	6		CRRC		CRRC-2	4.0	90%	21.6	100%	0%	0%	21.6	0.0	0.0	0	0.0	2.3	0.0	0.0	0.0	0.6	49.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						CRRC-3		10%	2.4	100%	0%	0%	2.4	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	0.2	15.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
32	NSWC UW Demo	85		CRRC		CRRC-2	6.0	90%	459.0	100%	0%	0%	459.0	0.0	0.0	0	0.0	2.3	0.0	0.0	0.0	12.1	1052.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						CRRC-3		10%	51.0	100%	0%	0%	51.0	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	3.7	321.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
33	Mat Weave	32		CRRC		CRRC-2	4.0	90%	115.2	100%	0%	0%	115.2	0.0	0.0	0	0.0	2.3	0.0	0.0	0.0	3.0	264.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						CRRC-3		10%	12.8	100%	0%	0%	12.8	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	0.9	80.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
34	NSWC Small Arms	24		CRRC		CRRC-2	6.0	90%	129.6	100%	0%	0%	129.6	0.0	0.0	0	0.0	2.3	0.0	0.0	0.0	3.4	297.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						CRRC-3		10%	14.4	100%	0%	0%	14.4	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	1.0	90.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
35	NSWC Land Nav	0																																						
36	NSW UAV Operationa	0																																						
37	Insertion/Extraction	0																																						
38	NSW Boat Operations	245		MK V	MK V	MK-1	10.0	50%	1225.0	5%	42%	53%	61.3	514.5	649.3	1.94	14.8	0.5	2.4	0.2	118.8	908.3	30.6	146.4	12.3	998.1	7630.0	257.3	1229.7	102.9	1259.5	9628.4	324.6	1551.7	129.9					
						MK-3		50%	1225.0	5%	42%	53%	61.3	514.5	649.3	13.22	71.5	1.1	15.7	1.2	809.7	4378.2	64.3	958.6	70.4	6801.7	36776.5	540.2	8051.9	591.7	8583.1	46408.4	681.7	10160.8	746.6					

Table C-2. Surface Ship Air Emissions—Alternative 1

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs)	Percent at Each Power Level	Total Time on Range (hrs)	Percentage 0-3 nm from Shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Emissions Factors (lb/hr)					Emissions: Emissions 0-3 nm Offshore (lbs)					Emissions 3-12 nm Offshore - US Territory (lbs)					Emissions >12 nm Offshore - Outside US Territory									
							Hours	%	Hours	Percent				Hours		CO	NOx	HC	SOx	PM10	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM
		75		RIB	Rigid Inflatable	RIB-3	10.0	50%	375.0	5%	42%	53%	18.8	157.5	198.8	0.08	3.0	0.0	0.4	0.0	1.5	56.3	0.2	6.8	0.8	12.6	472.5	1.6	56.7	6.3	15.9	596.3	2.0	71.6	8.0					
						RIB-4		50%	375.0	5%	42%	53%	18.8	157.5	198.8	0.34	9.1	0.1	1.4	0.2	6.4	171.4	1.1	27.0	2.8	53.6	1439.6	9.5	226.8	23.6	67.6	1816.6	11.9	286.2	29.8					
39	NSWG-1 Platoon Ops	3		PC	Coastal Patrol-Independent Low Speed (	PC-3	4.0	100%	12.0	20%	30%	50%	2.4	3.6	6.0	59.93	187.6	9.3	47.1	4.8	143.8	450.3	22.4	113.1	11.4	215.7	675.4	33.6	169.6	17.2	359.6	1125.7	55.9	282.7	28.6					
		38		CRRC		CRRC-5	0.5	100%	19.0	100%	0%	0%	19.0	0.0	0.0	0	0.1	12.9	0.0	0.0	0.0	2.8	245.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		63		SOW	MK V	MK-3	0.5	100%	31.5	100%	0%	0%	31.5	0.0	0.0	13.22	71.5	1.1	15.7	1.2	416.4	2251.6	33.1	493.0	36.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
40	Direct Action	2		PC	Coastal Patrol-Independent Low Speed (	PC-2	8.0	80%	12.8	30%	20%	50%	3.8	2.6	6.4	17.21	38.1	2.9	8.2	0.9	66.1	146.5	11.3	31.6	3.5	44.1	97.6	7.5	21.1	2.4	110.1	244.1	18.8	52.7	5.9					
					Dynamic Maneuvering	PC-3		20%	3.2	30%	20%	50%	1.0	0.6	1.6	59.93	187.6	9.3	47.1	4.8	57.5	180.1	8.9	45.2	4.6	38.4	120.1	6.0	30.2	3.1	95.9	300.2	14.9	75.4	7.6					
		3		SOW	MK V	MK-1	4.0	80%	9.6	30%	25%	45%	2.9	2.4	4.3	1.94	14.8	0.5	2.4	0.2	5.6	42.7	1.4	6.9	0.6	4.7	35.6	1.2	5.7	0.5	8.4	64.1	2.2	10.3	0.9					
						MK-3		20%	2.4	30%	25%	45%	0.7	0.6	1.1	13.22	71.5	1.1	15.7	1.2	9.5	51.5	0.8	11.3	0.8	7.9	42.9	0.6	9.4	0.7	14.3	77.2	1.1	16.9	1.2					
		1		LCAC	Landing Craft Air Cushion	LCAC	1.0	100%	1.0	100%	0%	0%	1.0	0.0	0.0	25.41	55.3	0.7	43.3	3.9	25.4	55.3	0.7	43.3	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		10		CRRC	Combat Rubber Raiding Craft	CRRC-3	1.0	100%	10.0	100%	0%	0%	10.0	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	0.7	63.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		10		SDV	Combat Rubber Raiding Craft	CRRC-3	1.0	100%	10.0	100%	0%	0%	10.0	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	0.7	63.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
41	Bombing Exercise - Land	0																																						
42	CSAR	0																																						
43	EOD Outside SHOBA	0																																						
44	USCG Ops	149		Response	Coastal Patrol-Independent Low Speed (	PC-1	3.2	2%	9.5	80%	20%	0%	7.6	1.9	0.0	6.5	12.5	1.1	2.5	0.4	49.6	95.1	8.0	19.1	2.7	12.4	23.8	2.0	4.8	0.7	0.0	0.0	0.0	0.0	0.0					
						PC-2		2%	9.5	80%	20%	0%	7.6	1.9	0.0	17.21	38.1	2.9	8.2	0.9	131.3	291.0	22.4	62.8	7.0	32.8	72.7	5.6	15.7	1.8	0.0	0.0	0.0	0.0	0.0					
				Utility	Dynamic Maneuvering	PC-3		96%	457.7	80%	20%	0%	366.2	91.5	0.0	59.93	187.6	9.3	47.1	4.8	21945.3	68699.5	3412.8	17254.5	1746.7	5486.3	17174.9	853.2	4313.6	436.7	0.0	0.0	0.0	0.0	0.0					
		149		Utility	Coastal Patrol-Independent Low Speed (	PC-1	3.2	15%	71.5	80%	20%	0%	57.2	14.3	0.0	6.5	12.5	1.1	2.5	0.4	371.9	712.9	60.1	143.6	20.0	93.0	178.2	15.0	35.9	5.0	0.0	0.0	0.0	0.0	0.0					
						PC-2		60%	286.1	80%	20%	0%	228.9	57.2	0.0	17.21	38.1	2.9	8.2	0.9	3938.7	8728.9	672.9	1883.6	210.6	984.7	2182.2	168.2	470.9	52.6	0.0	0.0	0.0	0.0	0.0					
					Dynamic Maneuvering	PC-3		25%	119.2	80%	20%	0%	95.4	23.8	0.0	59.93	187.6	9.3	47.1	4.8	5714.9	17890.5	888.8	4493.4	454.9	1428.7	4472.6	222.2	1123.3	113.7	0.0	0.0	0.0	0.0	0.0					
		100		Cutter	US Coast Guard	USCG	3.2	100%	320.0	20%	20%	60%	64.0	64.0	192.0	5.74	57.9	0.9	11.6	0.2	367.4	3706.2	56.3	739.2	13.4	367.4	3706.2	56.3	739.2	13.4	1102.1	11118.7	169.0	2217.6	40.3					
		49		Cutter	US Coast Guard	USCG	3.2	100%	156.8	5%	5%	90%	7.8	7.8	141.1	5.74	57.9	0.9	11.6	0.2	45.0	454.0	6.9	90.6	1.6	45.0	454.0	6.9	90.6	1.6	810.0	8172.3	124.2	1629.9	29.6					
45	NALF Airfield	0																																						
46	Ship Torpedo Test	1		DDG	Guided Missile Destroyer	DDG-3	6.5	100%	6.5	0%	23%	77%	0.0	1.5	5.0	106.67	53.8	7.8	21.2	2.8	0.0	0.0	0.0	0.0	0.0	160.9	81.2	11.8	32.0	4.2	532.5	268.8	39.1	105.9	14.0					
		1		DDH	Japanese Destroye Helo Deck (FMS)	CG-3	6.5	100%	6.5	0%	23%	77%	0.0	1.5	5.0	114.75	65.2	7.7	33.6	3.4	0.0	0.0	0.0	0.0	0.0	173.0	98.4	11.6	50.6	5.2	572.8	325.6	38.3	167.5	17.2					
		1		DD	Japanese Destroyer (FMS)	CG-3	6.5	100%	6.5	0%	23%	77%	0.0	1.5	5.0	114.75	65.2	7.7	33.6	3.4	0.0	0.0	0.0	0.0	0.0	173.0	98.4	11.6	50.6	5.2	572.8	325.6	38.3	167.5	17.2					
		5		FFH	Helicopter Frigate (Canadian)	FFG-3	6.5	100%	32.5	0%	23%	77%	0.0	7.5	25.0	120.04	78.1	11.6	16.1	4.3	0.0	0.0	0.0	0.0	0.0	905.1	588.9	87.8	121.2	32.4	2996.2	1949.6	290.5	401.4	107.3					
47	UUV	10		BW	Boston Whalers	BW-1	10.0	100%	100.0	100%	0%	0%	100.0	0.0	0.0	0	0.1	7.5	0.0	0.0	0.0	7.6	751.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		10		HS	Harbor Security	RIB-2	10.0	100%	100.0	100%	0%	0%	100.0	0.0	0.0	0.04	1.6	0.0	0.2	0.0	4.0	159.0	1.0	17.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		20			Phanton DS4 (no emissions)					100%	0%	0%																												
48	Sonobuoy QA/QC	60		AE	Acoustic Explorer	AE-2	4.0	100%	240.0	50%	30%	20%	120.0	72.0	48.0	20.17	20.9	1.0	6.0	1.6	2420.4	2511.6	118.8	716.4	188.4	1452.2	1507.0	71.3	429.8	113.0	968.2	1004.6	47.5	286.6	75.4					
49	Ocean Engineering	65		BW	Boston Whaler	BW-2	3.0	100%	195.0	100%	0%	0%	195.0	0.0	0.0	0	0.1	9.0	0.0	0.0	0.0	17.7	1758.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
50	MM Mine Location	4		AE	Acoustic Explorer	AE-1	12.0	100%	48.0	100%	0%	0%	48.0	0.0	0.0	7.31	8.5	0.4	2.1	0.6	350.9	406.1	18.2	101.8	26.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		20		BW	Boston Whaler	BW-2	12.0	100%	240.0	100%	0%	0%	240.0	0.0	0.0	0	0.1	9.0	0.0	0.0	0.0	21.8	2164.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
51	Missile Flight Test	9		CG		CG-2	4.0	100%	36.0	0%	0%	100%	0.0	0.0	36.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3880.1	1696.3	317.5	756.7	94.7					
		18		DDG	Guided Missile Destroyer	DDG-2	4.0	100%	72.0	0%	0%	100%	0.0	0.0	72.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7487.3	3520.8	578.2	1291.7	177.1					
52	NUWC UW Acoustic	83		FFG	Guided Missile Frigate	FFG-2	4.0	100%	332.0	0%	0%	100%	0.0	0.0	332.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22184.2	22483.0	2592.9	3841.2	1079.0					
		23		AE	Acoustic Explorer	AE-1	4.0	100%	92.0	0%	0%	100%	0.0	0.0	92.0	7.31	8.5	0.4	2.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	672.5	778.3	35.0	195.0	50.6					
		83		BW	Boston Whaler	BW-2	4.0	100%	332.0	0%	0%	100%	0.0	0.0	332.0	0	0.1	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.1	2993.8	0.0	0.0					
53	Other Tests	3		CG	Cruiser	CG-2	4.0	100%	12.0	0%	0%	100%	0.0	0.0	12.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1293.4	565.4	105.8	252.2	31.6					
	(MCM, ASUW, FIREX)	8		DDG	Guided Missile Destroyer	DDG-2	4.0	100%	32.0	0%	0%	100%	0.0	0.0	32.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3327.7	1564.8	257.0	574.1	78.7					
		0		FFH	Helicopter Frigate (Canadian)	FFG-2	4.0	100%	0.0	0%	0%	100%	0.0	0.0	0.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		8		DD	Japanese Destroyer (FMS)	CG-2	4.0	100%	32.0	0%	0%	100%	0.0	0.0	32.0	107.78	47.1	8.8	21.02	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3449.0	1507.8	282.2	672.6	84.2					
		2		AOR	Canadian	AOE-1	4.0	100%	8.0	0%	0%	100%	0.0	0.0	8.0	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.8	175.9	22.3	529.1	106.2					
	Total ####															**Total Emissions (SCI) tons**					**10.90**	**17.35**	**4.88**	**10.34**	**4.13**	**61.75**	**39.01**	**5.63**	**19.15**	**5.66**	**636.96**	**492.10**	**57.58**	**310.73**	**74.35**	**49.73**	**32.19**	**4.50**	**13.14**	**2.11**
																Total Emissions (SD) tons					**106.77**	**236.91**	**13.36**	**90.56**	**15.68**	**122.89**	**323.63**	**16.31**	**134.24**	**16.40**										
																Total Emissions within US Territory (SCI)					**72.65**	**56.36**	**10.51**	**29.48**	**9.78**															
																Total Emissions within US Territory (SD)					**229.65**	**560.54**	**29.67**	**224.80**	**32.08**															

Date: 13-May-2007

Notes: 1 - Ship nomenclature highlighted in yellow signifies no specific AQ Emissions data for that vessel.
For vessels without AQ emissions data, the following data was used:

56768.0

Support (for USW)	TRB	AGF	LPD
Support (for Surf Firing)	PC	WHEC	USCG
MCM	USCG	Unknown (for Elec Combat)	PC
MHC	USCG	SOW	MKV
LSD	LPD	EFV	AAV
Unknown (for VBSS)	PC	DDH	CG
DD	CG	HS	RIB
FFH	FFG	AOR	AOE

Table C-3. Surface Ship Air Emissions—Alternative 2

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs)	Percent at Each Power Level	Total Time on Range (hrs)	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Emissions: Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10	Emissions 0-3 nm Offshore (lbs) CO	Nox	HC	Sox	PM	Emissions 3-12 nm Offshore - US Territory (lbs) CO	Nox	HC	Sox	PM	Emissions >12 nm Offshore - Outside US Territory: Offshore San Diego CO	Nox	HC	Sox	PM	Offshore Mexico CO	Nox	HC	Sox	PM
							Hours	%	Hours	Percent				Hours																										
Training Exercises																																								
1	Air Combat Maneuvers	0																																						
2	Air Defense Exercise	117		CG	Cruiser	CG-2	1.0	100%	117.0	0%	0%	100%	0.0	0.0	117.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12610.3	5513.0	1031.9	2459.3	307.7					
		234		DDG	Guided Missile Destroyer	DDG-2	1.0	100%	234.0	0%	0%	100%	0.0	0.0	234.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24333.7	11442.6	1879.0	4198.0	575.6					
		24		CVN	Nuclear Carrier (No emissions)					0%	0%	100%																												
		4		FFG	Guided Missile Frigate	FFG-2	3.7	100%	14.8	0%	0%	100%	0.0	0.0	14.8	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	988.9	1002.3	115.6	171.2	48.1					
3	S-A Missiles	6		CVN	Nuclear Carrier (No emissions)					0%	0%	100%																												
		6		TRB	Torpedo Retrieval Boats	TRB-3	4.0	100%	24.0	1%	2%	97%	0.2	0.5	23.3	6.47	56.2	1.6	7.4	1.2	1.6	13.5	0.4	1.8	0.3	3.1	27.0	0.7	3.6	0.6	150.6	1308.8	36.1	172.3	27.5					
4	S-A Gunnery Exercise	23		CVN						0%	0%	100%																												
		44		CG	Cruiser	CG-2	1.5	100%	66.0	0%	0%	100%	0.0	0.0	66.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						7113.5	3109.9	582.1	1387.3	173.6
		91		DDG	Guided Missile Destroyer	DDG-2	1.5	100%	136.5	0%	0%	100%	0.0	0.0	136.5	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						14194.6	6674.9	1096.1	2448.8	335.8
		55		FFG	Guided Missile Frigate	FFG-2	1.5	100%	82.5	0%	0%	100%	0.0	0.0	82.5	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						5512.7	5586.9	644.3	954.5	268.1
		13		LHA	Amphib. Assault Ship - Tarawa	LHA-1	1.5	100%	19.5	0%	0%	100%	0.0	0.0	19.5	7.38	43.5	5.5	131.0	26.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						143.9	848.8	107.8	2553.9	512.7
		15		LDH	Large Helicopter-dock Ships	LHD-1	1.5	100%	22.5	0%	0%	100%	0.0	0.0	22.5	5.89	34.8	4.4	104.6	21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						132.5	782.3	99.5	2353.5	472.3
		21		LPD	Amphibious Transport Dock - Wasp	LPD-1	1.5	100%	31.5	0%	0%	100%	0.0	0.0	31.5	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						58.1	343.0	43.6	1031.8	207.1
		24		LSD	Landing Ship Dock	LPD-1	1.5	100%	36.0	0%	0%	100%	0.0	0.0	36.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						66.4	392.0	49.8	1179.2	236.7
		37		USCGS	US Coast Guard	USCG	1.5	100%	55.5	0%	0%	100%	0.0	0.0	55.5	5.74	57.9	0.9	11.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						318.6	3214.0	48.8	641.0	11.7
		27		Other Ship	Coastal Patrol-Independent Low Speed (	PC-1	1.5	100%	40.5	0%	0%	100%	0.0	0.0	40.5	6.5	12.5	1.1	2.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						263.3	504.6	42.5	101.7	14.2
5	A-A Missiles	1		TRB	Torpedo Retrieval Boats	TRB-3	4.0	100%	4.0	1%	2%	97%	0.0	0.1	3.9	6.47	56.2	1.6	7.4	1.2	0.3	2.2	0.1	0.3	0.0	0.5	4.5	0.1	0.6	0.1						25.1	218.1	6.0	28.7	4.6
6	Helicopter ASW TRACKEX	28		CG	Cruiser	CG-3	3.6	100%	100.8	1%	10%	89%	1.0	10.1	89.7	114.75	65.2	7.7	33.6	3.4	115.7	65.7	7.7	33.8	3.5	1156.7	657.4	77.3	338.2	34.7	10294.5	5851.0	688.1	3009.8	308.6					
		71		DDG	Guided Missile Destroyer	DDG-3	3.6	100%	255.6	1%	10%	89%	2.6	25.6	227.5	106.67	53.8	7.8	21.2	2.8	272.6	137.6	20.0	54.2	7.2	2726.5	1376.2	200.4	542.4	71.6	24265.7	12247.7	1783.5	4827.2	637.0					
		43		TRB	Torpedo Retrieval Boats	TRB-3	3.6	100%	154.8	1%	10%	89%	1.5	15.5	137.8	6.47	56.2	1.6	7.4	1.2	10.0	87.0	2.4	11.5	1.8	100.2	870.3	24.0	114.6	18.3	891.4	7745.5	213.5	1019.5	162.6					
7	Helicopter ASW TORPEX	28		CG	Cruiser	CG-3	3.6	100%	100.8	1%	10%	89%	1.0	10.1	89.7	114.75	65.2	7.7	33.6	3.4	115.7	65.7	7.7	33.8	3.5	1156.7	657.4	77.3	338.2	34.7	10294.5	5851.0	688.1	3009.8	308.6					
		75		DDG	Guided Missile Destroyer	DDG-3	3.6	100%	270.0	1%	10%	89%	2.7	27.0	240.3	106.67	53.8	7.8	21.2	2.8	288.0	145.4	21.2	57.3	7.6	2880.1	1453.7	211.7	572.9	75.6	25632.8	12937.8	1884.0	5099.2	672.8					
		72		TRB	Torpedo Retrieval Boats	TRB-3	3.6	100%	259.2	1%	10%	89%	2.6	25.9	230.7	6.47	56.2	1.6	7.4	1.2	16.8	145.7	4.0	19.2	3.1	167.7	1457.2	40.2	191.8	30.6	1492.6	12969.3	357.6	1707.1	272.2					
8	MPA ASW TRACKEX																																							
9	MPA ASW TORPEX	2		CG	Cruiser	CG-3	2.0	100%	4.0	5%	10%	85%	0.2	0.4	3.4	114.75	65.2	7.7	33.6	3.4	23.0	13.0	1.5	6.7	0.7	45.9	26.1	3.1	13.4	1.4	390.2	221.7	26.1	114.1	11.7					
		5		DDG	Guided Missile Destroyer	DDG-3	2.0	100%	10.0	5%	10%	85%	0.5	1.0	8.5	106.67	53.8	7.8	21.2	2.8	53.3	26.9	3.9	10.6	1.4	106.7	53.8	7.8	21.2	2.8	906.7	457.6	66.6	180.4	23.8					
		3		FFG	Guided Missile Frigate	FFG-3	2.0	100%	6.0	5%	10%	85%	0.3	0.6	5.1	120.04	78.1	11.6	16.1	4.3	36.0	23.4	3.5	4.8	1.3	72.0	46.9	7.0	9.6	2.6	612.2	398.4	59.4	82.0	21.9					
		10		TRB	Torpedo Retrieval Boats	TRB-3	2.0	100%	20.0	5%	10%	85%	1.0	2.0	17.0	6.47	56.2	1.6	7.4	1.2	6.5	56.2	1.6	7.4	1.2	12.9	112.4	3.1	14.8	2.4	110.0	955.7	26.4	125.8	20.1					
10	EER/IEER ASW																																							
11	Surface Ship ASW TRACKEX	225		CG	Cruiser	CG-3	2.0	100%	450.0	1%	10%	89%	4.5	45.0	400.5	114.75	65.2	7.7	33.6	3.4	516.4	293.5	34.5	151.0	15.5	5163.8	2934.9	345.2	1509.8	154.8	45957.4	26120.6	3071.8	13436.8	1377.7					
		450		DDG	Guided Missile Destroyer	DDG-3	2.0	100%	900.0	1%	10%	89%	9.0	90.0	801.0	106.67	53.8	7.8	21.2	2.8	960.0	484.6	70.6	191.0	25.2	9600.3	4845.6	705.6	1909.8	252.0	85442.7	43125.8	6279.8	16997.2	2242.8					
		225		FFG	Guided Missile Frigate	FFG-3	2.0	100%	450.0	1%	10%	89%	4.5	45.0	400.5	120.04	78.1	11.6	16.1	4.3	540.2	351.5	52.4	72.4	19.4	5401.8	3515.0	523.8	723.6	193.5	48076.0	31283.1	4661.8	6440.0	1722.2					
		0		Support	Torpedo Retrieval Boats	TRB-3	2.0	100%	0.0	1%	10%	89%	0.0	0.0	0.0	6.47	56.2	1.6	7.4	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
12	Surface Ship ASW TORPEX	8		CG	Cruiser	CG-3	3.7	100%	29.6	1%	10%	89%	0.3	3.0	26.3	114.75	65.2	7.7	33.6	3.4	34.0	19.3	2.3	9.9	1.0	339.7	193.1	22.7	99.3	10.2	3023.0	1718.2	202.1	883.8	90.6					
		12		DDG	Guided Missile Destroyer	DDG-3	3.7	100%	44.4	1%	10%	89%	0.4	4.4	39.5	106.67	53.8	7.8	21.2	2.8	47.4	23.9	3.5	9.4	1.2	473.6	239.0	34.8	94.2	12.4	4215.2	2127.5	309.8	838.5	110.6					
		6		FFG	Guided Missile Frigate	FFG-3	3.7	100%	22.2	1%	10%	89%	0.2	2.2	19.8	120.04	78.1	11.6	16.1	4.3	26.6	17.3	2.6	3.6	1.0	266.5	173.4	25.8	35.7	9.5	2371.8	1543.3	230.0	317.7	85.0					
		12		TRB	Torpedo Retrieval Boats	TRB-3	3.7	100%	44.4	1%	10%	89%	0.4	4.4	39.5	6.47	56.2	1.6	7.4	1.2	2.9	25.0	0.7	3.3	0.5	28.7	249.6	6.9	32.9	5.2	255.7	2221.6	61.2	292.4	46.6					
13	Sub ASW Trackex	53		SSN	Submarines (No emissions)																																			
		16		TRB	Torpedo Retrieval Boats	TRB-3	12.8	100%	204.8	1%	2%	97%	2.0	4.1	198.7	6.47	56.2	1.6	7.4	1.2	13.3	115.1	3.2	15.2	2.4	26.5	230.3	6.3	30.3	4.8	1285.3	11168.4	307.9	1470.1	234.4					
14	Sub ASW TORPEX	22		SSN	Submarines (No emissions)																																			
		22		TRB	Torpedo Retrieval Boats	TRB-3	11.7	100%	257.4	1%	2%	97%	2.6	5.1	249.7	6.47	56.2	1.6	7.4	1.2	16.7	144.7	4.0	19.0	3.0	33.3	289.4	8.0	38.1	6.1	1615.4	14036.9	387.0	1847.6	294.6					
15	VBSS	21		CG	Cruiser	CG-2	4.0	100%	84.0	0%	0%	100%	0.0	0.0	84.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9053.5	3958.1	740.9	1765.7	220.9					
		42		DDG	Guided Missile Destroyer	DDG-2	4.0	100%	168.0	0%	0%	100%	0.0	0.0	168.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17470.3	8215.2	1349.0	3013.9	413.3					
		8		FFG	Guided Missile Frigate	FFG-2	4.0	100%	32.0	0%	0%	100%	0.0	0.0	32.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2138.2	2167.0	249.9	370.2	104.0					
		3		LPD	Amphibious Transport Dock - Wasp	LPD-1	4.0	100%	12.0	0%	0%	100%	0.0	0.0	12.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.1	130.7	16.6	393.1	78.9					
		8		LSD		LPD-1	4.0	100%	32.0	0%	0%	100%	0.0	0.0	32.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	59.1	348.4	44.3	1048.2	210.4					
16	ASUW MISSILEX	32		TRB	Torpedo Retrieval Boats	TRB-2	7.0	100%	224.0	5%	28%	67%	11.2	62.7	150.1	7.64	33.1	0.6	3.4	1.2	85.6	370.6	6.6	38.0	13.0	479.2	2075.4	37.0	212.6	72.8	1146.6	4966.1	88.5	508.8	174.1					
17	A-S BOMBEX	0																																						
18	A-S GUNEX	0																																						
19	S-S GUNEX	1		CVN	Nuclear Carrier (No emissions)																																			
		71		CG	Cruiser	CG-1	2.5	100%	177.5	0%	28%	72%	0.0	49.7	127.8	102.58	40.6	9.2	17.7	2.1	0.0	0.0	0.0	0.0	0.0	5098.2	2018.3	458.2	880.2	105.4						13109.7	5190.0	1178.3	2263.3	270.9
		147		DDG	Guided Missile Destroyer	DDG-1	2.5	100%	367.5	0%	28%	72%	0.0	102.9	264.6	102.98	47.3	8.1	17.0	2.4	0.0	0.0	0.0	0.0	0.0	10596.6	4871.3	833.5	1753.4	241.8						27248.5	12526.2	2143.3	4508.8	621.8
		49		FFG	Guided Missile Frigate	FFG-1	2.5	100%	122.5	0%	28%	72%	0.0	34.3	88.2	65.75	66.4	7.9	10.9	3.1	0.0	0.0	0.0	0.0	0.0	2255.2	2275.8	270.6	373.5	107.7						5799.2	5852.1	695.9	960.5	276.9
		2		LPD	Amphibious Transport Dock - Wasp	LPD-1	2.5	100%	5.0	0%	28%	72%	0.0	1.4	3.6	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	2.6	15.2	1.9	45.9	9.2						6.6	39.2	5.0	117.9	23.7
		1		LSD	Landing Ship Dock	LPD-1	2.5	100%	2.5	0%	28%	72%	0.0	0.7	1.8	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	1.3	7.6	1.0	22.9	4.6						3.3	19.6	2.5	59.0	11.8
		1		LHD	Large Helicopter-dock Ships	LHD-2	2.5	100%	2.5	0%	28%	72%	0.0	0.7	1.8	6.8	40.1	5.1	120.7	24.2	0.0	0.0	0.0	0.0	0.0	4.8	28.1	3.6	84.5	17.0						12.2	72.2	9.2	217.3	43.6
		18		Unknown	Other	PC-2	2.5	100%	45.0	0%	28%	72%	0.0	12.6	32.4	17.21	38.1	2.9	8.2	0.9	0.0	0.0	0.0	0.0	0.0	216.8	480.6	37.0	103.7	11.6						557.6	1235.7	95.3	266.7	29.8
		40		USCG	US Coast Guard	USCG	2.5	100%	100.0	0%	28%	72%	0.0	28.0	72.0	5.74	57.9	0.9	11.6	0.2	0.0	0.0	0.0	0.0	0.0	160.7	1621.5	24.6	323.4	5.9						413.3	4169.5	63.4	831.6	15.1
20	SINKEX	6		CG	Cruiser	CG-2	16.0	100%	96.0	0%	0%	100%	0.0	0.0	96.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						10346.9	4523.5	846.7	2017.9	252.5
		12		DDG	Guided Missile Destroyer	DDG-2	16.0	100%	192.0	0%	0%	100%	0.0	0.0	192.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						19966.1	9388.8	1541.8	3444.5	472.3
		0		DD	Destroyer	DDG-2	16.0	100%	0.0	0%	0%	100%	0.0	0.0	0.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0	0.0	0.0	0.0	0.0
		6		FFG	Guided Missile Frigate	FFG-2	16.0	100%	96.0	0%	0%	100%	0.0	0.0	96.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						6414.7	6501.1	749.8	1110.7	312.0
		3		SSN	Submarines (No emissions)																																			
21	NSFS	17		CG	Cruiser	CG-2	9.0	100%	153.0	0%	30%	70%	0.0	45.9	107.1	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	4947.1	2162.8	404.8	964.8	120.7	11543.2	5046.6	944.6	2251.2	281.7					
		35		DDG	Guided Missile Destroyer	DDG-2	9.0	100%	315.0	0%	30%	70%	0.0	94.5	220.5	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	9827.1	4621.1	758.8	1695.3	232.5	22929.8	10782.5	1770.6	3955.8	542.4					
		4		FFG	Guided Missile Frigate	FFG-2	9.0	100%	36.0	0%	30%	70%	0.0	10.8	25.2	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	721.7	731.4	84.3	125.0	35.1	1683.9	1706.5	196.8	291.6	81.9					
22	EFEX	3		CG	Cruiser	CG-2	72.0	100%	216.0	0%	100%	0%	0.0	216.0	0.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	23280.5	10177.9	1905.1	4540.3	568.1	0.0	0.0	0.0	0.0	0.0					
		3		DDG	Guided Missile Destroyer	DDG-2	72.0	100%	216.0	0%	100%	0%	0.0	216.0	0.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	22461.8	10562.4	1734.5	3875.0	531.4	0.0	0.0	0.0	0.0	0.0					
23	Battalion Landing	2		LHA	Amphib. Assault Ship - Tarawa	LHA-1	6.0	100%	12.0	10%	30%	60%	1.2	3.6	7.2	7.38	131.0	26.3	7.4	43.5	8.9	157.2	31.5	8.9	52.2	26.6	471.5	94.6	26.6	156.7	53.1	943.0	189.3	53.1	313.4					
		2		LHD	Large Helicopter-dock Ships	LHD-2	2.5	100%	5.0	10%	30%	60%	0.5	1.5	3.0	6.8	40.1	5.1	120.7	24.2	3.4	20.1	2.6	60.4	12.1	10.2	60.2	7.7	181.1	36.3	20.4	120.4	15.3	362.1	72.7					
		2		LPD	Amphibious Transport Dock - Wasp	LPD-1	2.5	100%	5.0	10%	30%	60%	0.5	1.5	3.0	1.845393	10.9	1.4	32.8	6.6	0.9	5.4	0.7	16.4	3.3	2.8	16.3	2.1	49.1	9.9	5.5	32.7	4.2	98.3	19.7					
		12		LCU	Landing Craft Utility	LCU	3.0	100%	36.0	10%	30%	60%	3.6	10.8	21.6	36.21	3.1	1.6	36.2	45.0	130.4	11.2	5.7	130.4	161.8	391.1	33.6	17.0	391.1	485.5	782.1	67.2	33.9	782.1	970.9					
		48		AAV/EFV	Amphibious Assault Vehicle	EFV-2	6.0	100%	288.0	10%	30%	60%	28.8	86.4	172.8	2.0611	4.17	0.72	0.06	0.3211	59.4	120.0	20.8	1.8	9.2	178.1	360.0	62.3	5.5	27.7	356.2	720.1	124.6	10.9	55.5					
		10		LCAC	Landing Craft Air Cushioned	LCAC	3.0	100%	30.0	10%	30%	60%	3.0	9.0	18.0	25.41	43.3	3.9	25.4	55.3	76.2	129.9	11.7	76.2	166.0	228.7	389.7	35.0	228.7	497.9	457.4	779.4	70.0	457.4	995.8					
		0		CRRC	Combat Raiding Rubber Craft	CRRC-4	6.0	100%	0.0	10%	30%	60%	0.0	0.0	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
24	USMC Stinger	0																																						
25	Amphibious Landings & Raids																																							
25A	Recon Mission	12		LPD	Amphibious Transport Dock - Wasp	LPD-1	4.0	100%	48.0	0%	0%	100%	0.0	0.0	48.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	88.6	522.6	66.4	1572.3	315.6					
25B	Helicopter Assault	6		LHD	Large Helicopter-dock Ships	LHD-2	6.0	100%	36.0	0%	0%	100%	0.0	0.0	36.0	6.8	40.1	5.1	120.7	24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	244.8	1444.3	183.6	4345.2	872.3					
		6		LHA	Amphib. Assault Ship - Tarawa	LHA-1	6.0	100%	36.0	0%	0%	100%	0.0	0.0	36.0	7.38	131.0	26.3	7.4	43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	265.7	4714.9	946.4	265.7	1567.1					
25C	Armored Operations	4		LHD	Large Helicopter-dock Ships	LHD-2	12.0	100%	48.0	33%	33%	33%	16.0	16.0	16.0	6.8	40.1	5.1	120.7	24.2	108.7	641.3	81.5	1929.3	387.3	108.7	641.3	81.5	1929.3	387.3	108.7	641.3	81.5	1929.3	387.3					
		4		LHA	Amphib. Assault Ship - Tarawa	LHA-1	12.0	100%	48.0	33%	33%	33%	16.0	16.0	16.0	7.38	131.0	26.3	7.4	43.5	118.0	2093.4	420.2	118.0	695.8	118.0	2093.4	420.2	118.0	695.8	118.0	2093.4	420.2	118.0	695.8					
		8		LCAC	Landing Craft Air Cushioned	LCAC	12.0	100%	96.0	33%	33%	33%	32.0	32.0	32.0	25.41	43.3	3.9	25.4	55.3	812.3	1384.2	124.4	812.3	1768.5	812.3	1384.2	124.4	812.3	1768.5	812.3	1384.2	124.4	812.3	1768.5					
		8		LCU	Landing Craft Utility	LCU	12.0	100%	96.0	33%	33%	33%	32.0	32.0	32.0	36.21	3.1	1.6	36.2	45.0	1157.6	99.4	50.2	1157.6	1437.0	1157.6	99.4	50.2	1157.6	1437.0	1157.6	99.4	50.2	1157.6	1437.0					
25D	Artillery Operations	2		LHD	Large Helicopter-dock Ships	LHD-2	24.0	100%	48.0	100%	0%	0%	48.0	0.0	0.0	6.8	40.1	5.1	120.7	24.2	326.4	1925.8	244.8	5793.6	1163.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		2		LHA	Amphib. Assault Ship - Tarawa	LHA-1	24.0	100%	48.0	20%	40%	40%	9.6	19.2	19.2	7.38	43.5	5.5	131.0	26.3	70.8	417.9	53.1	1257.3	252.4	141.7	835.8	106.2	2514.6	504.8	141.7	835.8	106.2	2514.6	504.8					

Table C-3. Surface Ship Air Emissions—Alternative 2

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs)	Percent at Each Power Level	Total Time on Range (hrs)	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Emissions Factors (lb/hr)					Emissions 0-3 nm Offshore (lbs)					Emissions 3-12 nm Offshore - US Territory (lbs)					Emissions >12 nm Offshore - Outside US Territory									
							Hours	%	Hours	Percent			Hours			CO	NOx	HC	SOx	PM10	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM
		4		LCAC	Landing Craft Air Cushion	LCAC	24.0	100%	96.0	100%	0%	0%	96.0	0.0	0.0	25.41	55.3	0.7	43.3	3.9	2439.4	5310.7	69.1	4156.8	373.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		4		LCU	Landing Craft Utility	LCU	24.0	100%	96.0	100%	0%	0%	96.0	0.0	0.0	36.21	45.0	0.5	3.1	1.6	3476.2	4315.2	49.9	298.6	150.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
25E	Amphibious Assault	2		LHD	Large Helicopter-dock Ships	LHD-2	8.0	100%	16.0	38%	38%	25%	6.0	6.0	4.0	6.8	40.1	5.1	120.7	24.2	40.8	240.7	30.6	724.2	145.4	40.8	240.7	30.6	724.2	145.4	27.2	160.5	20.4	482.8	96.9					
		2		LHA	Amphib. Assault Ship - Tarawa	LHA-1	8.0	100%	16.0	38%	38%	25%	6.0	6.0	4.0	7.38	43.5	5.5	131.0	26.3	44.3	261.2	33.2	785.8	157.7	44.3	261.2	33.2	785.8	157.7	29.5	174.1	22.1	523.9	105.2					
		4		LPD	Amphibious Transport Dock - Wasp	LPD-1	8.0	100%	32.0	38%	38%	25%	12.0	12.0	8.0	1.845393	10.9	1.4	32.8	6.6	22.1	130.7	16.6	393.1	78.9	22.1	130.7	16.6	393.1	78.9	14.8	87.1	11.1	262.0	52.6					
		6		LCAC	Landing Craft Air Cushioned	LCAC	8.0	100%	48.0	38%	38%	25%	18.0	18.0	12.0	25.41	43.3	3.9	25.4	55.3	457.4	779.4	70.0	457.4	995.8	457.4	779.4	70.0	457.4	995.8	304.9	519.6	46.7	304.9	663.8					
		6		LCU	Landing Craft Utility	LCU	8.0	100%	48.0	38%	38%	25%	18.0	18.0	12.0	36.21	3.1	1.6	36.2	45.0	651.8	56.0	28.3	651.8	809.1	651.8	56.0	28.3	651.8	809.1	434.5	37.3	18.8	434.5	539.4					
25F	Combat Engineer Ops	2		LHA	Amphib. Assault Ship - Tarawa	LHA-1	6.0	100%	12.0	33%	33%	33%	4.0	4.0	4.0	7.38	131.0	26.3	7.4	43.5	29.5	523.4	105.1	29.5	173.9	29.5	523.4	105.1	29.5	173.9	29.5	523.4	105.1	29.5	173.9					
		4		LCU	Landing Craft Utility	LCU	6.0	100%	24.0	33%	33%	33%	8.0	8.0	8.0	36.21	3.1	1.6	36.2	45.0	289.4	24.9	12.5	289.4	359.2	289.4	24.9	12.5	289.4	359.2	289.4	24.9	12.5	289.4	359.2					
25G	Amphibious Assault Vehicle Ops	8		LHA	Amphib. Assault Ship - Tarawa	LHA-1	8.0	100%	64.0	25%	25%	50%	16.0	16.0	32.0	7.38	131.0	26.3	7.4	43.5	118.1	2095.5	420.6	118.1	696.5	118.1	2095.5	420.6	118.1	696.5	236.2	4191.0	841.3	236.2	1393.0					
		48		EFV	Expeditionary Fighting Vessel	EFV-1	8.0	100%	384.0	25%	25%	50%	96.0	96.0	192.0	2.0611	4.17	0.72	0.06	0.3211	197.9	400.0	69.2	6.1	30.8	197.9	400.0	69.2	6.1	30.8	395.7	800.1	138.5	12.1	61.7					
25H	EFV	4		LPD	Amphibious Transport Dock - Wasp	LPD-1	8.0	100%	32.0	25%	25%	50%	8.0	8.0	16.0	1.845393	10.9	1.4	32.8	6.6	14.8	87.1	11.1	262.0	52.6	14.8	87.1	11.1	262.0	52.6	29.5	174.2	22.1	524.1	105.2					
		2		LCAC	Landing Craft Air Cushioned	LCAC	8.0	100%	16.0	25%	25%	50%	4.0	4.0	8.0	25.41	43.3	3.9	25.4	55.3	101.6	173.2	15.6	101.6	221.3	101.6	173.2	15.6	101.6	221.3	203.3	346.4	31.1	203.3	442.6					
		92		EFV	Expeditionary Fighting Vessel	EFV-1	8.0	100%	736.0	25%	25%	50%	184.0	184.0	368.0	2.0611	4.17	0.72	0.06	0.3211	379.2	766.7	132.7	11.6	59.1	379.2	766.7	132.7	11.6	59.1	758.5	1533.5	265.4	23.3	118.2					
25I	Assault Amphibian School	120		LCAC	Landing Craft Air Cushioned	LCAC	8.0	100%	960.0	0%	0%	100%	0.0	0.0	960.0	25.41	43.3	3.9	25.4	55.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24393.6	41568.0	3734.4	24393.6	53107.2					
		60		LCU	Landing Craft Utility	LCU	8.0	100%	480.0	0%	0%	100%	0.0	0.0	480.0	36.21	3.1	1.6	36.2	45.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17380.8	1492.8	753.6	17380.8	21576.0					
		90		EFV	Amphibious Assault Vehicle	EFV-1	8.0	100%	720.0	0%	0%	100%	0.0	0.0	720.0	2.0611	4.17	0.72	0.06	0.3211	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1484.0	3000.2	519.2	45.5	231.2					
26	Ambphibious Operations CPAAA																																							
26A	Amphibious Operations	1688		AAV/EFV	Amphibious Assault Vehicle	EFV-1	16.8	20%	5671.7	28%	70%	2%	1588.1	3970.2	113.4	2.0611	4.17	0.72	0.06	0.3211	3273.2	6617.5	1145.2	100.4	509.9	8182.9	16543.7	2862.9	250.9	1274.8	233.8	472.7	81.8	7.2	36.4					
				AAV/EFV	Amphibious Assault Vehicle	EFV-2	16.8	80%	22686.7	28%	70%	2%	6352.3	15880.7	453.7	2.0611	4.17	0.72	0.06	0.3211	13092.7	26470.0	4580.6	401.5	2039.7	32731.7	66174.9	11451.6	1003.7	5099.3	935.2	1890.7	327.2	28.7	145.7					
		6		LCAC	Landing Craft Air Cushion	LCAC	16.8	100%	100.8	100%	0%	0%	100.8	0.0	0.0	25.41	55.3	0.7	43.3	3.9	2561.3	5576.3	72.6	4364.6	392.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
26B	Amphibious Ops	5		LHD	Large Helicopter-dock Ships	LHD-1	4.2	90%	18.9	0%	0%	100%	0.0	0.0	18.9	5.89	34.8	4.4	104.6	21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.6	658.7	83.7	1981.6	397.7					
				LHD	Large Helicopter-dock Ships	LHD-2	4.2	10%	2.1	0%	0%	100%	0.0	0.0	2.1	6.8	40.1	5.1	120.7	24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	84.5	10.7	254.1	51.0					
		5		LCAC	Landing Craft Air Cushion	LCAC	4.2	100%	21.1	0%	0%	100%	0.0	0.0	21.1	25.41	55.3	0.7	43.3	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	534.9	1164.5	15.2	911.5	81.9					
		74		CRRC	Combat Raiding Rubber Craft	CRRC-1	4.2	22%	68.5	28%	36%	36%	19.2	24.7	24.7	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.5					
				CRRC	Combat Raiding Rubber Craft	CRRC-4	4.2	27%	84.1	28%	36%	36%	23.6	30.3	30.3	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	4.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-5	4.2	51%	158.9	28%	36%	36%	44.5	57.2	57.2	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	6.6	0.0	0.0	0.0	0.0	8.5	0.0	0.0	0.0	0.0	8.5					
		5		LCU	Landing Craft Utility	LCU	4.2	100%	21.1	32%	0%	68%	6.7	0.0	14.3	36.21	45.0	0.5	3.1	1.6	243.9	302.8	3.5	20.9	10.6	0.0	0.0	0.0	0.0	0.0	518.3	643.4	7.4	44.5	22.5					
26C	Amphibious Ops	143		AAV/EFV	Amphibious Assault Vehicle	EFV-1	2.4	33%	112.0	28%	70%	2%	31.4	78.4	2.2	2.0611	4.17	0.72	0.06	0.3211	64.6	130.7	22.6	2.0	10.1	161.6	326.7	56.5	5.0	25.2	4.6	9.3	1.6	0.1	0.7					
						EFV-2	2.4	67%	224.0	28%	70%	2%	62.7	156.8	4.5	2.0611	4.17	0.72	0.06	0.3211	129.3	261.4	45.2	4.0	20.1	323.2	653.5	113.1	9.9	50.4	9.2	18.7	3.2	0.3	1.4					
26D	Amphibious Ops	5		AAV	Amphibious Assault Vehicle	AAV-1	2.4	20%	2.4	100%	0%	0%	2.4	0.0	0.0	0.444918	1.0	0.2	0.1	0.2	1.0	2.4	0.4	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						AAV-2	2.4	80%	9.4	100%	0%	0%	9.4	0.0	0.0	0.633674	3.8	0.2	0.1	0.3	6.0	35.3	1.6	1.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		3004		EFV	Amphibious Assault Vehicle	EFV-1	2.4	33%	2352.9	28%	70%	2%	658.8	1647.0	47.1	2.0611	4.17	0.72	0.06	0.3211	1357.9	2745.3	475.1	41.6	211.5	3394.7	6863.2	1187.7	104.1	528.9	97.0	196.1	33.9	3.0	15.1					
						EFV-2	2.4	67%	4706.5	28%	70%	2%	1317.8	3294.6	94.1	2.0611	4.17	0.72	0.06	0.3211	2716.2	5491.4	950.3	83.3	423.2	6790.4	13728.4	2375.7	208.2	1057.9	194.0	392.2	67.9	5.9	30.2					
		2268		RIB	Rigid Inflatable	RIB-1	2.4	7%	355.5	28%	70%	2%	99.5	248.8	7.1	0.04	1.6	0.0	0.2	0.0	4.0	158.3	1.0	16.9	2.0	10.0	395.7	2.5	42.3	5.0	0.3	11.3	0.1	1.2	0.1					
						RIB-3		13%	708.9	28%	70%	2%	198.5	496.2	14.2	0.08	3.0	0.0	0.4	0.0	15.9	595.4	2.0	71.5	7.9	39.7	1488.6	5.0	178.6	19.8	1.1	42.5	0.1	5.1	0.6					
						RIB-4		80%	4263.8	28%	70%	2%	1193.9	2984.7	85.3	0.34	9.1	0.1	1.4	0.2	405.9	10912.0	71.6	1719.2	179.1	1014.8	27280.0	179.1	4298.0	447.7	29.0	779.4	5.1	122.8	12.8					
		756		Support	Coastal Patrol-Independent Low Speed (	PC-1	2.4	20%	355.3	28%	70%	2%	99.5	248.7	7.1	6.5	12.5	1.1	2.5	0.4	646.7	1239.6	104.5	249.7	34.8	1616.7	3099.1	261.2	624.3	87.1	46.2	88.5	7.5	17.8	2.5					
					Dynamic Maneuvering	PC-3		80%	1421.3	28%	70%	2%	398.0	994.9	28.4	59.93	187.6	9.3	47.1	4.8	23849.6	74661.0	3709.0	18751.8	1898.3	59624.1	186652.4	9272.4	46879.5	4745.7	1703.5	5332.9	264.9	1339.4	135.6					
26E	Amphibious Ops	386		AAV	Amphibious Assault Vehicle	AAV-1	13.2	20%	1019.0	100%	0%	0%	1019.0	0.0	0.0	0.444918	1.0	0.2	0.1	0.2	453.4	1055.8	177.4	52.5	182.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						AAV-2	13.2	80%	4076.2	100%	0%	0%	4076.2	0.0	0.0	0.633674	3.8	0.2	0.1	0.3	2583.0	15319.8	698.9	429.2	1199.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		173		CRRC	Combat Raiding Rubber Craft	CRRC-1	13.2	28%	628.0	70%	30%	0%	439.6	188.4	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.7	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-4	13.2	18%	399.6	70%	30%	0%	279.7	119.9	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	36.9	0.0	0.0	0.0	0.0	15.8	0.0	0.0	0.0	0.0	0.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-5	13.2	55%	1256.0	70%	30%	0%	879.2	376.8	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	130.6	0.0	0.0	0.0	0.0	56.0	0.0	0.0	0.0	0.0	0.0					
26F	Amphibious Warfare	964		LCAC	Landing Craft Air Cushion	LCAC	8.5	100%	8194.0	16%	55%	29%	1311.0	4506.7	2376.3	25.41	55.3	0.7	43.3	3.9	33313.5	72526.7	943.9	56768.0	5099.9	114515.2	249310.6	3244.8	195140.1	17531.1	60380.8	131454.7	1710.9	102892.1	9243.7					
		221		LCU	Landing Craft Utility	LCU	8.5	100%	1878.5	75%	5%	20%	1408.9	93.9	375.7	36.21	45.0	0.5	3.1	1.6	51015.4	63328.9	732.6	4381.6	2211.9	3401.0	4221.9	48.8	292.1	147.5	13604.1	16887.7	195.4	1168.4	589.8					
		72		Support	Coastal Patrol-Independent Low Speed (	PC-2	8.5	100%	612.0	100%	0%	0%	612.0	0.0	0.0	17.21	38.1	2.9	8.2	0.9	10532.5	23341.7	1799.3	5036.8	563.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		72		LCM-8		LCU	8.5	100%	612.0	100%	0%	0%	612.0	0.0	0.0	36.21	45.0	0.5	3.1	1.6	22160.5	27509.4	318.2	1903.3	960.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		30		LARC		LCU	8.5	100%	255.0	100%	0%	0%	255.0	0.0	0.0	36.21	45.0	0.5	3.1	1.6	9233.6	11462.3	132.6	793.1	400.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		36		SLWT	SLWT (assume LPD)	LPD-2	8.5	20%	61.2	95%	5%	0%	58.1	3.1	0.0	2.935967	17.3	2.2	52.1	10.5	170.7	1007.1	128.0	3029.9	608.1	9.0	53.0	6.7	159.5	32.0	0.0	0.0	0.0	0.0	0.0					
						LPD-3	8.5	80%	244.8	95%	5%	0%	232.6	12.2	0.0	6.549492	38.6	4.9	116.3	23.3	1523.1	8986.6	1142.4	27035.9	5426.2	80.2	473.0	60.1	1422.9	285.6	0.0	0.0	0.0	0.0	0.0					
		36		SLWT	SLWT (assume LPD)	LPD-2	8.5	20%	61.2	95%	5%	0%	58.1	3.1	0.0	2.935967	17.3	2.2	52.1	10.5	170.7	1007.1	128.0	3029.9	608.1	9.0	53.0	6.7	159.5	32.0	0.0	0.0	0.0	0.0	0.0					
						LPD-3	8.5	80%	244.8	95%	5%	0%	232.6	12.2	0.0	6.549492	38.6	4.9	116.3	23.3	1523.1	8986.6	1142.4	27035.9	5426.2	80.2	473.0	60.1	1422.9	285.6	0.0	0.0	0.0	0.0	0.0					
		18		BW	Boston Whaler	BW-2	8.5	20%	30.6	95%	5%	0%	29.1	1.5	0.0	0	0.1	9.0	0.0	0.0	0.0	2.6	262.1	0.0	0.0	0.0	0.1	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						BW-3	8.5	80%	122.4	95%	5%	0%	116.3	6.1	0.0	0	0.3	26.3	0.0	0.0	0.0	30.7	3058.2	0.0	0.0	0.0	1.6	161.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
26G	Amphibious Ops	675		CRRC	Combat Raiding Rubber Craft	CRRC-1	6.2	28%	1141.6	80%	20%	0%	913.3	228.3	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.1	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-4	6.2	18%	726.5	80%	20%	0%	581.2	145.3	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	76.7	0.0	0.0	0.0	0.0	19.2	0.0	0.0	0.0	0.0	0.0					
				CRRC	Combat Raiding Rubber Craft	CRRC-5	6.2	55%	2283.2	80%	20%	0%	1826.6	456.6	0.0	0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	271.3	0.0	0.0	0.0	0.0	67.8	0.0	0.0	0.0	0.0	0.0					
27	Elec Combat	325		CVN	Nuclear Carrier (No emissions)																																			
		768		CG	Cruiser	CG-2	4.9	100%	3763.2	0%	3%	97%	0.0	112.9	3650.3	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	12167.9	5319.7	995.7	2373.1	296.9	393429.8	172002.3	32195.7	76729.4	9600.3					
		658		DDG	Guided Missile Destroyer	DDG-2	4.9	100%	3224.2	0%	3%	97%	0.0	96.7	3127.5	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	10058.5	4729.9	776.7	1735.3	237.9	325226.0	152933.5	25113.6	56106.9	7693.6					
		24		DD	Destroyer	DDG-2	4.9	100%	117.6	0%	3%	97%	0.0	3.5	114.1	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	366.9	172.5	28.3	63.3	8.7	11862.3	5578.1	916.0	2046.5	280.6					
		19		FFG	Guided Missile Frigate	FFG-2	4.9	100%	93.1	0%	3%	97%	0.0	2.8	90.3	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	186.6	189.1	21.8	32.3	9.1	6034.3	6115.6	705.3	1044.9	293.5					
		5		FFH	Canadian Frigate	FFG-2	4.9	100%	24.5	0%	3%	97%	0.0	0.7	23.8	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	49.1	49.8	5.7	8.5	2.4	1588.0	1609.4	185.6	275.0	77.2					
		5		AOE	Logistics/Support	AOE-1	4.9	100%	24.5	0%	3%	97%	0.0	0.7	23.8	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	2.7	16.2	2.1	48.6	9.8	88.6	522.6	66.3	1571.8	315.6					
		2		MHC		PC-1	4.9	100%	9.8	0%	3%	97%	0.0	0.3	9.5	6.5	12.5	1.1	2.5	0.4	0.0	0.0	0.0	0.0	0.0	1.9	3.7	0.3	0.7	0.1	61.8	118.4	10.0	23.9	3.3					
		17		LPD	Amphibious Transport Dock - Wasp	LPD-1	4.9	100%	83.3	0%	3%	97%	0.0	2.5	80.8	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	4.6	27.2	3.5	81.9	16.4	149.1	879.7	111.8	2646.7	531.2					
		238		LHD	Large Helicopter-dock Ships	LHD-1	4.9	100%	1166.2	0%	3%	97%	0.0	35.0	1131.2	5.89	34.8	4.4	104.6	21.0	0.0	0.0	0.0	0.0	0.0	206.1	1216.5	154.6	3659.5	734.4	6662.9	39332.3	5000.0	118325.0	23744.2					
		16		LSD	Landing Ship Dock	LPD-1	4.9	100%	78.4	0%	3%	97%	0.0	2.4	76.0	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	4.3	25.6	3.3	77.0	15.5	140.3	828.0	105.3	2491.0	500.0					
		181		LHA	Amphib. Assault Ship - Tarawa	LHA-1	4.9	100%	886.9	0%	3%	97%	0.0	26.6	860.3	7.38	43.5	5.5	131.0	26.3	0.0	0.0	0.0	0.0	0.0	196.4	1158.2	147.1	3484.7	699.5	6349.0	37448.6	4757.4	112672.6	22617.1					
		1		AGF		LPD-1	4.9	100%	4.9	0%	3%	97%	0.0	0.1	4.8	1.845393	10.9	1.4	32.8	6.6	0.0	0.0	0.0	0.0	0.0	0.3	1.6	0.2	4.8	1.0	8.8	51.7	6.6	155.7	31.2					
		4		WHEC	US Coast Guard	USCG	4.9	100%	19.6	0%	3%	97%	0.0	0.6	19.0	5.74	57.9	0.9	11.6	0.2	0.0	0.0	0.0	0.0	0.0	3.4	34.1	0.5	6.8	0.1	109.1	1101.0	16.7	219.6	4.0					
		149		Unknown		PC-1	4.9	100%	730.1	0%	3%	97%	0.0	21.9	708.2	6.5	12.5	1.1	2.5	0.4	0.0	0.0	0.0	0.0	0.0	142.4	272.9	23.0	55.0	7.7	4603.3	8824.1	743.6	1777.6	247.9					
		209		SSN	Submarines (No emissions)																																			
		42		SSBN	Submarines (No emissions)																																			
28A	Sm Obj Avoidance	9		CG	Cruiser	CG-2	1.8	100%	15.8	100%	0%	0%	15.8	0.0	0.0	107.78	47.1	8.8	21.0	2.6	1697.5	742.1	138.9	331.1	41.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		14		DDG	Guided Missile Destroyer	DDG-2	1.8	100%	24.5	100%	0%	0%	24.5	0.0	0.0	103.99	48.9	8.0	17.9	2.5	2547.8	1198.1	196.7	439.5	60.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		11		FFG	Guided Missile Frigate	FFG-2	1.8	100%	19.3	100%	0%	0%	19.3	0.0	0.0	66.82	67.7	7.8	11.6	3.3	1286.3	1303.6	150.3	222.7	62.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		16		MCM		USCG	1.8	100%	28.0	100%	0%	0%	28.0	0.0	0.0	5.74	57.9	0.9	11.6	0.2	160.7	1621.5	24.6	323.4	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		23		MHC		USCG	1.8	100%	40.3	100%	0%	0%	40.3	0.0	0.0	5.74	57.9	0.9	11.6	0.2	231.0	2330.9	35.4	464.9	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
29	Mine Neutralization	0																																						
30	Mining Exercise	2		MHC		USCG	0.5	100%	1.0	50%	40%	10%	0.5	0.4	0.1	5.74	57.9	0.9	11.6	0.2	2.9	29.0	0.4	5.8	0.1	2.3	23.2	0.4	4.6	0.1	0.6	5.8	0.1	1.2	0.0					
31	NSWC Land Demolition	6		CRRC		CRRC-2	4.0	90%	21.6	100%	0%	0%	21.6	0.0	0.0	0	0.0	2.3	0.0	0.0	0.0	0.6	49.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						CRRC-3		10%	2.4	100%	0%	0%	2.4	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	0.2	15.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
32	NSWC UW Demo	85		CRRC		CRRC-2	6.0	90%	459.0	100%	0%	0%	459.0	0.0	0.0	0	0.0	2.3	0.0	0.0	0.0	12.1	1052.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						CRRC-3		10%	51.0	100%	0%	0%	51.0	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	3.7	321.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
33	Mat Weave	36		CRRC		CRRC-2	4.0	90%	129.6	100%	0%	0%	129.6	0.0	0.0	0	0.0	2.3	0.0	0.0	0.0	3.4	297.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						CRRC-3		10%	14.4	100%	0%	0%	14.4	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	1.0	90.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
34	NSWC Small Arms	24		CRRC		CRRC-2	6.0	90%	129.6	100%	0%	0%	129.6	0.0	0.0	0	0.0	2.3	0.0	0.0	0.0	3.4	297.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
						CRRC-3		10%	14.4	100%	0%	0%	14.4	0.0	0.0	0	0.1	6.3	0.0	0.0	0.0	1.0	90.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
35	NSWC Land Nav	0																																						
36	NSW UAV Operationa	0																																						

Table C-3. Surface Ship Air Emissions—Alternative 2

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs)	Percent at Each Power Level	Total Time on Range (hrs)	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10
							Hours	%	Hours	Percent			Hours			CO	NOx	HC	SOx	PM10
37	Insertion/Extraction	0																		
38	NSW Boat Operations	245		MK V	MK V	MK-1	10.0	50%	1225.0	5%	42%	53%	61.3	514.5	649.3	1.94	14.8	0.5	2.4	0.2
						MK-3		50%	1225.0	5%	42%	53%	61.3	514.5	649.3	13.22	71.5	1.1	15.7	1.2
		75		RIB	Rigid Inflatable	RIB-3	10.0	50%	375.0	5%	42%	53%	18.8	157.5	198.8	0.08	3.0	0.0	0.4	0.0
						RIB-4		50%	375.0	5%	42%	53%	18.8	157.5	198.8	0.34	9.1	0.1	1.4	0.2
39	NSWG-1 Platoon Ops	4		PC	Coastal Patrol-Independent Low Speed (	PC-3	4.0	100%	16.0	20%	30%	50%	3.2	4.8	8.0	59.93	187.6	9.3	47.1	4.8
		49		CRRC		CRRC-5	0.5	100%	24.5	100%	0%	0%	24.5	0.0	0.0	0	0.1	12.9	0.0	0.0
		83		SOW	MK V	MK-3	0.5	100%	41.5	100%	0%	0%	41.5	0.0	0.0	13.22	71.5	1.1	15.7	1.2
40	Direct Action	2		PC	Coastal Patrol-Independent Low Speed (	PC-2	8.0	80%	12.8	30%	20%	50%	3.8	2.6	6.4	17.21	38.1	2.9	8.2	0.9
					Dynamic Maneuvering	PC-3		20%	3.2	30%	20%	50%	1.0	0.6	1.6	59.93	187.6	9.3	47.1	4.8
		4		SOW	MK V	MK-1	4.0	80%	12.8	30%	25%	45%	3.8	3.2	5.8	1.94	14.8	0.5	2.4	0.2
						MK-3		20%	3.2	30%	25%	45%	1.0	0.8	1.4	13.22	71.5	1.1	15.7	1.2
		1		LCAC	Landing Craft Air Cushion	LCAC	1.0	100%	1.0	100%	0%	0%	1.0	0.0	0.0	25.41	55.3	0.7	43.3	3.9
		12		CRRC	Combat Rubber Raiding Craft	CRRC-3	1.0	100%	12.0	100%	0%	0%	12.0	0.0	0.0	0	0.1	6.3	0.0	0.0
		12		SDV	Combat Rubber Raiding Craft	CRRC-3	1.0	100%	12.0	100%	0%	0%	12.0	0.0	0.0	0	0.1	6.3	0.0	0.0
41	Bombing Exercise - Land	0																		
42	CSAR	0																		
43	EOD Outside SHOBA	0																		
44	USCG Ops	149		Response	Coastal Patrol-Independent Low Speed (	PC-1	3.2	2%	9.5	80%	20%	0%	7.6	1.9	0.0	6.5	12.5	1.1	2.5	0.4
						PC-2		2%	9.5	80%	20%	0%	7.6	1.9	0.0	17.21	38.1	2.9	8.2	0.9
				Utility	Dynamic Maneuvering	PC-3		96%	457.7	80%	20%	0%	366.2	91.5	0.0	59.93	187.6	9.3	47.1	4.8
		149		Utility	Coastal Patrol-Independent Low Speed (	PC-1	3.2	15%	71.5	80%	20%	0%	57.2	14.3	0.0	6.5	12.5	1.1	2.5	0.4
						PC-2		60%	286.1	80%	20%	0%	228.9	57.2	0.0	17.21	38.1	2.9	8.2	0.9
					Dynamic Maneuvering	PC-3		25%	119.2	80%	20%	0%	95.4	23.8	0.0	59.93	187.6	9.3	47.1	4.8
		100		Cutter	US Coast Guard	USCG	3.2	100%	320.0	20%	20%	60%	64.0	64.0	192.0	5.74	57.9	0.9	11.6	0.2
		49		Cutter	US Coast Guard	USCG	3.2	100%	156.8	5%	5%	90%	7.8	7.8	141.1	5.74	57.9	0.9	11.6	0.2
45	NALF Airfield	0																		
46	Ship Torpedo Test	2		DDG	Guided Missile Destroyer	DDG-3	6.5	100%	13.0	0%	23%	77%	0.0	3.0	10.0	106.67	53.8	7.8	21.2	2.8
		2		DDH	Japanese Destroye Helo Deck (FMS)	CG-3	6.5	100%	13.0	0%	23%	77%	0.0	3.0	10.0	114.75	65.2	7.7	33.6	3.4
		2		DD	Japanese Destroyer (FMS)	CG-3	6.5	100%	13.0	0%	23%	77%	0.0	3.0	10.0	114.75	65.2	7.7	33.6	3.4
		6		FFH	Helicopter Frigate (Canadian)	FFG-3	6.5	100%	39.0	0%	23%	77%	0.0	9.0	30.0	120.04	78.1	11.6	16.1	4.3
47	UUV	15		BW	Boston Whalers	BW-1	10.0	100%	150.0	100%	0%	0%	150.0	0.0	0.0	0	0.1	7.5	0.0	0.0
		15		HS	Harbor Security	RIB-2	10.0	100%	150.0	100%	0%	0%	150.0	0.0	0.0	0.04	1.6	0.0	0.2	0.0
		30			Phanton DS4 (no emissions)					100%	0%	0%								
48	Sonobuoy QA/QC	62		AE	Acoustic Explorer	AE-2	4.0	100%	248.0	50%	30%	20%	124.0	74.4	49.6	20.17	20.9	1.0	6.0	1.6
49	Ocean Engineering	65		BW	Boston Whaler	BW-2	3.0	100%	195.0	100%	0%	0%	195.0	0.0	0.0	0	0.1	9.0	0.0	0.0
50	MM Mine Location	6		AE	Acoustic Explorer	AE-1	12.0	100%	72.0	100%	0%	0%	72.0	0.0	0.0	7.31	8.5	0.4	2.1	0.6
		30		BW	Boston Whaler	BW-2	12.0	100%	360.0	100%	0%	0%	360.0	0.0	0.0	0	0.1	9.0	0.0	0.0
51	Missile Flight Test	12		CG		CG-2	4.0	100%	48.0	0%	0%	100%	0.0	0.0	48.0	107.78	47.1	8.8	21.0	2.6
		24		DDG	Guided Missile Destroyer	DDG-2	4.0	100%	96.0	0%	0%	100%	0.0	0.0	96.0	103.99	48.9	8.0	17.9	2.5
52	NUWC UW Acoustic	139		FFG	Guided Missile Frigate	FFG-2	4.0	100%	556.0	0%	0%	100%	0.0	0.0	556.0	66.82	67.7	7.8	11.6	3.3
		38		AE	Acoustic Explorer	AE-1	4.0	100%	152.0	0%	0%	100%	0.0	0.0	152.0	7.31	8.5	0.4	2.1	0.6
		139		BW	Boston Whaler	BW-2	4.0	100%	556.0	0%	0%	100%	0.0	0.0	556.0	0	0.1	9.0	0.0	0.0
53	Other Tests	3		CG	Cruiser	CG-2	4.0	100%	12.0	0%	0%	100%	0.0	0.0	12.0	107.78	47.1	8.8	21.0	2.6
	(MCM, ASUW, FIREX)	10		DDG	Guided Missile Destroyer	DDG-2	4.0	100%	40.0	0%	0%	100%	0.0	0.0	40.0	103.99	48.9	8.0	17.9	2.5
		1		FFH	Helicopter Frigate (Canadian)	FFG-2	4.0	100%	4.0	0%	0%	100%	0.0	0.0	4.0	66.82	67.7	7.8	11.6	3.3
		11		DD	Japanese Destroyer (FMS)	CG-2	4.0	100%	44.0	0%	0%	100%	0.0	0.0	44.0	107.78	47.1	8.8	21.02	2.6
		2		AOR	Canadian	AOE-1	4.0	100%	8.0	0%	0%	100%	0.0	0.0	8.0	3.73	22.0	2.8	66.1	13.3
	Total	####																		

Emissions

Scenario	Vessel Mode	Emissions 0-3 nm Offshore (lbs) CO	Nox	HC	Sox	PM	Emissions 3-12 nm Offshore - US Territory (lbs) CO	Nox	HC	Sox	PM	Emissions >12 nm Offshore - Outside US Territory CO	Nox	HC	Sox	PM	CO	Nox	HC	Sox	PM
37																					
38	MK-1	118.8	908.3	30.6	146.4	12.3	998.1	7630.0	257.3	1229.7	102.9	1259.5	9628.4	324.6	1551.7	129.9					
	MK-3	809.7	4378.2	64.3	958.6	70.4	6801.7	36776.5	540.2	8051.9	591.7	8583.1	46408.4	681.7	10160.8	746.6					
	RIB-3	1.5	56.3	0.2	6.8	0.8	12.6	472.5	1.6	56.7	6.3	15.9	596.3	2.0	71.6	8.0					
	RIB-4	6.4	171.4	1.1	27.0	2.8	53.6	1439.6	9.5	226.8	23.6	67.6	1816.6	11.9	286.2	29.8					
39	PC-3	191.8	600.4	29.8	150.8	15.3	287.7	900.5	44.7	226.2	22.9	479.4	1500.9	74.6	377.0	38.2					
	CRRC-5	0.0	3.6	316.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
	MK-3	548.6	2966.4	43.6	649.5	47.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
40	PC-2	66.1	146.5	11.3	31.6	3.5	44.1	97.6	7.5	21.1	2.4	110.1	244.1	18.8	52.7	5.9					
	PC-3	57.5	180.1	8.9	45.2	4.6	38.4	120.1	6.0	30.2	3.1	95.9	300.2	14.9	75.4	7.6					
	MK-1	7.4	56.9	1.9	9.2	0.8	6.2	47.5	1.6	7.6	0.6	11.2	85.4	2.9	13.8	1.2					
	MK-3	12.7	68.6	1.0	15.0	1.1	10.6	57.2	0.8	12.5	0.9	19.0	102.9	1.5	22.5	1.7					
	LCAC	25.4	55.3	0.7	43.3	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
	CRRC-3	0.0	0.9	75.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
	CRRC-3	0.0	0.9	75.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
41																					
42																					
43																					
44	PC-1	49.6	95.1	8.0	19.1	2.7	12.4	23.8	2.0	4.8	0.7	0.0	0.0	0.0	0.0	0.0					
	PC-2	131.3	291.0	22.4	62.8	7.0	32.8	72.7	5.6	15.7	1.8	0.0	0.0	0.0	0.0	0.0					
	PC-3	21945.3	68699.5	3412.8	17254.5	1746.7	5486.3	17174.9	853.2	4313.6	436.7	0.0	0.0	0.0	0.0	0.0					
	PC-1	371.9	712.9	60.1	143.6	20.0	93.0	178.2	15.0	35.9	5.0	0.0	0.0	0.0	0.0	0.0					
	PC-2	3938.7	8728.9	672.9	1883.6	210.6	984.7	2182.2	168.2	470.9	52.6	0.0	0.0	0.0	0.0	0.0					
	PC-3	5714.9	17890.5	888.8	4493.4	454.9	1428.7	4472.6	222.2	1123.3	113.7	0.0	0.0	0.0	0.0	0.0					
	USCG	367.4	3706.2	56.3	739.2	13.4	367.4	3706.2	56.3	739.2	13.4	1102.1	11118.7	169.0	2217.6	40.3					
	USCG	45.0	454.0	6.9	90.6	1.6	45.0	454.0	6.9	90.6	1.6	810.0	8172.3	124.2	1629.9	29.6					
45																					
46	DDG-3	0.0	0.0	0.0	0.0	0.0	321.7	162.4	23.6	64.0	8.4	1065.0	537.5	78.3	211.9	28.0					
	CG-3	0.0	0.0	0.0	0.0	0.0	346.1	196.7	23.1	101.2	10.4	1145.7	651.2	76.6	335.0	34.3					
	CG-3	0.0	0.0	0.0	0.0	0.0	346.1	196.7	23.1	101.2	10.4	1145.7	651.2	76.6	335.0	34.3					
	FFG-3	0.0	0.0	0.0	0.0	0.0	1086.1	706.7	105.3	145.5	38.9	3595.4	2339.6	348.6	481.6	128.8					
47	BW-1	0.0	11.3	1127.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
	RIB-2	6.0	238.5	1.5	25.5	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
48	AE-2	2501.1	2595.3	122.8	740.3	194.7	1500.6	1557.2	73.7	444.2	116.8	1000.4	1038.1	49.1	296.1	77.9					
49	BW-2	0.0	17.7	1758.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
50	AE-1	526.3	609.1	27.4	152.6	39.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
	BW-2	0.0	32.6	3246.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
51	CG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5173.4	2261.8	423.4	1009.0	126.2					
	DDG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9983.0	4694.4	770.9	1722.2	236.2					
52	FFG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37151.9	37652.3	4342.4	6432.9	1807.0					
	AE-1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1111.1	1285.9	57.8	322.2	83.6					
	BW-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.4	5013.7	0.0	0.0					
53	CG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1293.4	565.4	105.8	252.2	31.6					
	DDG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4159.6	1956.0	321.2	717.6	98.4					
	FFG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	267.3	270.9	31.2	46.3	13.0					
	CG-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4742.3	2073.3	388.1	924.9	115.7					
	AOE-1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.8	175.9	22.3	529.1	106.2					
Total Emissions (SCI) tons		**12.09**	**19.82**	**5.99**	**12.03**	**5.51**	**71.36**	**45.13**	**6.65**	**22.83**	**7.51**	**670.52**	**521.13**	**62.50**	**328.43**	**90.70**	**55.85**	**35.60**	**5.03**	**14.24**	**2.28**
Total Emissions (SD) tons		**107.27**	**237.93**	**13.54**	**90.57**	**15.76**	**124.15**	**326.19**	**16.75**	**134.28**	**16.59**										
Total Emissions within US Territory (SCI)		**83.45**	**64.95**	**12.64**	**34.86**	**13.02**															
Total Emissions within US Territory (SD)		**231.42**	**564.12**	**30.29**	**224.86**	**32.36**															

Date: 13-May-2007

Notes: 1 - Ship nomenclature highlighted in yellow signifies no specific AQ Emissions data for that vessel.
For vessels without AQ emissions data, the following data was used:

Support (for USW)	TRB	AGF	LPD
Support (for Surf Firing)	PC	WHEC	USCG
MCM	USCG	Unknown (for Elec Combat)	PC
MHC	USCG	SOW	MKV
LSD	LPD	EFV	AAV
Unknown (for VBSS)	PC	DDH	CG
DD	CG	HS	RIB
FFH	FFG	AOR	AOE

Table C-4. Aircraft Air Emissions—No Action Alternative

Scenario	Type Training	A/C Sorties (No.)	Nomenclature	Ave. A/C Time on Range (hrs) (Hours)	Total Time on Range (hrs) (Hours)	% Below 3,000 ft (%)	Time Below 3,000 ft (Hours)	Percentage 0-3 nm from shore (Percent)	Percentage 3-12 nm from Shore (Percent)	Percentage >12 nm from Shore (Percent)	Total Time 0-3 nm from shore (Hours)	Total Time 3-12 nm from shore (Hours)	Total Time >12 nm from shore (Hours)	Scenario (No.)	Aircraft (Type)	Engines (Engine Model)	Engines (No.)	Fuel Flow (lbs/hr)
Training Operations																		
1	Air Combat Maneuvers	10200	FA-18E/F	1.1	1123.1			1%	2%	97%					FA-18E/F	F414-GE-400 (assume a	2	4049
		624	AV-8B	1.2	748.8			1%	2%	97%					AV-8B	F402-RR-406A (assume	1	6381
2	Air Defense Exercise	107	E-2	1.0	107.0	50%	53.5	1%	2%	97%	0.54	1.07	51.90		E-2	T56-A-425 (assume 30%	2	1100
		642	FA-18E/F	1.0	642.0	50%	321.0	1%	2%	97%	3.21	6.42	311.37		FA-18E/F	F414-GE-400 (assume a	2	4049
		107	S-3B	1.0	107.0	50%	53.5	1%	2%	97%	0.54	1.07	51.90		S-3B	TF34-GE-400 (assume t	2	1145
		321	FA-18E/F	1.0	321.0	50%	160.5	1%	2%	97%	1.61	3.21	155.69		FA-18E/F	F414-GE-400 (assume a	2	4049
		107	Learjet	1.0	107.0	50%	53.5	1%	2%	97%	0.54	1.07	51.90		Learjet	TFE 731-2-2B	2	531.76
3	S-A MISSILEX	1	SH-60B	1.0	1.0	100%	1.0	1%	2%	97%	0.01	0.02	0.97		SH-60B	T700-GE-401C	2	600
		1	P-3	3.0	3.0	67%	2.0	1%	2%	97%	0.02	0.04	1.94		P-3	T56-A-14 (assume ASU\	4	1200
		1	Learjet	1.5	1.5	67%	1.0	1%	2%	97%	0.01	0.02	0.97		Learjet	TFE 731-2-2B	2	531.76
		1	C-130	1.5	1.5	67%	1.0	1%	2%	97%	0.01	0.02	0.97		C-130	T56-A-425 (assume appı	4	850
4	S-A GUNEX	262	Learjet	1.5	393.0	50%	196.5	1%	2%	97%	1.97	3.93	190.61		Learjet	TFE 731-2-2B	2	531.76
5	A-A MISSILEX	52	FA-18A/C	2.0	104.0					100%					FA-18A/C	F404-GE-400 (assume a	2	3318
		78	FA-18E/F	2.0	156.0					100%					FA-18E/F	F414-GE-400 (assume a	2	4049
		13	E-2C	4.0	52.0					100%					E-2C	T56-A-425 (assume 40%	2	1100
		13	DC-130	4.0	52.0			1%	2%	97%					DC-130	T56-A-425 (assume appı	4	850
6	Helicopter ASW TRACKEX	95	SH-60B	3.6	342.0	100%	342.0		24%	76%		80.71	261.29	6	SH-60B	T700-GE-401C	2	600
		449	SH-60F	3.6	1616.4	100%	1616.4		24%	76%		381.47	#####		SH-60F	T700-GE-401C	2	600
7	Helicopter ASW TORPEX	65	SH-60B	3.6	234.0	100%	234.0		24%	76%		55.22	178.78	7	SH-60B	T700-GE-401C	2	600
		122	SH-60F	3.6	439.2	100%	439.2		24%	76%		103.65	335.55		SH-60F	T700-GE-401C	2	600
		16	Other Helo (SH-3)	3.6	57.6	100%	57.6		24%	76%		13.59	44.01		Other Helo (SH	T58-GE-402 (assume 49	2	529
8	MPA ASW TRACKEX	25	P-3	6.0	150.0	75%	112.5	5%	10%	85%	5.63	11.25	95.63		P-3	T56-A-14 (assume ASU\	4	1200
9	MPA ASW TORPEX	35	P-3	2.0	70.0	100%	70.0	1%	2%	97%	0.70	1.40	67.90		P-3	T56-A-14 (assume ASU\	4	1200
		9	SH-60B	2.0	18.0	100%	18.0	1%	2%	97%	0.18	0.36	17.46		SH-60B	T700-GE-401C	2	600
10	EER/IEER ASW	2	P-3	6.0	12.0	75%	9.0			100%			9.00		P-3	T56-A-14 (assume ASU\	4	1200
11	Surface Ship ASW TRACKEX																	
12	Surface Ship ASW TORPEX	7	Other Helo (SH-3)	3.7	25.9	100%	25.9	1%	2%	97%	0.26	0.52	25.12		Other Helo (SH	T58-GE-402 (assume 49	2	529
13	Submarine ASW TORPEX																	
14	Submarine ASW TORPEX																	
15	VBSS	12	SH-60B	4.0	48.0	100%	48.0			100%			48.00		SH-60B	T700-GE-401C	2	600
		1	SH-60F	4.0	4.0	100%	4.0			100%			4.00					
16	A-S MISSILEX	26	SH-60B	3.0	78.0	100%	78.0	1%	2%	97%	0.78	1.56	75.66		SH-60B	T700-GE-401C	2	600
		13	SH-60F	3.0	39.0	100%	39.0	1%	2%	97%	0.39	0.78	37.83		SH-60F	T700-GE-401C	2	600
		14	FA-18A/C	2.0	28.0			1%	2%	97%					FA-18A/C	F404-GE-400 (assume a	2	3318
		14	FA-18E/F	2.0	28.0			1%	2%	97%					FA-18E/F	F414-GE-400 (assume a	2	4049
		11	S-3B	3.0	33.0	100%	33.0	1%	2%	97%	0.33	0.66	32.01		S-3B	TF34-GE-400 (assume t	2	1145
17	A-S BOMBEX	17	FA-18A/C	1.0	17.0	10%	1.7		50%	50%		0.85	0.85		FA-18A/C	F404-GE-400 (assume a	2	3318
		17	FA-18E/F	1.0	17.0	10%	1.7		50%	50%		0.85	0.85		FA-18E/F	F414-GE-400 (assume a	2	4049
		9	P-3	1.0	9.0	10%	0.9		50%	50%		0.45	0.45		P-3	T56-A-14 (assume ASU\	4	1200
		15	S-3B	1.0	15.0	10%	1.5		50%	50%		0.75	0.75		S-3B	TF34-GE-400 (assume t	2	1145
18	A-S GUNEX	76	SH-60B	1.0	76.0	100%	76.0		50%	50%		38.00	38.00		SH-60B	T700-GE-401C	2	600
		26	SH-60F	1.0	26.0	100%	26.0		50%	50%		13.00	13.00		SH-60F	T700-GE-401C	2	600
		1	HH-60	1.0	1.0	100%	1.0		50%	50%		0.50	0.50		HH-60	T700-GE-401C	2	600
19	S-S GUNEX																	
20	SINKEX	4	E-2	16.0	64.0	10%	6.4			100%			6.40		E-2	T56-A-425 (assume 30%	2	1100
		16	FA-18E/F	16.0	256.0	10%	25.6			100%			25.60		FA-18E/F	F414-GE-400 (assume a	2	4049
		2	P-3	16.0	32.0	10%	3.2			100%			3.20		P-3	T56-A-14 (assume ASU\	4	1200
		4	SH-60B	16.0	64.0	10%	6.4			100%			6.40		SH-60B	T700-GE-401C	2	600
21	Naval Surface Fire Support Exercise																	
22	Expeditionary Fires Exercise	1	FA-18E/F	3.0	3.0	100%	3.0		100%			3.00			FA-18E/F	F414-GE-400 (assume a	2	4049
		1	AH-1	3.0	3.0	100%	3.0		100%			3.00			AH-1	T700-GE-401 (assume c	2	425.1
		1	AV-8B	3.0	3.0	100%	3.0		100%			3.00			AV-8B	F402-RR-406A (assume	1	6381
23	USMC Battalion Landing		FA-18A/C	0.5		15%		20%	50%	30%					FA-18A/C	F404-GE-400 (assume a	2	3318
			FA-18E/F	0.5		15%		20%	50%	30%					FA-18E/F	F414-GE-400 (assume a	2	4049
			AV-8B	0.5		25%		90%	5%	5%					AV-8B	F402-RR-406A (assume	1	6381
			AH-1	1.0		100%		90%	5%	5%					AH-1	T700-GE-401 (assume c	2	425.1
			C-130	1.4				20%	50%	30%					C-130	T56-A-425 (assume appı	4	850
			H-53	1.5		100%		90%	5%	5%					H-53	T64-GE-415 (assume crı	3	1488
			H-46	1.5		100%		90%	5%	5%					H-46	T58-GE-16	2	560
			UH-1	1.0		100%		90%	5%	5%					UH-1	T400-CP-400	2	346.2
24	USMC Stinger Firings																	
25	Amphibious Landings and Raids																	
25A	Amphibious Ops		AH-1	4.0		100%		100%							AH-1	T700-GE-401 (assume c	2	425.1
			CH-46	4.0		100%		100%							CH-46	T58-GE-16	2	560
			CH-53	4.0		100%		100%							CH-53	T64-GE-415 (assume crı	3	1488
			UH-1	4.0		100%		100%							UH-1	T400-CP-400	2	346.2
25B	Helicopter Assault		AH-1	2.0		60%		100%							AH-1	T700-GE-401 (assume c	2	425.1
			CH-46	2.0		60%		100%							CH-46	T58-GE-16	2	560
			CH-53	2.0		60%		100%							CH-53	T64-GE-415 (assume crı	3	1488
			AV-8B	2.0		60%		100%							AV-8B	F402-RR-406A (assume	1	6381
			UH-1	2.0		60%		100%							UH-1	T400-CP-400	2	346.2
25C	Armored Ops		AH-1	8.0		50%		100%							AH-1	T700-GE-401 (assume c	2	425.1
			AV-8B	8.0		50%		100%							AV-8B	F402-RR-406A (assume	1	6381
25D	Artillery Ops		AH-1	3.0		100%		100%							AH-1	T700-GE-401 (assume c	2	425.1
			CH-46	3.0		100%		100%							CH-46	T58-GE-16	2	560
			CH-53	3.0		100%		100%							CH-53	T64-GE-415 (assume crı	3	1488
25E	Amphibious Assault		AH-1	3.0		100%		100%							AH-1	T700-GE-401 (assume c	2	425.1
			CH-46	3.0		100%		100%							CH-46	T58-GE-16	2	560
			CH-53	3.0		100%		100%							CH-53	T64-GE-415 (assume crı	3	1488
			UH-1	3.0		100%		100%							UH-1	T400-CP-400	2	346.2
25F	Combat Engineer		None															
25G	AAV Ops		AH-1	4.0		100%		100%							AH-1	T700-GE-401 (assume c	2	425.1
25H	EFV Ops		AH-1	4.0		100%		100%							AH-1	T700-GE-401 (assume c	2	425.1
25I	Assault Amphibian School		None															
26	Amphibious Operations - CPAAA																	
26A	Amphibious Operations		None															
26B	Amphibious Operations	24	CH-46	4.2	101.0	100%	101.0	79%	21%		79.42	21.52			CH-46	T58-GE-16	2	560
		24	CH-53	4.2	101.0	100%	101.0	79%	21%		79.42	21.52			CH-53	T64-GE-415 (assume crı	3	1488
26C	Amphibious Operations		None															
26D	Amphibious Operations		None															
26E	Amphibious Operations	68	AV-8B	0.5	34.0	97%	33.0	50%	30%	20%	16.49	9.89	6.60		AV-8B	F402-RR-406A (assume	1	6381
		80	AH-1	0.5	40.0	97%	38.8	50%	30%	20%	19.40	11.64	7.76		AH-1	T700-GE-401 (assume c	2	425.1
		59	UH-1	0.5	29.5	97%	28.6	50%	30%	20%	14.31	8.58	5.72		UH-1	T400-CP-400	2	346.2

Scenario	Aircraft Type	Emission Indices, lbs/1,000 lbs fuel: CO	NOx	HC	SOx	PM10	Emissions Factors (lb/hr): CO	NOx	HC	SOx	PM10
1	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	AV-8B	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
2	E-2	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	S-3B	14.10	4.07	1.86	0.40	3.62	32.29	9.32	4.26	0.92	8.29
	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	Learjet	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
3	SH-60B	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	P-3	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
	Learjet	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
	C-130	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
4	Learjet	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
5	FA-18A/C	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	E-2C	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
	DC-130	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
6	SH-60B	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	SH-60F	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
7	SH-60B	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	SH-60F	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	Other Helo (SH	21.28	3.88	2.20	0.40	4.00	22.51	4.11	2.33	0.42	4.23
8	P-3	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
9	P-3	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
	SH-60B	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
10	P-3	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
12	Other Helo (SH	21.28	3.88	2.20	0.40	4.00	22.51	4.11	2.33	0.42	4.23
15	SH-60B	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
16	SH-60B	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	SH-60F	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	FA-18A/C	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	S-3B	14.10	4.07	1.86	0.40	3.62	32.29	9.32	4.26	0.92	8.29
17	FA-18A/C	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	P-3	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
	S-3B	14.10	4.07	1.86	0.40	3.62	32.29	9.32	4.26	0.92	8.29
18	SH-60B	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	SH-60F	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	HH-60	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
20	E-2	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	P-3	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
	SH-60B	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
22	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	AH-1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
	AV-8B	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
23	FA-18A/C	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	AV-8B	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
	AH-1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
	C-130	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
	H-53	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
	H-46	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
	UH-1	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91
25A	AH-1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
	CH-46	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
	CH-53	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
	UH-1	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91
25B	AH-1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
	CH-46	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
	CH-53	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
	AV-8B	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
	UH-1	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91
25C	AH-1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
	AV-8B	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
25D	AH-1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
	CH-46	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
	CH-53	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
25E	AH-1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
	CH-46	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
	CH-53	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
	UH-1	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91
25G	AH-1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
25H	AH-1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
26B	CH-46	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
	CH-53	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
26E	AV-8B	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
	AH-1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
	UH-1	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91

Emissions

Scenario	Aircraft Type	Emissions 0-3 nm Offshore (lbs): CO	NOx	HC	SOx	PM	Emissions 3-12 nm Offshore—US Territory (lbs): CO	NOx	HC	SOx	PM	Emissions >12 nm Offshore—Outside US Territory, Offshore San Diego: CO	NOx	HC	SOx	PM	Offshore Mexico			SOx	PM
2	E-2	2.54	9.49	0.58	0.47	4.67	5.08	18.97	1.15	0.94	9.35	246.61	920.20	55.94	45.67	453.25					
	FA-18E/F	23.14	301.02	3.12	10.40	164.03	46.27	602.03	6.24	20.80	328.05	2244.11	29198.67	302.58	1008.59	15910.50					
	S-3B	17.27	4.99	2.28	0.49	4.44	34.55	9.97	4.56	0.98	8.87	1675.64	483.68	221.04	47.54	430.20					
	FA-18E/F	11.57	150.51	1.56	5.20	82.01	23.14	301.02	3.12	10.40	164.03	1122.06	14599.34	151.29	504.29	7955.25					
	Learjet	12.73	3.36	2.44	0.31	2.39	25.47	6.71	4.87	0.61	4.78	1235.18	325.63	236.22	29.80	231.80					
3	SH-60B	0.08	0.08	0.01	0.00	0.05	0.15	0.15	0.01	0.01	0.10	7.28	7.45	0.64	0.47	4.89					
	P-3	0.17	0.81	0.04	0.04	0.38	0.35	1.62	0.08	0.08	0.76	16.96	78.54	3.82	3.73	36.99					
	Learjet	0.24	0.06	0.05	0.01	0.04	0.48	0.13	0.09	0.01	0.09	23.10	6.09	4.42	0.56	4.33					
	C-130	0.14	0.23	0.03	0.01	0.14	0.27	0.46	0.07	0.03	0.27	13.30	22.14	3.20	1.32	13.10					
4	Learjet	46.77	12.33	8.94	1.13	8.78	93.54	24.66	17.89	2.26	17.55						4536.70	1196.00	867.61	109.46	851.39
6	SH-60B						605.34	619.87	53.27	38.74	406.79	1959.66	2006.69	172.45	125.42	1316.89					
	SH-60F						2861.03	2929.69	251.77	183.11	1922.61	9261.97	9484.26	815.05	592.77	6224.05					
7	SH-60B						414.18	424.12	36.45	26.51	278.33	1340.82	1373.00	117.99	85.81	901.03					
	SH-60F						777.38	796.04	68.41	49.75	522.40	2516.62	2577.01	221.46	161.06	1691.17					
	Other Helo (SH						306.05	55.80	31.64	5.75	57.53	990.77	180.65	102.43	18.62	186.24					
8	P-3	49.14	227.61	11.07	10.80	107.19	98.28	455.22	22.14	21.60	214.38	835.38	3869.37	188.19	183.60	1822.23					
9	P-3	6.12	28.32	1.38	1.34	13.34	12.23	56.65	2.76	2.69	26.68	593.17	2747.51	133.63	130.37	1293.90					
	SH-60B	1.35	1.38	0.12	0.09	0.91	2.70	2.76	0.24	0.17	1.81	130.95	134.09	11.52	8.38	88.00					
10	P-3											78.62	364.18	17.71	17.28	171.50					
12	Other Helo (SH	5.83	1.06	0.60	0.11	1.10	11.66	2.13	1.21	0.22	2.19	565.63	103.13	58.48	10.63	106.32					
15	SH-60B											360.00	368.64	31.68	23.04	241.92					
16	SH-60B	5.85	5.99	0.51	0.37	3.93	11.70	11.98	1.03	0.75	7.86	567.45	581.07	49.94	36.32	381.33					
	SH-60F	2.93	3.00	0.26	0.19	1.97	5.85	5.99	0.51	0.37	3.93	283.73	290.53	24.97	18.16	190.66					
	S-3B	10.66	3.08	1.41	0.30	2.74	21.31	6.15	2.81	0.60	5.47	1033.57	298.34	136.34	29.32	265.36					
17	FA-18A/C						13.76	38.02	2.48	2.26	35.87	13.76	38.02	2.48	2.26	35.87					
	FA-18E/F						6.13	79.71	0.83	2.75	43.43	6.13	79.71	0.83	2.75	43.43					
	P-3						3.93	18.21	0.89	0.86	8.58	3.93	18.21	0.89	0.86	8.58					
	S-3B						24.22	6.99	3.19	0.69	6.22	24.22	6.99	3.19	0.69	6.22					
18	SH-60B						285.00	291.84	25.08	18.24	191.52	285.00	291.84	25.08	18.24	191.52					
	SH-60F						97.50	99.84	8.58	6.24	65.52	97.50	99.84	8.58	6.24	65.52					
	HH-60						3.75	3.84	0.33	0.24	2.52	3.75	3.84	0.33	0.24	2.52					
20	E-2																30.41	113.48	6.90	5.63	55.90
	FA-18E/F																184.50	2400.64	24.88	82.92	1308.12
	P-3																27.96	129.48	6.30	6.14	60.98
	SH-60B																48.00	49.15	4.22	3.07	32.26
22	FA-18E/F						21.62	281.32	2.92	9.72	153.30										
	AH-1						26.88	14.16	1.43	1.02	10.71										
	AV-8B						147.40	164.63	10.34	7.66	72.74										
26B	CH-46	1755.82	350.45	305.09	35.58	158.33	475.81	94.97	82.68	9.64	42.91										
	CH-53	755.13	2864.52	53.18	141.81	783.49	204.63	776.26	14.41	38.43	212.32										
26E	AV-8B	810.21	904.92	56.82	42.09	399.85	486.13	542.95	34.09	25.25	239.91	324.09	361.97	22.73	16.84	159.94					
	AH-1	173.85	91.54	9.24	6.60	69.27	104.31	54.92	5.54	3.96	41.56	69.54	36.62	3.69	2.64	27.71					
	UH-1	10.01	57.36	1.29	3.96	41.61	6.00	34.42	0.77	2.38	24.96	4.00	22.94	0.52	1.59	16.64					

Scenario No.	Type Training	A/C Sorties No.	Nomenclature	Ave. A/C Time on Range (hrs) Hours	Total Time on Range (hrs) Hours	% Below 3,000 ft %	Time Below 3,000 ft Hours	Percentage 0-3 nm from shore (Percent)	Percentage 3-12 nm from Shore (Percent)	Percentage >12 nm from Shore (Percent)	Total Time 0-3 nm from shore (Hours)	Total Time 3-12 nm from shore (Hours)	Total Time >12 nm from shore (Hours)	Scenario No.	Aircraft Type	Engines Engine Model	No.	Fuel Flow lbs/hr
		62	CH-46	0.5	31.0	97%	30.1	50%	30%	20%	15.04	9.02	6.01		CH-46	T58-GE-16	2	560
		228	CH-53	0.5	114.0	97%	110.6	50%	30%	20%	55.29	33.17	22.12		CH-53	T64-GE-415 (assume cr	3	1488
26F	Amphibious Operations		None															
26G	Amphibious Operations		None															
27	Electronic Combat Exercise	60	SH-60B	2.1	126.0	100%	126.0		3%	97%		3.78	122.22		SH-60B	T700-GE-401C	2	600
		37	SH-60F	2.1	77.7	100%	77.7		3%	97%		2.33	75.37		SH-60F	T700-GE-401C	2	600
		3	HH-60	2.1	6.3	100%	6.3		3%	97%		0.19	6.11		HH-60	T700-GE-401C	2	600
		31	P-3	2.0	62.0				3%	97%					P-3	T56-A-14 (assume ASU\	4	1200
		202	FA-18A/C	2.0	404.0				3%	97%					FA-18A/C	F404-GE-400 (assume a	2	3318
		203	FA-18E/F	2.0	406.0				3%	97%					FA-18E/F	F414-GE-400 (assume a	2	4049
		15	E-2C	2.0	30.0				3%	97%					E-2C	T56-A-425 (assume 40%	2	1100
		17	EA-6B	2.0	34.0				3%	97%					EA-6B	J52-P-408A (assume ap	2	4227
		144	Learjet	2.0	288.0				3%	97%					Learjet	TFE 731-2-2B	2	531.76
		8	Unknown	2.0	16.0				3%	97%					Unknown	TFE 731-2-2B	2	531.76
28A	Small Object Avoidance	15	MH-60R	1.8	26.3	100%	26.3	100%			26.25				MH-60R	T700-GE-401C	2	600
29	Mine Neutralization																	
30	Mine Laying	5	P-3	0.9	4.5	67%	3.0	50%	40%	10%	1.50	1.20	0.30		P-3	T56-A-14 (assume ASU\	4	1200
		11	FA-18A/C	0.5	5.5	7%	0.4	50%	40%	10%	0.18	0.15	0.04		FA-18A/C	F404-GE-400 (assume a	2	3318
		10	FA-18E/F	0.5	5.0	7%	0.3	50%	40%	10%	0.17	0.13	0.03		FA-18E/F	F414-GE-400 (assume a	2	4049
31	NSW Center Land Demolitions																	
32	NSWC Underwater Demolitions		NONE															
33	NSWC Underwater Mat Weave		NONE															
34	NSWC BUD/S Small Arms Training	10	SH-60F	6.0	60.0	100%	60.0	100%			60.00				SH-60F	T700-GE-401C	2	600
35	NSWC BUD/S Land Navigation		NONE															
36	NSW UAV Operations	16	Neptune/Scan	1.0	16.0	100%	16.0	100%			16.00							
37	Insertion/Extraction	5	C-130	2.0	10.0	50%	5.0		5%	95%		0.25	4.75		C-130	T56-A-425 (assume app	4	850
38	NSW Boat Operations																	
39	NSW GRU ONE SEAL Platoon Ops	3	SH-60B	8.0	24.0	100%	24.0	20%	30%	50%	4.80	7.20	12.00		SH-60B	T700-GE-401C	2	600
		1	SH-60F	8.0	8.0	100%	8.0	20%	30%	50%	1.60	2.40	4.00		SH-60F	T700-GE-401C	2	600
		6	CH-46	8.0	48.0	100%	48.0	20%	30%	50%	9.60	14.40	24.00		CH-46	T58-GE-16	2	560
40	Direct Action																	
41	Bombing Exercise - Land	2	SH-60F	2.5	5.0	100%	5.0	40%	40%	20%	2.00	2.00	1.00		SH-60F	T700-GE-401C	2	600
		389	FA-18A/C	1.0	389.0	10%	38.9	10%	30%	60%	3.89	11.67	23.34		FA-18A/C	F404-GE-400 (assume a	2	3318
		388	FA-19E/F	1.0	388.0	10%	38.8	10%	30%	60%	3.88	11.64	23.28		FA-19E/F	F414-GE-400 (assume a	2	4049
		12	E-2	2.5	30.0					100%					E-2	T56-A-425 (assume 40%	2	1100
		7	EA-6B	2.5	17.5					100%					EA-6B	J52-P-408A (assume ap	2	4227
		6	AH-1	2.5	15.0	100%	15.0	40%	40%	20%	6.00	6.00	3.00		AH-1	T700-GE-401 (assume c	2	425.1
		1	AV-8B	1.0	1.0	20%	0.2	30%	50%	20%	0.06	0.10	0.04		AV-8B	F402-RR-406A (assume	1	6381
		3	KC-130	1.0	3.0			10%	30%	60%					KC-130	T56-A-425 (assume app	4	850
			H-53	2.5		100%		40%	40%	20%					H-53	T64-GE-415 (assume cr	3	1488
			H-46	2.5		100%		40%	40%	20%					H-46	T58-GE-16	2	560
42	Combat Search and Rescue	49	MH-60S	3.0	147.0	100%	147.0	40%	40%	20%	58.80	58.80	29.40		MH-60S	T700-GE-401C	2	600
		133	FA-18A/C	1.5	199.5	10%	20.0	10%	30%	60%	2.00	5.99	11.97		FA-18A/C	F404-GE-400 (assume a	2	3318
		133	FA-18E/F	1.5	199.5	10%	20.0	10%	30%	60%	2.00	5.99	11.97		FA-18E/F	F414-GE-400 (assume a	2	4049
		14	E-2	3.0	42.0					100%					E-2	T56-A-425 (assume 40%	2	1100
43	EOD Outside SHOBA																	
44	USCG Ops	70	HH-60	3.2	224.0	100%	224.0	50%	30%	20%	112.00	67.20	44.80		HH-60	T700-GE-401C	2	600
45	NALF Airfield		See NALF Ops															
46	Ship Torpedo Tests	3	SH-60B	3.0	9.0	100%	9.0		23%	77%		2.09	6.91		SH-60B	T700-GE-401C	2	600
		15	MH-60R	3.0	45.0	100%	45.0		23%	77%		10.44	34.56		MH-60R	T700-GE-401C	2	600
		2	SH-3	3.0	6.0	100%	6.0		23%	77%		1.39	4.61		SH-3	T58-GE-402 (assume 49	2	529
47	Unmanned Underwater Vehicle Test		NONE															
48	Sonobuoy QA/QC Test	2	P-3	5.0	10.0	100%	10.0	50%	30%	20%	5.00	3.00	2.00		P-3	T56-A-14 (assume ASU\	4	1200
		115	NC-12B Kingair	3.0	345.0	100%	345.0	50%	30%	20%	172.50	103.50	69.00		NC-12B Kinga	PT6A-42 (assume appro	2	249
49	Ocean Engineering		NONE	NONE														
50	Marine Mammal Mine Shape Location		NONE	NONE														
51	Missile Flight Test	1	SH-60B	4.0	4.0	100%	4.0	5%	10%	85%	0.20	0.40	3.40		SH-60B	T700-GE-401C	2	600
		4	P-3	4.0	16.0	50%	8.0	5%	10%	85%	0.40	0.80	6.80		P-3	T56-A-14 (assume ASU\	4	1200
		6	FA-18A/C	4.0	24.0				5%	95%					FA-18A/C	F404-GE-400 (assume a	2	3318
		3	FA-18E/F	4.0	12.0				5%	95%					FA-18E/F	F414-GE-400 (assume a	2	4049
		2	Learjet	4.0	8.0				5%	95%					Learjet	TFE 731-2-2B	2	531.76
		1	Gulfstream	4.0	4.0				5%	95%					Gulfstream	BR700-710A1-10	2	1698
		1	Other Helo	4.0	4.0	100%	4.0	5%	10%	85%	0.20	0.40	3.40		Other Helo (S-	T58-GE-402 (assume 49	2	529
52	NUWC Underwater Acoustics Testing		NONE															
53	Other Tests	4	SH-60F	4.0	16.0	100%	16.0	5%	8%	77%	0.80	1.28	12.32		SH-60F	T700-GE-401C	2	600
		2	P-3	4.0	8.0	50%	4.0	5%	8%	77%	0.20	0.32	3.08		P-3	T56-A-14 (assume ASU\	4	1200
		2	Learjet	4.0	8.0			1%	2%	97%					Learjet	TFE 731-2-2B	2	531.76
		1	Other Helo	4.0	4.0	100%	4.0	5%	8%	77%	0.20	0.32	3.08		Other Helo (S-	T58-GE-402 (assume 49	2	529
	Totals	16354																

Scenario No.	Aircraft Type	Emission Indices, lbs/1,000 lbs fuel CO	NOx	HC	SOx	PM10	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10	Emissions: Emissions 0-3 nm Offshore (lbs) CO	NOx	HC	SOx	PM	Emissions 3-12 nm Offshore—US Territory (lbs) CO	NOx	HC	SOx	PM	Emissions >12 nm Offshore—Outside US Territory CO	NOx	HC	SOx	PM				SOx	PM
	CH-46	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99	332.41	66.35	57.76	6.74	29.97	199.44	39.81	34.66	4.04	17.98	132.96	26.54	23.10	2.69	11.99					
	CH-53	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87	525.72	1994.26	37.02	98.73	545.46	315.43	1196.56	22.21	59.24	327.28	210.29	797.70	14.81	39.49	218.18					
27	SH-60B	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04						28.35	29.03	2.49	1.81	19.05	916.65	938.65	80.67	58.67	615.99					
	SH-60F	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04						17.48	17.90	1.54	1.12	11.75	565.27	578.83	49.74	36.18	379.86					
	HH-60	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04						1.42	1.45	0.12	0.09	0.95	45.83	46.93	4.03	2.93	30.80					
	P-3	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06																				
	FA-18A/C	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20																				
	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10																				
	E-2C	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73																				
	EA-6B	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60																				
	Learjet	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47																				
	Unknown	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47																				
28A	MH-60R	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	196.88	201.60	17.33	12.60	132.30															
30	P-3	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	13.10	60.70	2.95	2.88	28.59	10.48	48.56	2.36	2.30	22.87	2.62	12.14	0.59	0.58	5.72					
	FA-18A/C	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20	2.97	8.20	0.54	0.49	7.74	2.38	6.56	0.43	0.39	6.19	0.59	1.64	0.11	0.10	1.55					
	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10	1.20	15.64	0.16	0.54	8.52	0.96	12.51	0.13	0.43	6.82	0.24	3.13	0.03	0.11	1.70					
34	SH-60F	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	450.00	460.80	39.60	28.80	302.40															
37	C-130	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50						3.43	5.70	0.82	0.34	3.37	65.08	108.37	15.67	6.46	64.12					
39	SH-60B	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	36.00	36.86	3.17	2.30	24.19	54.00	55.30	4.75	3.46	36.29	90.00	92.16	7.92	5.76	60.48					
	SH-60F	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	12.00	12.29	1.06	0.77	8.06	18.00	18.43	1.58	1.15	12.10	30.00	30.72	2.64	1.92	20.16					
	CH-46	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99	212.24	42.36	36.88	4.30	19.14	318.37	63.54	55.32	6.45	28.71	530.61	105.91	92.20	10.75	47.85					
41	SH-60F	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	15.00	15.36	1.32	0.96	10.08	15.00	15.36	1.32	0.96	10.08	7.50	7.68	0.66	0.48	5.04					
	FA-18A/C	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20	62.99	173.99	11.36	10.33	164.18	188.96	521.96	34.07	30.98	492.53	377.92	1043.92	68.15	61.95	985.06					
	FA-19E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10	27.96	363.85	3.77	12.57	198.26	83.89	1091.54	11.31	37.70	594.79	167.78	2183.08	22.62	75.41	1189.57					
	E-2	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73																				
	EA-6B	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60																				
	AH-1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57	53.77	28.31	2.86	2.04	21.43	53.77	28.31	2.86	2.04	21.43	26.88	14.16	1.43	1.02	10.71					
	AV-8B	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25	2.95	3.29	0.21	0.15	1.45	4.91	5.49	0.34	0.26	2.42	1.97	2.20	0.14	0.10	0.97					
	KC-130	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50																				
	H-53	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87																				
	H-46	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99																				
42	MH-60S	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	441.00	451.58	38.81	28.22	296.35	441.00	451.58	38.81	28.22	296.35	220.50	225.79	19.40	14.11	148.18					
	FA-18A/C	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20	32.30	89.23	5.83	5.30	84.20	96.91	267.69	17.48	15.89	252.60	193.82	535.38	34.95	31.77	505.19					
	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10	14.38	187.08	1.94	6.46	101.94	43.14	561.24	5.82	19.39	305.82	86.27	1122.48	11.63	38.77	611.65					
	E-2	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73																				
44	HH-60	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	840.00	860.16	73.92	53.76	564.48	504.00	516.10	44.35	32.26	338.69	336.00	344.06	29.57	21.50	225.79					
46	SH-60B	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04						15.66	16.04	1.38	1.00	10.52	51.84	53.08	4.56	3.32	34.84					
	MH-60R	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04						78.30	80.18	6.89	5.01	52.62	259.20	265.42	22.81	16.59	174.18					
	SH-3	21.28	3.88	2.20	0.40	4.00	22.51	4.11	2.33	0.42	4.23						31.34	5.71	3.24	0.59	5.89	103.75	18.92	10.73	1.95	19.50					
48	P-3	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	43.68	202.32	9.84	9.60	95.28	26.21	121.39	5.90	5.76	57.17	17.47	80.93	3.94	3.84	38.11					
	NC-12B Kinga	4.93	4.42	0.23	0.40	4.20	2.46	2.20	0.11	0.20	2.09	423.51	379.70	19.76	34.36	360.80	254.11	227.82	11.85	20.62	216.48	169.40	151.88	7.90	13.74	144.32					
51	SH-60B	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	1.50	1.54	0.13	0.10	1.01	3.00	3.07	0.26	0.19	2.02	25.50	26.11	2.24	1.63	17.14					
	P-3	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	3.49	16.19	0.79	0.77	7.62	6.99	32.37	1.57	1.54	15.24	59.40	275.16	13.38	13.06	129.58					
	FA-18A/C	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20																				
	FA-18E/F	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10																				
	Learjet	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47																				
	Gulfstream	4.78	7.68	0.05	1.00	0.00	16.23	26.08	0.17	3.40	0.00																				
	Other Helo (S-	21.28	3.88	2.20	0.40	4.00	22.51	4.11	2.33	0.42	4.23	4.50	0.82	0.47	0.08	0.85	9.01	1.64	0.93	0.17	1.69	76.55	13.96	7.91	1.44	14.39					
53	SH-60F	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	6.00	6.14	0.53	0.38	4.03	9.60	9.83	0.84	0.61	6.45	92.40	94.62	8.13	5.91	62.09					
	P-3	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	1.75	8.09	0.39	0.38	3.81	2.80	12.95	0.63	0.61	6.10	26.91	124.63	6.06	5.91	58.69					
	Learjet	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47																				
	Other Helo (S-	21.28	3.88	2.20	0.40	4.00	22.51	4.11	2.33	0.42	4.23	4.50	0.82	0.47	0.08	0.85	7.20	1.31	0.74	0.14	1.35	69.34	12.64	7.17	1.30	13.03					
							Total Emissions (SCI) tons					**1.13**	**1.76**	**0.12**	**0.10**	**1.14**	**3.91**	**5.52**	**0.39**	**0.30**	**3.54**	**16.45**	**40.16**	**1.85**	**1.81**	**23.16**	**2.41**	**1.94**	**0.45**	**0.10**	**1.15**
							Total Emissions (SD) tons					**2.60**	**3.59**	**0.30**	**0.19**	**1.30**	**1.15**	**1.63**	**0.12**	**0.09**	**0.62**										

Source: SCORE FY2004 Participants Conversion.xls

Table C-5. Aircraft Air Emissions—Alternative 1

Scenario	Type Training	A/C Sorties	Nomenclature	Ave. A/C Time on Range (hrs)	Total Time on Range (hrs)	% Below 3,000 ft	Time Below 3,000 ft	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore
		No.		Hours	Hours	%	Hours	Percent			Hours		
Training Operations													
1	Air Combat Maneuvers	11223	FA-18E/F	1.1	1123.1			1%	2%	97%			
		687	AV-8B	1.2	824.4			1%	2%	97%			
2	Air Defense Exercise	111	E-2	1.0	111.0	50%	55.5	1%	2%	97%	0.56	1.11	53.84
		665	FA-18E/F	1.0	665.0	50%	332.5	1%	2%	97%	3.33	6.65	322.53
			S-3B	1.0		50%		1%	2%	97%			
		333	FA-18E/F	1.0	333.0	50%	166.5	1%	2%	97%	1.67	3.33	161.51
		111	Learjet	1.0	111.0	50%	55.5	1%	2%	97%	0.56	1.11	53.84
3	S-A MISSILEX	4	SH-60B	1.0	4.0	100%	4.0	1%	2%	97%	0.04	0.08	3.88
		4	P-3	3.0	12.0	67%	8.0	1%	2%	97%	0.08	0.16	7.76
		4	Learjet	1.5	6.0	67%	4.0	1%	2%	97%	0.04	0.08	3.88
		4	C-130	1.5	6.0	67%	4.0	1%	2%	97%	0.04	0.08	3.88
4	S-A GUNEX	350	Learjet	1.5	525.0	50%	262.5	1%	2%	97%	2.63	5.25	254.63
5	A-A MISSILEX	52	FA-18A/C	2.0	104.0					100%			
		78	FA-18E/F	2.0	156.0					100%			
		13	E-2C	4.0	52.0					100%			
		13	DC-130	4.0	52.0			1%	2%	97%			
6	Helicopter ASW TRACKEX	1690	MH-60R	3.6	6084.0	100%	6084.0		24%	76%		#####	#####
7	Helicopter ASW TORPEX	245	MH-60R	3.6	882.0	100%	882.0		24%	76%		208.15	673.85
		21	Other Helo (SH-3)	3.6	75.6	100%	75.6		24%	76%		17.84	57.76
8	MPA ASW TRACKEX	28	P-3	6.0	168.0	75%	126.0	5%	10%	85%	6.30	12.60	107.10
9	MPA ASW TORPEX	37	P-3	2.0	74.0	100%	74.0	1%	2%	97%	0.74	1.48	71.78
		10	SH-60B	2.0	20.0	100%	20.0	1%	2%	97%	0.20	0.40	19.40
10	EER/IEER ASW	3	P-3	6.0	18.0	75%	13.5			100%			13.50
11	Surface Ship ASW TRACKEX												
12	Surface Ship ASW TORPEX	8	Other Helo (SH-3)	3.7	29.6	100%	29.6	1%	2%	97%	0.30	0.59	28.71
13	Submarine ASW TORPEX												
14	Submarine ASW TORPEX												
15	VBSS	18	MH-60R	4.0	72.0	100%	72.0			100%			72.00
16	A-S MISSILEX	41	MH-60R	3.0	123.0	100%	123.0	1%	2%	97%	1.23	2.46	119.31
		15	FA-18A/C	2.0	30.0			1%	2%	97%			
		15	FA-18E/F	2.0	30.0			1%	2%	97%			
			S-3B	3.0		100%		1%	2%	97%			
17	A-S BOMBEX	19	FA-18A/C	1.0	19.0	10%	1.9		50%	50%		0.95	0.95
		19	FA-18E/F	1.0	19.0	10%	1.9		50%	50%		0.95	0.95
		10	P-3	1.0	10.0	10%	1.0		50%	50%		0.50	0.50
			S-3B	1.0		10%			50%	50%			
18	A-S GUNEX	110	MH-60R	1.0	110.0	100%	110.0		50%	50%		55.00	55.00
19	S-S GUNEX												
20	SINKEX	4	E-2	16.0	64.0	10%	6.4			100%			6.40
		16	FA-18E/F	16.0	256.0	10%	25.6			100%			25.60
		2	P-3	16.0	32.0	10%	3.2			100%			3.20
		4	SH-60B	16.0	64.0	10%	6.4			100%			6.40
21	Naval Surface Fire Support Exercise												
22	Expeditionary Fires Exercise	1	FA-18E/F	3.0	3.0	100%	3.0		100%			3.00	
		1	AH-1	3.0	3.0	100%	3.0		100%			3.00	
		1	AV-8B	3.0	3.0	100%	3.0		100%			3.00	
23	USMC Battalion Landing	16	FA-18A/C	0.5	8.0	15%	1.2	20%	50%	30%	0.24	0.60	0.36
			FA-18E/F	0.5		15%		20%	50%	30%			
		6	AV-8B	0.5	3.0	25%	0.8	90%	5%	5%	0.68	0.04	0.04
		4	AH-1	1.0	4.0	100%	4.0	90%	5%	5%	3.60	0.20	0.20
		2	C-130	1.4	2.8			20%	50%	30%			
		4	H-53	1.5	6.0	100%	6.0	90%	5%	5%	5.40	0.30	0.30
		12	H-46	1.5	18.0	100%	18.0	90%	5%	5%	16.20	0.90	0.90
		3	UH-1	1.0	3.0	100%	3.0	90%	5%	5%	2.70	0.15	0.15
24	USMC Stinger Firings												
25	Amphibious Landings and Raids												
25A	Amphibious Ops		AH-1	4.0		100%		100%					
			CH-46	4.0		100%		100%					
			CH-53	4.0		100%		100%					
		32	UH-1	4.0	128.0	100%	128.0	100%			128.00		
25B	Helicopter Assault	32	AH-1	2.0	64.0	60%	38.4	100%			38.40		
		48	CH-46	2.0	96.0	60%	57.6	100%			57.60		
		24	CH-53	2.0	48.0	60%	28.8	100%			28.80		
		32	AV-8B	2.0	64.0	60%	38.4	100%			38.40		
		8	UH-1	2.0	16.0	60%	9.6	100%			9.60		
25C	Armored Ops	6	AH-1	8.0	48.0	50%	24.0	100%			24.00		
		6	AV-8B	8.0	48.0	50%	24.0	100%			24.00		
25D	Artillery Ops	24	AH-1	3.0	72.0	100%	72.0	100%			72.00		
		9	CH-46	3.0	27.0	100%	27.0	100%			27.00		
		9	CH-53	3.0	27.0	100%	27.0	100%			27.00		
25E	Amphibious Assault	16	AH-1	3.0	48.0	100%	48.0	100%			48.00		
			CH-46	3.0		100%		100%					
			CH-53	3.0		100%		100%					
		8	UH-1	3.0	24.0	100%	24.0	100%			24.00		
25F	Combat Engineer		None										
25G	AAV Ops	12	AH-1	4.0	48.0	100%	48.0	100%			48.00		
25H	EFV Ops	2	AH-1	4.0	8.0	100%	8.0	100%			8.00		
25I	Assault Amphibian School		None										
26	Amphibious Operations - CPAAA												
26A	Amphibious Operations		None										
26B	Amphibious Operations	28	CH-46	4.2	117.9	100%	117.9	79%	21%		92.65	25.11	
		28	CH-53	4.2	117.9	100%	117.9	79%	21%		92.65	25.11	
26C	Amphibious Operations		None										
26D	Amphibious Operations		None										
26E	Amphibious Operations	75	AV-8B	0.5	37.5	97%	36.4	50%	30%	20%	18.19	10.91	7.28
		89	AH-1	0.5	44.5	97%	43.2	50%	30%	20%	21.58	12.95	8.63
		65	UH-1	0.5	32.5	97%	31.5	50%	30%	20%	15.76	9.46	6.31

Scenario	Nomenclature	Scenario No.	Aircraft Type	Engines: Engine Model	No.	Fuel Flow lbs/hr	Emission Indices, lbs/1,000 lbs fuel: CO	NOx	HC	SOx	PM10	Emissions Factors (lb/hr): CO	NOx	HC	SOx	PM10
1	FA-18E/F		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
1	AV-8B		AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
2	E-2		E-2	T56-A-425 (assume 30%	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
2	FA-18E/F		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
2	S-3B		S-3B	TF34-GE-400 (assume t	2	1145	14.10	4.07	1.86	0.40	3.62	32.29	9.32	4.26	0.92	8.29
2	FA-18E/F		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
2	Learjet		Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
3	SH-60B		SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
3	P-3		P-3	T56-A-14 (assume ASU	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
3	Learjet		Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
3	C-130		C-130	T56-A-425 (assume app	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
4	Learjet		Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
5	FA-18A/C		FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
5	FA-18E/F		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
5	E-2C		E-2C	T56-A-425 (assume 40%	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
5	DC-130		DC-130	T56-A-425 (assume app	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
6	MH-60R		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
7	MH-60R	7	MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
7	Other Helo (SH-3)		Other Helo (SH	T58-GE-402 (assume 49	2	529	21.28	3.88	2.20	0.40	4.00	22.51	4.11	2.33	0.42	4.23
8	P-3		P-3	T56-A-14 (assume ASU	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
9	P-3		P-3	T56-A-14 (assume ASU	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
9	SH-60B		SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
10	P-3		P-3	T56-A-14 (assume ASU	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
12	Other Helo (SH-3)		Other Helo (SH	T58-GE-402 (assume 49	2	529	21.28	3.88	2.20	0.40	4.00	22.51	4.11	2.33	0.42	4.23
15	MH-60R		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
16	MH-60R		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
16	FA-18A/C		FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
16	FA-18E/F		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
16	S-3B		S-3B	TF34-GE-400 (assume t	2	1145	14.10	4.07	1.86	0.40	3.62	32.29	9.32	4.26	0.92	8.29
17	FA-18A/C		FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
17	FA-18E/F		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
17	P-3		P-3	T56-A-14 (assume ASU	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
17	S-3B		S-3B	TF34-GE-400 (assume t	2	1145	14.10	4.07	1.86	0.40	3.62	32.29	9.32	4.26	0.92	8.29
18	MH-60R		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
20	E-2		E-2	T56-A-425 (assume 30%	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
20	FA-18E/F		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
20	P-3		P-3	T56-A-14 (assume ASU	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
20	SH-60B		SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
22	FA-18E/F		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
22	AH-1		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
22	AV-8B		AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
23	FA-18A/C		FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
23	FA-18E/F		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
23	AV-8B		AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
23	AH-1		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
23	C-130		C-130	T56-A-425 (assume app	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
23	H-53		H-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
23	H-46		H-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
23	UH-1		UH-1	T400-CP-400	2	346.2	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91
25A	AH-1		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
25A	CH-46		CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
25A	CH-53		CH-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
25A	UH-1		UH-1	T400-CP-400	2	346.2	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91
25B	AH-1		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
25B	CH-46		CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
25B	CH-53		CH-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
25B	AV-8B		AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
25B	UH-1		UH-1	T400-CP-400	2	346.2	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91
25C	AH-1		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
25C	AV-8B		AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
25D	AH-1		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
25D	CH-46		CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
25D	CH-53		CH-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
25E	AH-1		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
25E	CH-46		CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
25E	CH-53		CH-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
25E	UH-1		UH-1	T400-CP-400	2	346.2	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91
25G	AH-1		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
25H	AH-1		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
26B	CH-46		CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
26B	CH-53		CH-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
26E	AV-8B		AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
26E	AH-1		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
26E	UH-1		UH-1	T400-CP-400	2	346.2	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91

Emissions

Scenario	Nomenclature	Emissions 0-3 nm Offshore (lbs): CO	NOx	HC	SOx	PM	Emissions 3-12 nm Offshore—US Territory (lbs): CO	NOx	HC	SOx	PM	Emissions >12 nm Offshore—Outside US Territory, Offshore San Diego: CO	NOx	HC	SOx	PM	Offshore Mexico: CO	NOx	HC	SOx	PM
2	E-2	2.64	9.84	0.60	0.49	4.85	5.27	19.68	1.20	0.98	9.69	255.82	954.60	58.03	47.37	470.19					
2	FA-18E/F	23.96	311.80	3.23	10.77	169.90	47.93	623.60	6.46	21.54	339.80	2324.51	30244.73	313.42	1044.72	16480.51					
2	FA-18E/F	12.00	156.14	1.62	5.39	85.08	24.00	312.27	3.24	10.79	170.16	1164.00	15145.11	156.94	523.15	8252.64					
2	Learjet	13.21	3.48	2.53	0.32	2.48	26.42	6.96	5.05	0.64	4.96	1281.36	337.80	245.05	30.92	240.47					
3	SH-60B	0.30	0.31	0.03	0.02	0.20	0.60	0.61	0.05	0.04	0.40	29.10	29.80	2.56	1.86	19.56					
3	P-3	0.70	3.24	0.16	0.15	1.53	1.40	6.48	0.32	0.31	3.05	67.83	314.16	15.28	14.91	147.95					
3	Learjet	0.95	0.25	0.18	0.02	0.18	1.91	0.50	0.36	0.05	0.36	92.40	24.36	17.67	2.23	17.34					
3	C-130	0.55	0.91	0.13	0.05	0.54	1.10	1.83	0.26	0.11	1.08	53.19	88.56	12.80	5.28	52.40					
4	Learjet	62.48	16.47	11.95	1.51	11.73	124.96	32.94	23.90	3.02	23.45						6060.48	1597.71	1159.02	146.23	1137.35
6	MH-60R						10768.68	11027.13	947.64	689.20	7236.55	34861.32	35697.99	3067.80	2231.12	23426.81					
7	MH-60R						1561.14	1598.61	137.38	99.91	1049.09	5053.86	5175.15	444.74	323.45	3396.19					
7	Other Helo (SH-3)						401.69	73.24	41.53	7.55	75.51	1300.39	237.10	134.44	24.44	244.43					
8	P-3	55.04	254.92	12.40	12.10	120.05	110.07	509.85	24.80	24.19	240.11	935.63	4333.69	210.77	205.63	2040.90					
9	P-3	6.46	29.94	1.46	1.42	14.10	12.93	59.89	2.91	2.84	28.20	627.07	2904.51	141.26	137.82	1367.84					
9	SH-60B	1.50	1.54	0.13	0.10	1.01	3.00	3.07	0.26	0.19	2.02	145.50	148.99	12.80	9.31	97.78					
10	P-3											117.94	546.26	26.57	25.92	257.26					
12	Other Helo (SH-3)	6.66	1.22	0.69	0.13	1.25	13.33	2.43	1.38	0.25	2.51	646.43	117.86	66.83	12.15	121.51					
15	MH-60R											540.00	552.96	47.52	34.56	362.88					
16	MH-60R	9.23	9.45	0.81	0.59	6.20	18.45	18.89	1.62	1.18	12.40	894.83	916.30	78.74	57.27	601.32					
17	FA-18A/C						15.38	42.49	2.77	2.52	40.09	15.38	42.49	2.77	2.52	40.09					
17	FA-18E/F						6.85	89.09	0.92	3.08	48.54	6.85	89.09	0.92	3.08	48.54					
17	P-3						4.37	20.23	0.98	0.96	9.53	4.37	20.23	0.98	0.96	9.53					
18	MH-60R						412.50	422.40	36.30	26.40	277.20	412.50	422.40	36.30	26.40	277.20					
20	E-2																30.41	113.48	6.90	5.63	55.90
20	FA-18E/F																184.50	2400.64	24.88	82.92	1308.12
20	P-3																27.96	129.48	6.30	6.14	60.98
20	SH-60B																48.00	49.15	4.22	3.07	32.26
22	FA-18E/F						21.62	281.32	2.92	9.72	153.30										
22	AH-1						26.88	14.16	1.43	1.02	10.71										
22	AV-8B						147.40	164.63	10.34	7.66	72.74										
23	FA-18A/C	3.89	10.73	0.70	0.64	10.13	9.72	26.84	1.75	1.59	25.32	5.83	16.10	1.05	0.96	15.19					
23	AV-8B	33.17	37.04	2.33	1.72	16.37	1.84	2.06	0.13	0.10	0.91	1.84	2.06	0.13	0.10	0.91					
23	AH-1	32.26	16.99	1.71	1.22	12.86	1.79	0.94	0.10	0.07	0.71	1.79	0.94	0.10	0.07	0.71					
23	H-53	51.34	194.77	3.62	9.64	53.27	2.85	10.82	0.20	0.54	2.96	2.85	10.82	0.20	0.54	2.96					
23	H-46	358.16	71.49	62.23	7.26	32.30	19.90	3.97	3.46	0.40	1.79	19.90	3.97	3.46	0.40	1.79					
23	UH-1	1.89	10.82	0.24	0.75	7.85	0.10	0.60	0.01	0.04	0.44	0.10	0.60	0.01	0.04	0.44					
25A	UH-1	89.51	513.15	11.52	35.45	372.23															
25B	AH-1	344.11	181.19	18.28	13.06	137.12															
25B	CH-46	1273.47	254.18	221.28	25.80	114.83															
25B	CH-53	273.84	1038.79	19.28	51.43	284.12															
25B	AV-8B	1886.73	2107.26	132.32	98.01	931.12															
25B	UH-1	6.71	38.49	0.86	2.66	27.92															
25C	AH-1	215.07	113.25	11.43	8.16	85.70															
25C	AV-8B	1179.21	1317.04	82.70	61.26	581.95															
25D	AH-1	645.20	339.74	34.28	24.49	257.10															
25D	CH-46	596.94	119.15	103.72	12.10	53.83															
25D	CH-53	256.72	973.87	18.08	48.21	266.37															
25E	AH-1	430.13	226.49	22.85	16.32	171.40															
25E	UH-1	16.78	96.22	2.16	6.65	69.79															
25G	AH-1	430.13	226.49	22.85	16.32	171.40															
25H	AH-1	71.69	37.75	3.81	2.72	28.57															
26B	CH-46	2048.46	408.86	355.94	41.51	184.71	555.12	110.80	96.46	11.25	50.06										
26B	CH-53	880.98	3341.94	62.04	165.44	914.07	238.74	905.64	16.81	44.83	247.71										
26E	AV-8B	893.62	998.07	62.67	46.42	441.01	536.17	598.84	37.60	27.85	264.60	357.45	399.23	25.07	18.57	176.40					
26E	AH-1	193.40	101.84	10.28	7.34	77.07	116.04	61.10	6.17	4.40	46.24	77.36	40.74	4.11	2.94	30.83					
26E	UH-1	11.02	63.19	1.42	4.37	45.84	6.61	37.92	0.85	2.62	27.50	4.41	25.28	0.57	1.75	18.34					

Scenario	Type Training	A/C Sorties	Nomenclature	Ave. A/C Time on Range (hrs)	Total Time on Range (hrs)	% Below 3,000 ft	Time Below 3,000 ft	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore
		No.		Hours	Hours	%	Hours	Percent			Hours		
		69	CH-46	0.5	34.5	97%	33.5	50%	30%	20%	16.73	10.04	6.69
		253	CH-53	0.5	126.5	97%	122.7	50%	30%	20%	61.35	36.81	24.54
26F	Amphibious Operations		None										
26G	Amphibious Operations		None										
27	Electronic Combat Exercise	98	MH-60R	2.1	205.8	100%	205.8		3%	97%		6.17	199.63
		3	HH-60	2.1	6.3	100%	6.3		3%	97%		0.19	6.11
		31	P-3	2.0	62.0				3%	97%			
		204	FA-18A/C	2.0	408.0				3%	97%			
		205	FA-18E/F	2.0	410.0				3%	97%			
		15	E-2C	2.0	30.0				3%	97%			
		17	EA-6B	2.0	34.0				3%	97%			
		145	Learjet	2.0	290.0				3%	97%			
		8	Unknown	2.0	16.0				3%	97%			
28A	Small Object Avoidance	16	MH-60R	1.8	28.0	100%	28.0	100%			28.00		
29	Mine Neutralization	720	MH-60R	2.5	1800.0	100%	1800.0	55%	40%	5%	990.00	720.00	90.00
30	Mine Laying	5	P-3	0.9	4.5	67%	3.0	50%	40%	10%	1.50	1.20	0.30
		11	FA-18A/C	0.5	5.5	7%	0.4	50%	40%	10%	0.18	0.15	0.04
		10	FA-18E/F	0.5	5.0	7%	0.3	50%	40%	10%	0.17	0.13	0.03
31	NSW Center Land Demolitions												
32	NSWC Underwater Demolitions		NONE										
33	NSWC Underwater Mat Weave		NONE										
34	NSWC BUD/S Small Arms Training	12	SH-60F	6.0	72.0	100%	72.0	100%			72.00		
35	NSWC BUD/S Land Navigation		NONE										
36	NSW UAV Operations	3	Neptune/Scan	1.0	3.0	100%	3.0	100%			3.00		
37	Insertion/Extraction	10	C-130	2.0	20.0	50%	10.0		5%	95%		0.50	9.50
38	NSW Boat Operations												
39	NSW GRU ONE SEAL Platoon Ops	5	SH-60B	8.0	40.0	100%	40.0	20%	30%	50%	8.00	12.00	20.00
		2	SH-60F	8.0	16.0	100%	16.0	20%	30%	50%	3.20	4.80	8.00
		9	CH-46	8.0	72.0	100%	72.0	20%	30%	50%	14.40	21.60	36.00
40	Direct Action												
41	Bombing Exercise - Land	2	SH-60F	2.5	5.0	100%	5.0	40%	40%	20%	2.00	2.00	1.00
		435	FA-18A/C	1.0	435.0	10%	43.5	10%	30%	60%	4.35	13.05	26.10
		434	FA-19E/F	1.0	434.0	10%	43.4	10%	30%	60%	4.34	13.02	26.04
		13	E-2	2.5	32.5					100%			
		8	EA-6B	2.5	20.0					100%			
		7	AH-1	2.5	17.5	100%	17.5	40%	40%	20%	7.00	7.00	3.50
		1	AV-8B	1.0	1.0	20%	0.2	30%	50%	20%	0.06	0.10	0.04
		3	KC-130	1.0	3.0			10%	30%	60%			
			H-53	2.5		100%		40%	40%	20%			
			H-46	2.5		100%		40%	40%	20%			
42	Combat Search and Rescue	56	MH-60S	3.0	168.0	100%	168.0	40%	40%	20%	67.20	67.20	33.60
		152	FA-18A/C	1.5	228.0	10%	22.8	10%	30%	60%	2.28	6.84	13.68
		152	FA-18E/F	1.5	228.0	10%	22.8	10%	30%	60%	2.28	6.84	13.68
		16	E-2	3.0	48.0					100%			
43	EOD Outside SHOBA												
44	USCG Ops	70	HH-60	3.2	224.0	100%	224.0	50%	30%	20%	112.00	67.20	44.80
45	NALF Airfield		See NALF Ops										
46	Ship Torpedo Tests	12	MH-60R	3.0	36.0	100%	36.0		23%	77%		8.35	27.65
47	Unmanned Underwater Vehicle Test		NONE										
48	Sonobuoy QA/QC Test	2	P-3	5.0	10.0	100%	10.0	50%	30%	20%	5.00	3.00	2.00
		115	NC-12B Kingair	3.0	345.0	100%	345.0	50%	30%	20%	172.50	103.50	69.00
49	Ocean Engineering		NONE	NONE									
50	Marine Mammal Mine Shape Location		NONE	NONE									
51	Missile Flight Test	3	MH-60R	4.0	12.0	100%	12.0	5%	10%	85%	0.60	1.20	10.20
		12	P-3	4.0	48.0	50%	24.0	5%	10%	85%	1.20	2.40	20.40
		18	FA-18A/C	4.0	72.0				5%	95%			
		9	FA-18E/F	4.0	36.0				5%	95%			
		6	Learjet	4.0	24.0				5%	95%			
		3	Gulfstream	4.0	12.0				5%	95%			
		3	MH-60R	4.0	12.0	100%	12.0	5%	10%	85%	0.60	1.20	10.20
52	NUWC Underwater Acoustics Testing		NONE										
53	Other Tests	2	SH-60F	4.0	8.0	100%	8.0	5%	8%	77%	0.40	0.64	6.16
		1	P-3	4.0	4.0	50%	2.0	5%	8%	77%	0.10	0.16	1.54
		1	Learjet	4.0	4.0			1%	2%	97%			
			Other Helo	4.0		100%		5%	8%	77%			
	Totals	19957											

Scenario	Scenario No.	Aircraft Type	Engine Model	No.	Fuel Flow lbs/hr	Emission Indices, lbs/1,000 lbs fuel CO	NOx	HC	SOx	PM10	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10
		CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
		CH-53	T64-GE-415 (assume cru	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
27		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
		HH-60	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
		P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
		FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
		E-2C	T56-A-425 (assume 40%	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
		EA-6B	J52-P-408A (assume ap	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60
		Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
		Unknown	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
28A		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
29		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
30		P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
		FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
34		SH-60F	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
37		C-130	T56-A-425 (assume appr	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
39		SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
		SH-60F	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
		CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
41		SH-60F	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
		FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
		FA-19E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
		E-2	T56-A-425 (assume 40%	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
		EA-6B	J52-P-408A (assume ap	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60
		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
		AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
		KC-130	T56-A-425 (assume appr	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
		H-53	T64-GE-415 (assume cru	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
		H-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
42		MH-60S	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
		FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
		E-2	T56-A-425 (assume 40%	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
44		HH-60	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
46		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
48		P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
		NC-12B Kinga	PT6A-42 (assume appro	2	249	4.93	4.42	0.23	0.40	4.20	2.46	2.20	0.11	0.20	2.09
51		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
		P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
		FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
		Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
		Gulfstream	BR700-710A1-10	2	1698	4.78	7.68	0.05	1.00	0.00	16.23	26.08	0.17	3.40	0.00
		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
53		SH-60F	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
		P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
		Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
		Other Helo (S-	T58-GE-402 (assume 49	2	529	21.28	3.88	2.20	0.40	4.00	22.51	4.11	2.33	0.42	4.23

Emissions

Scenario	Aircraft Type	Emissions 0-3 nm Offshore (lbs) CO	NOx	HC	SOx	PM	Emissions 3-12 nm Offshore—US Territory (lbs) CO	NOx	HC	SOx	PM	Emissions >12 nm Offshore—Outside US Territory CO	NOx	HC	SOx	PM	CO	NOx	HC	SOx	PM
	CH-46	369.94	73.84	64.28	7.50	33.36	221.96	44.30	38.57	4.50	20.01	147.97	29.53	25.71	3.00	13.34					
	CH-53	583.36	2212.93	41.08	109.55	605.27	350.02	1327.76	24.65	65.73	363.16	233.34	885.17	16.43	43.82	242.11					
27	MH-60R						46.31	47.42	4.07	2.96	31.12	1497.20	1533.13	131.75	95.82	1006.12					
	HH-60						1.42	1.45	0.12	0.09	0.95	45.83	46.93	4.03	2.93	30.80					
28A	MH-60R	210.00	215.04	18.48	13.44	141.12															
29	MH-60R	7425.00	7603.20	653.40	475.20	4989.60	5400.00	5529.60	475.20	345.60	3628.80	675.00	691.20	59.40	43.20	453.60					
30	P-3	13.10	60.70	2.95	2.88	28.59	10.48	48.56	2.36	2.30	22.87	2.62	12.14	0.59	0.58	5.72					
	FA-18A/C	2.97	8.20	0.54	0.49	7.74	2.38	6.56	0.43	0.39	6.19	0.59	1.64	0.11	0.10	1.55					
	FA-18E/F	1.20	15.64	0.16	0.54	8.52	0.96	12.51	0.13	0.43	6.82	0.24	3.13	0.03	0.11	1.70					
34	SH-60F	540.00	552.96	47.52	34.56	362.88															
37	C-130						6.85	11.41	1.65	0.68	6.75	130.17	216.73	31.33	12.92	128.23					
39	SH-60B	60.00	61.44	5.28	3.84	40.32	90.00	92.16	7.92	5.76	60.48	150.00	153.60	13.20	9.60	100.80					
	SH-60F	24.00	24.58	2.11	1.54	16.13	36.00	36.86	3.17	2.30	24.19	60.00	61.44	5.28	3.84	40.32					
	CH-46	318.37	63.54	55.32	6.45	28.71	477.55	95.32	82.98	9.68	43.06	795.92	158.86	138.30	16.13	71.77					
41	SH-60F	15.00	15.36	1.32	0.96	10.08	15.00	15.36	1.32	0.96	10.08	7.50	7.68	0.66	0.48	5.04					
	FA-18A/C	70.43	194.56	12.70	11.55	183.59	211.30	583.68	38.10	34.64	550.77	422.61	1167.37	76.21	69.28	1101.55					
	FA-19E/F	31.28	406.98	4.22	14.06	221.77	93.84	1220.95	12.65	42.17	665.30	187.68	2441.90	25.30	84.35	1330.60					
	AH-1	62.73	33.03	3.33	2.38	25.00	62.73	33.03	3.33	2.38	25.00	31.36	16.52	1.67	1.19	12.50					
	AV-8B	2.95	3.29	0.21	0.15	1.45	4.91	5.49	0.34	0.26	2.42	1.97	2.20	0.14	0.10	0.97					
42	MH-60S	504.00	516.10	44.35	32.26	338.69	504.00	516.10	44.35	32.26	338.69	252.00	258.05	22.18	16.13	169.34					
	FA-18A/C	36.92	101.98	6.66	6.05	96.23	110.75	305.93	19.97	18.16	288.68	221.50	611.86	39.94	36.31	577.36					
	FA-18E/F	16.43	213.81	2.22	7.39	116.50	49.30	641.42	6.65	22.16	349.51	98.59	1282.84	13.29	44.31	699.03					
44	HH-60	840.00	860.16	73.92	53.76	564.48	504.00	516.10	44.35	32.26	338.69	336.00	344.06	29.57	21.50	225.79					
46	MH-60R						62.64	64.14	5.51	4.01	42.09	207.36	212.34	18.25	13.27	139.35					
48	P-3	43.68	202.32	9.84	9.60	95.28	26.21	121.39	5.90	5.76	57.17	17.47	80.93	3.94	3.84	38.11					
	NC-12B Kinga	423.51	379.70	19.76	34.36	360.80	254.11	227.82	11.85	20.62	216.48	169.40	151.88	7.90	13.74	144.32					
51	MH-60R	4.50	4.61	0.40	0.29	3.02	9.00	9.22	0.79	0.58	6.05	76.50	78.34	6.73	4.90	51.41					
	P-3	10.48	48.56	2.36	2.30	22.87	20.97	97.11	4.72	4.61	45.73	178.21	825.47	40.15	39.17	388.74					
	MH-60R	4.50	4.61	0.40	0.29	3.02	9.00	9.22	0.79	0.58	6.05	76.50	78.34	6.73	4.90	51.41					
53	SH-60F	3.00	3.07	0.26	0.19	2.02	4.80	4.92	0.42	0.31	3.23	46.20	47.31	4.07	2.96	31.05					
	P-3	0.87	4.05	0.20	0.19	1.91	1.40	6.47	0.31	0.31	3.05	13.45	62.31	3.03	2.96	29.35					
Total Emissions (SCI) tons		9.11	9.73	0.85	0.57	5.61	10.65	12.56	1.00	0.74	8.14	28.69	55.15	2.93	2.69	32.66	3.18	2.15	0.60	0.12	1.30
Total Emissions (SD) tons		2.91	4.03	0.34	0.22	1.43	1.26	1.80	0.13	0.10	0.68										

Source: SCORE FY2004 Participants Conversion.xls

Table C-6. Aircraft Air Emissions—Alternative 2

Scenario	Type Training	A/C Sorties No.	Nomenclature	Ave. A/C Time on Range (hrs) Hours	Total Time on Range (hrs) Hours	% Below 3,000 ft %	Time Below 3,000 ft Hours	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore (Hours)	Total Time 3-12 nm from shore (Hours)	Total Time >12 nm from shore (Hours)	Scenario No.	Aircraft Type	Engines Engine Model	No.	Fuel Flow lbs/hr	Emission Indices, lbs/1,000 lbs fuel CO	NOx	HC	SOx	PM10	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10
Training Operations																												
1	Air Combat Maneuvers	11223	FA-18E/F	1.1	1123.1			1%	2%	97%					FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
		687	AV-8B	1.2	824.4			1%	2%	97%					AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
2	Air Defense Exercise	117	E-2	1.0	117.0	50%	58.5	1%	2%	97%	0.59	1.17	56.75		E-2	T56-A-425 (assume 30%	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
		703	FA-18E/F	1.0	703.0	50%	351.5	1%	2%	97%	3.52	7.03	340.96		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
			S-3B	1.0		50%		1%	2%	97%					S-3B	TF34-GE-400 (assume t	2	1145	14.10	4.07	1.86	0.40	3.62	32.29	9.32	4.26	0.92	8.29
		352	FA-18E/F	1.0	352.0	50%	176.0	1%	2%	97%	1.76	3.52	170.72		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
		117	Learjet	1.0	117.0	50%	58.5	1%	2%	97%	0.59	1.17	56.75		Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
3	S-A MISSILEX	6	SH-60B	1.0	6.0	100%	6.0	1%	2%	97%	0.06	0.12	5.82		SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
		6	P-3	3.0	18.0	67%	12.0	1%	2%	97%	0.12	0.24	11.65		P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
		6	Learjet	1.5	9.0	67%	6.0	1%	2%	97%	0.06	0.12	5.82		Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
		6	C-130	1.5	9.0	67%	6.0	1%	2%	97%	0.06	0.12	5.82		C-130	T56-A-425 (assume appr	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
4	S-A GUNEX	350	Learjet	1.5	525.0	50%	262.5	1%	2%	97%	2.63	5.25	254.63		Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
5	A-A MISSILEX	52	FA-18A/C	2.0	104.0					100%					FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
		78	FA-18E/F	2.0	156.0					100%					FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
		13	E-2C	4.0	52.0					100%					E-2C	T56-A-425 (assume 40%	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
		13	DC-130	4.0	52.0			1%	2%	97%					DC-130	T56-A-425 (assume appr	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
6	Helicopter ASW TRACKEX	1690	MH-60R	3.6	6084.0	100%	6084.0		24%	76%		#####	#####		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
7	Helicopter ASW TORPEX	245	MH-60R	3.6	882.0	100%	882.0		24%	76%		208.15	673.85	7	MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
		21	Other Helo (SH-3)	3.6	75.6	100%	75.6		24%	76%		17.84	57.76		Other Helo (SH	T58-GE-402 (assume 49	2	529	21.28	3.88	2.20	0.40	4.00	22.51	4.11	2.33	0.42	4.23
8	MPA ASW TRACKEX	29	P-3	6.0	174.0	75%	130.5	5%	10%	85%	6.53	13.05	110.93		P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
9	MPA ASW TORPEX	40	P-3	2.0	80.0	100%	80.0	1%	2%	97%	0.80	1.60	77.60		P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
		10	SH-60B	2.0	20.0	100%	20.0	1%	2%	97%	0.20	0.40	19.40		SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
10	EER/IEER ASW	3	P-3	6.0	18.0	75%	13.5			100%			13.50		P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
11	Surface Ship ASW TRACKEX																											
12	Surface Ship ASW TORPEX	8	Other Helo (SH-3)	3.7	29.6	100%	29.6	1%	2%	97%	0.30	0.59	28.71		Other Helo (SH	T58-GE-402 (assume 49	2	529	21.28	3.88	2.20	0.40	4.00	22.51	4.11	2.33	0.42	4.23
13	Submarine ASW TORPEX																											
14	Submarine ASW TORPEX																											
15	VBSS	21	MH-60R	4.0	84.0	100%	84.0			100%			84.00		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
16	A-S MISSILEX	41	MH-60R	3.0	123.0	100%	123.0	1%	2%	97%	1.23	2.46	119.31		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
		15	FA-18A/C	2.0	30.0			1%	2%	97%					FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
		15	FA-18E/F	2.0	30.0			1%	2%	97%					FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
			S-3B	3.0		100%		1%	2%	97%					S-3B	TF34-GE-400 (assume t	2	1145	14.10	4.07	1.86	0.40	3.62	32.29	9.32	4.26	0.92	8.29
17	A-S BOMBEX	21	FA-18A/C	1.0	21.0	10%	2.1		50%	50%		1.05	1.05		FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
		21	FA-18E/F	1.0	21.0	10%	2.1		50%	50%		1.05	1.05		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
		11	P-3	1.0	11.0	10%	1.1		50%	50%		0.55	0.55		P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
			S-3B	1.0		10%			50%	50%					S-3B	TF34-GE-400 (assume t	2	1145	14.10	4.07	1.86	0.40	3.62	32.29	9.32	4.26	0.92	8.29
18	A-S GUNEX	131	MH-60R	1.0	131.0	100%	131.0		50%	50%		65.50	65.50		MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
19	S-S GUNEX																											
20	SINKEX	6	E-2	16.0	96.0	10%	9.6			100%			9.60		E-2	T56-A-425 (assume 30%	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
		24	FA-18E/F	16.0	384.0	10%	38.4			100%			38.40		FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
		3	P-3	16.0	48.0	10%	4.8			100%			4.80		P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
		6	SH-60B	16.0	96.0	10%	9.6			100%			9.60		SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
21	Naval Surface Fire Support Exercise																											
22	Expeditionary Fires Exercise	1	FA-18E/F	3.0	3.0	100%	3.0		100%			3.00			FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
		1	AH-1	3.0	3.0	100%	3.0		100%			3.00			AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
		1	AV-8B	3.0	3.0	100%	3.0		100%			3.00			AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
23	USMC Battalion Landing	32	FA-18A/C	0.5	16.0	15%	2.4	20%	50%	30%	0.48	1.20	0.72		FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
			FA-18E/F	0.5		15%		20%	50%	30%					FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
		12	AV-8B	0.5	6.0	25%	1.5	90%	5%	5%	1.35	0.08	0.08		AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
		8	AH-1	1.0	8.0	100%	8.0	90%	5%	5%	7.20	0.40	0.40		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
		4	C-130	1.4	5.6			20%	50%	30%					C-130	T56-A-425 (assume appr	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
		8	H-53	1.5	12.0	100%	12.0	90%	5%	5%	10.80	0.60	0.60		H-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
		24	H-46	1.5	36.0	100%	36.0	90%	5%	5%	32.40	1.80	1.80		H-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
		6	UH-1	1.0	6.0	100%	6.0	90%	5%	5%	5.40	0.30	0.30		UH-1	T400-CP-400	2	346.2	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91
24	USMC Stinger Firings																											
25	Amphibious Landings and Raids																											
25A	Amphibious Ops		AH-1	4.0		100%		100%							AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
			CH-46	4.0		100%		100%							CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
			CH-53	4.0		100%		100%							CH-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
		48	UH-1	4.0	192.0	100%	192.0	100%			192.00				UH-1	T400-CP-400	2	346.2	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91
25B	Helicopter Assault	48	AH-1	2.0	96.0	60%	57.6	100%			57.60				AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
		72	CH-46	2.0	144.0	60%	86.4	100%			86.40				CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
		36	CH-53	2.0	72.0	60%	43.2	100%			43.20				CH-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
		48	AV-8B	2.0	96.0	60%	57.6	100%			57.60				AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
		12	UH-1	2.0	24.0	60%	14.4	100%			14.40				UH-1	T400-CP-400	2	346.2	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91
25C	Armored Ops	8	AH-1	8.0	64.0	50%	32.0	100%			32.00				AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
		8	AV-8B	8.0	64.0	50%	32.0	100%			32.00				AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
25D	Artillery Ops	32	AH-1	3.0	96.0	100%	96.0	100%			96.00				AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
		12	CH-46	3.0	36.0	100%	36.0	100%			36.00				CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
		12	CH-53	3.0	36.0	100%	36.0	100%			36.00				CH-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
25E	Amphibious Assault	24	AH-1	3.0	72.0	100%	72.0	100%			72.00				AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
			CH-46	3.0		100%		100%							CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
			CH-53	3.0		100%		100%							CH-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
		12	UH-1	3.0	36.0	100%	36.0	100%			36.00				UH-1	T400-CP-400	2	346.2	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91
25F	Combat Engineer		None																									
25G	AAV Ops	16	AH-1	4.0	64.0	100%	64.0	100%			64.00				AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
25H	EFV Ops	4	AH-1	4.0	16.0	100%	16.0	100%			16.00				AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
25I	Assault Amphibian School		None																									
26	Amphibious Operations - CPAAA																											
26A	Amphibious Operations		None																									
26B	Amphibious Operations	30	CH-46	4.2	126.3	100%	126.3	79%	21%		99.27	26.90			CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
		30	CH-53	4.2	126.3	100%	126.3	79%	21%		99.27	26.90			CH-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
26C	Amphibious Operations		None																									
26D	Amphibious Operations		None																									
26E	Amphibious Operations	75	AV-8B	0.5	37.5	97%	36.4	50%	30%	20%	18.19	10.91	7.28		AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
		89	AH-1	0.5	44.5	97%	43.2	50%	30%	20%	21.58	12.95	8.63		AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
		65	UH-1	0.5	32.5	97%	31.5	50%	30%	20%	15.76	9.46	6.31		UH-1	T400-CP-400	2	346.2	1.01	5.79	0.13	0.40	4.20	0.70	4.01	0.09	0.28	2.91

Emissions

Scenario	Aircraft	Emissions 0-3 nm Offshore (lbs) CO	NOx	HC	SOx	PM	Emissions 3-12 nm Offshore—US Territory (lbs) CO	NOx	HC	SOx	PM	Emissions >12 nm Offshore—Outside US Territory: Offshore San Diego CO	NOx	HC	SOx	PM	Offshore Mexico CO	NOx	HC	SOx	PM
1	FA-18E/F																				
1	AV-8B																				
2	E-2	2.78	10.37	0.63	0.51	5.11	5.56	20.75	1.26	1.03	10.22	269.65	1006.20	61.17	49.94	495.61					
2	FA-18E/F	25.33	329.62	3.42	11.39	179.61	50.67	659.24	6.83	22.77	359.22	2457.34	31973.00	331.33	1104.42	17422.25					
2	S-3B																				
2	FA-18E/F	12.68	165.04	1.71	5.70	89.93	25.37	330.09	3.42	11.40	179.87	1230.42	16009.24	165.90	553.00	8723.52					
2	Learjet	13.92	3.67	2.66	0.34	2.61	27.85	7.34	5.33	0.67	5.23	1350.62	356.06	258.30	32.59	253.47					
3	SH-60B	0.45	0.46	0.04	0.03	0.30	0.90	0.92	0.08	0.06	0.60	43.65	44.70	3.84	2.79	29.33					
3	P-3	1.05	4.86	0.24	0.23	2.29	2.10	9.72	0.47	0.46	4.58	101.74	471.24	22.92	22.36	221.92					
3	Learjet	1.43	0.38	0.27	0.03	0.27	2.86	0.75	0.55	0.07	0.54	138.59	36.54	26.51	3.34	26.01					
3	C-130	0.82	1.37	0.20	0.08	0.81	1.65	2.74	0.40	0.16	1.62	79.79	132.84	19.20	7.92	78.60					
4	Learjet	62.48	16.47	11.95	1.51	11.73	124.96	32.94	23.90	3.02	23.45						6060.48	1597.71	1159.02	146.23	1137.35
5	FA-18A/C																				
5	FA-18E/F																				
5	E-2C																				
5	DC-130																				
6	MH-60R						10768.68	11027.13	947.64	689.20	7236.55	34861.32	35697.99	3067.80	2231.12	23426.81					
7	MH-60R						1561.14	1598.61	137.38	99.91	1049.09	5053.86	5175.15	444.74	323.45	3396.19					
7	Other Helo (SH-3)						401.69	73.24	41.53	7.55	75.51	1300.39	237.10	134.44	24.44	244.43					
8	P-3	57.00	264.03	12.84	12.53	124.34	114.00	528.06	25.68	25.06	248.68	969.04	4488.47	218.30	212.98	2113.79					
9	P-3	6.99	32.37	1.57	1.54	15.24	13.98	64.74	3.15	3.07	30.49	677.91	3140.01	152.72	148.99	1478.75					
9	SH-60B	1.50	1.54	0.13	0.10	1.01	3.00	3.07	0.26	0.19	2.02	145.50	148.99	12.80	9.31	97.78					
10	P-3											117.94	546.26	26.57	25.92	257.26					
12	Other Helo (SH-3)	6.66	1.22	0.69	0.13	1.25	13.33	2.43	1.38	0.25	2.51	646.43	117.86	66.83	12.15	121.51					
15	MH-60R											630.00	645.12	55.44	40.32	423.36					
16	MH-60R	9.23	9.45	0.81	0.59	6.20	18.45	18.89	1.62	1.18	12.40	894.83	916.30	78.74	57.27	601.32					
16	FA-18A/C																				
16	FA-18E/F																				
16	S-3B																				
17	FA-18A/C						17.00	46.96	3.07	2.79	44.32	17.00	46.96	3.07	2.79	44.32					
17	FA-18E/F						7.57	98.46	1.02	3.40	53.65	7.57	98.46	1.02	3.40	53.65					
17	P-3						4.80	22.26	1.08	1.06	10.48	4.80	22.26	1.08	1.06	10.48					
17	S-3B																				
18	MH-60R						491.25	503.04	43.23	31.44	330.12	491.25	503.04	43.23	31.44	330.12					
20	E-2																45.62	170.23	10.35	8.45	83.85
20	FA-18E/F																276.76	3600.95	37.32	124.39	1962.18
20	P-3																41.93	194.23	9.45	9.22	91.47
20	SH-60B																72.00	73.73	6.34	4.61	48.38
22	FA-18E/F						21.62	281.32	2.92	9.72	153.30										
22	AH-1						26.88	14.16	1.43	1.02	10.71										
22	AV-8B						147.40	164.63	10.34	7.66	72.74										
23	FA-18A/C	7.77	21.47	1.40	1.27	20.26	19.43	53.67	3.50	3.19	50.65	11.66	32.20	2.10	1.91	30.39					
23	FA-18E/F																				
23	AV-8B	66.33	74.08	4.65	3.45	32.73	3.69	4.12	0.26	0.19	1.82	3.69	4.12	0.26	0.19	1.82					
23	AH-1	64.52	33.97	3.43	2.45	25.71	3.58	1.89	0.19	0.14	1.43	3.58	1.89	0.19	0.14	1.43					
23	C-130																				
23	H-53	102.69	389.55	7.23	19.28	106.55	5.70	21.64	0.40	1.07	5.92	5.70	21.64	0.40	1.07	5.92					
23	H-46	716.33	142.97	124.47	14.52	64.59	39.80	7.94	6.91	0.81	3.59	39.80	7.94	6.91	0.81	3.59					
23	UH-1	3.78	21.65	0.49	1.50	15.70	0.21	1.20	0.03	0.08	0.87	0.21	1.20	0.03	0.08	0.87					
25A	AH-1																				
25A	CH-46																				
25A	CH-53																				
25A	UH-1	134.27	769.73	17.28	53.18	558.35															
25B	AH-1	516.16	271.79	27.42	19.59	205.68															
25B	CH-46	1910.20	381.27	331.91	38.71	172.25															
25B	CH-53	410.76	1558.19	28.93	77.14	426.19															
25B	AV-8B	2830.10	3160.89	198.47	147.02	1396.67															
25B	UH-1	10.07	57.73	1.30	3.99	41.88															
25C	AH-1	286.76	151.00	15.24	10.88	114.27															
25C	AV-8B	1572.28	1756.05	110.26	81.68	775.93															
25D	AH-1	860.27	452.99	45.71	32.65	342.80															
25D	CH-46	795.92	158.86	138.30	16.13	71.77															
25D	CH-53	342.30	1298.49	24.11	64.28	355.16															
25E	AH-1	645.20	339.74	34.28	24.49	257.10															
25E	CH-46																				
25E	CH-53																				
25E	UH-1	25.18	144.32	3.24	9.97	104.69															
25G	AH-1	573.51	301.99	30.47	21.77	228.53															
25H	AH-1	143.38	75.50	7.62	5.44	57.13															
26B	CH-46	2194.78	438.07	381.36	44.47	197.91	594.77	118.71	103.35	12.05	53.63										
26B	CH-53	943.91	3580.65	66.47	177.26	979.36	255.79	970.33	18.01	48.04	265.40										
26E	AV-8B	893.62	998.07	62.67	46.42	441.01	536.17	598.84	37.60	27.85	264.60	357.45	399.23	25.07	18.57	176.40					
26E	AH-1	193.40	101.84	10.28	7.34	77.07	116.04	61.10	6.17	4.40	46.24	77.36	40.74	4.11	2.94	30.83					
26E	UH-1	11.02	63.19	1.42	4.37	45.84	6.61	37.92	0.85	2.62	27.50	4.41	25.28	0.57	1.75	18.34					

Scenario	Type Training	A/C Sorties No.	Nomenclature	Ave. A/C Time on Range (hrs) Hours	Total Time on Range (hrs) Hours	% Below 3,000 ft %	Time Below 3,000 ft Hours	Percentage 0-3 nm from shore (Percent)	Percentage 3-12 nm from Shore (Percent)	Percentage >12 nm from Shore (Percent)	Total Time 0-3 nm from shore (Hours)	Total Time 3-12 nm from shore (Hours)	Total Time >12 nm from shore (Hours)
		69	CH-46	0.5	34.5	97%	33.5	50%	30%	20%	16.73	10.04	6.69
		253	CH-53	0.5	126.5	97%	122.7	50%	30%	20%	61.35	36.81	24.54
26F	Amphibious Operations		None										
26G	Amphibious Operations		None										
27	Electronic Combat Exercise	101	MH-60R	2.1	212.1	100%	212.1		3%	97%		6.36	205.74
		3	HH-60	2.1	6.3	100%	6.3		3%	97%		0.19	6.11
		32	P-3	2.0	64.0				3%	97%			
		209	FA-18A/C	2.0	418.0				3%	97%			
		210	FA-18E/F	2.0	420.0				3%	97%			
		16	E-2C	2.0	32.0				3%	97%			
		18	EA-6B	2.0	36.0				3%	97%			
		149	Learjet	2.0	298.0				3%	97%			
		8	Unknown	2.0	16.0				3%	97%			
28A	Small Object Avoidance	16	MH-60R	1.8	28.0	100%	28.0	100%			28.00		
29	Mine Neutralization	720	MH-60R	2.5	1800.0	100%	1800.0	55%	40%	5%	990.00	720.00	90.00
30	Mine Laying	5	P-3	0.9	4.5	67%	3.0	50%	40%	10%	1.50	1.20	0.30
		12	FA-18A/C	0.5	6.0	7%	0.4	50%	40%	10%	0.20	0.16	0.04
		11	FA-18E/F	0.5	5.5	7%	0.4	50%	40%	10%	0.18	0.15	0.04
31	NSW Center Land Demolitions												
32	NSWC Underwater Demolitions		NONE										
33	NSWC Underwater Mat Weave		NONE										
34	NSWC BUD/S Small Arms Training	12	SH-60F	6.0	72.0	100%	72.0	100%			72.00		
35	NSWC BUD/S Land Navigation		NONE										
36	NSW UAV Operations	5	Neptune/Scan	1.0	5.0	100%	5.0	100%			5.00		
37	Insertion/Extraction	15	C-130	2.0	30.0	50%	15.0		5%	95%		0.75	14.25
38	NSW Boat Operations												
39	NSW GRU ONE SEAL Platoon Ops	6	SH-60B	8.0	48.0	100%	48.0	20%	30%	50%	9.60	14.40	24.00
		2	SH-60F	8.0	16.0	100%	16.0	20%	30%	50%	3.20	4.80	8.00
		12	CH-46	8.0	96.0	100%	96.0	20%	30%	50%	19.20	28.80	48.00
40	Direct Action												
41	Bombing Exercise - Land	2	SH-60F	2.5	5.0	100%	5.0	40%	40%	20%	2.00	2.00	1.00
		477	FA-18A/C	1.0	477.0	10%	47.7	10%	30%	60%	4.77	14.31	28.62
		476	FA-19E/F	1.0	476.0	10%	47.6	10%	30%	60%	4.76	14.28	28.56
		15	E-2	2.5	37.5					100%			
		9	EA-6B	2.5	22.5					100%			
		7	AH-1	2.5	17.5	100%	17.5	40%	40%	20%	7.00	7.00	3.50
		1	AV-8B	1.0	1.0	20%	0.2	30%	50%	20%	0.06	0.10	0.04
		4	KC-130	1.0	4.0			10%	30%	60%			
			H-53	2.5		100%		40%	40%	20%			
			H-46	2.5		100%		40%	40%	20%			
42	Combat Search and Rescue	56	MH-60S	3.0	168.0	100%	168.0	40%	40%	20%	67.20	67.20	33.60
		152	FA-18A/C	1.5	228.0	10%	22.8	10%	30%	60%	2.28	6.84	13.68
		152	FA-18E/F	1.5	228.0	10%	22.8	10%	30%	60%	2.28	6.84	13.68
		16	E-2	3.0	48.0					100%			
43	EOD Outside SHOBA												
44	USCG Ops	70	HH-60	3.2	224.0	100%	224.0	50%	30%	20%	112.00	67.20	44.80
54	NALF Airfield		See NALF Ops										
46	Ship Torpedo Tests	16	MH-60R	3.0	48.0	100%	48.0		23%	77%		11.14	36.86
47	Unmanned Underwater Vehicle Test		NONE										
48	Sonobuoy QA/QC Test	2	P-3	5.0	10.0	100%	10.0	50%	30%	20%	5.00	3.00	2.00
		118	NC-12B Kingair	3.0	354.0	100%	354.0	50%	30%	20%	177.00	106.20	70.80
49	Ocean Engineering		NONE	NONE									
50	Marine Mammal Mine Shape Location		NONE	NONE									
51	Missile Flight Test	4	MH-60R	4.0	16.0	100%	16.0	5%	10%	85%	0.80	1.60	13.60
		16	P-3	4.0	64.0	50%	32.0	5%	10%	85%	1.60	3.20	27.20
		24	FA-18A/C	4.0	96.0				5%	95%			
		12	FA-18E/F	4.0	48.0				5%	95%			
		8	Learjet	4.0	32.0				5%	95%			
		4	Gulfstream	4.0	16.0				5%	95%			
		4	MH-60R	4.0	16.0	100%	16.0	5%	10%	85%	0.80	1.60	13.60
52	NUWC Underwater Acoustics Testing		NONE										
53	Other Tests	2	MH-60R	4.0	8.0	100%	8.0	5%	8%	77%	0.40	0.64	6.16
		1	P-3	4.0	4.0	50%	2.0	5%	8%	77%	0.10	0.16	1.54
		1	Learjet	4.0	4.0			1%	2%	97%			
		1	Other Helo	4.0	4.0	100%	4.0	5%	8%	77%	0.20	0.32	3.08
	Totals	20402											

Scenario	Aircraft Type	Engines Engine Model	No.	Fuel Flow lbs/hr	Emission Indices, lbs/1,000 lbs fuel CO	NOx	HC	SOx	PM10	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10
	CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
	CH-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
27	MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	HH-60	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
	FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
	FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	E-2C	T56-A-425 (assume 40%	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
	EA-6B	J52-P-408A (assume ap	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60
	Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
	Unknown	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
28A	MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
29	MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
30	P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
	FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
	FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
34	SH-60F	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
37	C-130	T56-A-425 (assume app	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
39	SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	SH-60F	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	CH-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
41	SH-60F	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
	FA-19E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	E-2	T56-A-425 (assume 40%	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
	EA-6B	J52-P-408A (assume ap	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60
	AH-1	T700-GE-401 (assume c	2	425.1	10.54	5.55	0.56	0.40	4.20	8.96	4.72	0.48	0.34	3.57
	AV-8B	F402-RR-406A (assume	1	6381	7.70	8.60	0.54	0.40	3.80	49.13	54.88	3.45	2.55	24.25
	KC-130	T56-A-425 (assume app	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50
	H-53	T64-GE-415 (assume cr	3	1488	2.13	8.08	0.15	0.40	2.21	9.51	36.07	0.67	1.79	9.87
	H-46	T58-GE-16	2	560	19.74	3.94	3.43	0.40	1.78	22.11	4.41	3.84	0.45	1.99
42	MH-60S	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
	FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	E-2	T56-A-425 (assume 40%	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73
44	HH-60	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
46	MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
48	P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
	NC-12B Kinga	PT6A-42 (assume appro	2	249	4.93	4.42	0.23	0.40	4.20	2.46	2.20	0.11	0.20	2.09
51	MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
	FA-18A/C	F404-GE-400 (assume a	2	3318	2.44	6.74	0.44	0.40	6.36	16.19	44.73	2.92	2.65	42.20
	FA-18E/F	F414-GE-400 (assume a	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10
	Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
	Gulfstream	BR700-710A1-10	2	1698	4.78	7.68	0.05	1.00	0.00	16.23	26.08	0.17	3.40	0.00
	MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
53	MH-60R	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04
	P-3	T56-A-14 (assume ASU\	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06
	Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47
	Other Helo (S-	T58-GE-402 (assume 49	2	529	21.28	3.88	2.20	0.40	4.00	22.51	4.11	2.33	0.42	4.23

Emissions

Scenario	Aircraft	Emissions 0-3 nm Offshore (lbs) CO	NOx	HC	SOx	PM	Emissions 3-12 nm Offshore—US Territory (lbs) CO	NOx	HC	SOx	PM	Emissions >12 nm Offshore—Outside US Territory CO	NOx	HC	SOx	PM	CO	NOx	HC	SOx	PM
	CH-46	369.94	73.84	64.28	7.50	33.36	221.96	44.30	38.57	4.50	20.01	147.97	29.53	25.71	3.00	13.34					
	CH-53	583.36	2212.93	41.08	109.55	605.27	350.02	1327.76	24.65	65.73	363.16	233.34	885.17	16.43	43.82	242.11					
27	MH-60R						47.72	48.87	4.20	3.05	32.07	1543.03	1580.06	135.79	98.75	1036.91					
	HH-60						1.42	1.45	0.12	0.09	0.95	45.83	46.93	4.03	2.93	30.80					
28A	MH-60R	210.00	215.04	18.48	13.44	141.12															
29	MH-60R	7425.00	7603.20	653.40	475.20	4989.60	5400.00	5529.60	475.20	345.60	3628.80	675.00	691.20	59.40	43.20	453.60					
30	P-3	13.10	60.70	2.95	2.88	28.59	10.48	48.56	2.36	2.30	22.87	2.62	12.14	0.59	0.58	5.72					
	FA-18A/C	3.24	8.95	0.58	0.53	8.45	2.59	7.16	0.47	0.42	6.76	0.65	1.79	0.12	0.11	1.69					
	FA-18E/F	1.32	17.20	0.18	0.59	9.37	1.06	13.76	0.14	0.48	7.50	0.26	3.44	0.04	0.12	1.87					
34	SH-60F	540.00	552.96	47.52	34.56	362.88															
37	C-130						10.28	17.11	2.47	1.02	10.12	195.25	325.10	47.00	19.38	192.35					
39	SH-60B	72.00	73.73	6.34	4.61	48.38	108.00	110.59	9.50	6.91	72.58	180.00	184.32	15.84	11.52	120.96					
	SH-60F	24.00	24.58	2.11	1.54	16.13	36.00	36.86	3.17	2.30	24.19	60.00	61.44	5.28	3.84	40.32					
	CH-46	424.49	84.73	73.76	8.60	38.28	636.73	127.09	110.64	12.90	57.42	1061.22	211.81	184.40	21.50	95.69					
41	SH-60F	15.00	15.36	1.32	0.96	10.08	15.00	15.36	1.32	0.96	10.08	7.50	7.68	0.66	0.48	5.04					
	FA-18A/C	77.24	213.35	13.93	12.66	201.32	231.71	640.04	41.78	37.98	603.95	463.41	1280.08	83.57	75.97	1207.91					
	FA-19E/F	34.31	446.37	4.63	15.42	243.23	102.92	1339.10	13.88	46.26	729.68	205.84	2678.21	27.75	92.51	1459.37					
	AH-1	62.73	33.03	3.33	2.38	25.00	62.73	33.03	3.33	2.38	25.00	31.36	16.52	1.67	1.19	12.50					
	AV-8B	2.95	3.29	0.21	0.15	1.45	4.91	5.49	0.34	0.26	2.42	1.97	2.20	0.14	0.10	0.97					
42	MH-60S	504.00	516.10	44.35	32.26	338.69	504.00	516.10	44.35	32.26	338.69	252.00	258.05	22.18	16.13	169.34					
	FA-18A/C	36.92	101.98	6.66	6.05	96.23	110.75	305.93	19.97	18.16	288.68	221.50	611.86	39.94	36.31	577.36					
	FA-18E/F	16.43	213.81	2.22	7.39	116.50	49.30	641.42	6.65	22.16	349.51	98.59	1282.84	13.29	44.31	699.03					
44	HH-60	840.00	860.16	73.92	53.76	564.48	504.00	516.10	44.35	32.26	338.69	336.00	344.06	29.57	21.50	225.79					
46	MH-60R						83.52	85.52	7.35	5.35	56.13	276.48	283.12	24.33	17.69	185.79					
48	P-3	43.68	202.32	9.84	9.60	95.28	26.21	121.39	5.90	5.76	57.17	17.47	80.93	3.94	3.84	38.11					
	NC-12B Kingair	434.56	389.61	20.27	35.26	370.21	260.74	233.76	12.16	21.16	222.13	173.82	155.84	8.11	14.10	148.09					
51	MH-60R	6.00	6.14	0.53	0.38	4.03	12.00	12.29	1.06	0.77	8.06	102.00	104.45	8.98	6.53	68.54					
	P-3	13.98	64.74	3.15	3.07	30.49	27.96	129.48	6.30	6.14	60.98	237.62	1100.62	53.53	52.22	518.32					
	MH-60R	6.00	6.14	0.53	0.38	4.03	12.00	12.29	1.06	0.77	8.06	102.00	104.45	8.98	6.53	68.54					
53	MH-60R	3.00	3.07	0.26	0.19	2.02	4.80	4.92	0.42	0.31	3.23	46.20	47.31	4.07	2.96	31.05					
	P-3	0.87	4.05	0.20	0.19	1.91	1.40	6.47	0.31	0.31	3.05	13.45	62.31	3.03	2.96	29.35					
	Other Helo	4.50	0.82	0.47	0.08	0.85	7.20	1.31	0.74	0.14	1.35	69.34	12.64	7.17	1.30	13.03					
Total Emissions (SCI) tons		**11.10**	**11.63**	**1.06**	**0.68**	**6.50**	**10.85**	**12.82**	**1.03**	**0.75**	**8.31**	**29.40**	**57.41**	**3.04**	**2.79**	**33.91**	**3.25**	**2.82**	**0.61**	**0.15**	**1.66**
Total Emissions (SD) tons		**3.02**	**4.16**	**0.35**	**0.23**	**1.47**	**1.29**	**1.84**	**0.14**	**0.10**	**0.69**										

Source: SCORE FY2004 Participants Conversion.xls

Table C-7. Takeoffs/Landings from NALF SCI—No Action Alternative

Aircraft Type	Engine Model	Type of Operation	Baseline Total Number of "Operations"	Emissions per Operation, lbs/operation CO	NOx	HC	SO2	PM10	Total Emissions, tons/year CO	NOx	HC	SO2	PM10
Navy/Marines													
F/A-18C/D[1]	F404-GE-400		**9,617**										
		Start/Taxi/TO	**961**	69.38	10.23	24.47	0.49	7.04	33.34	4.92	11.76	0.24	3.38
		Touch and Go	**3,845**	0.95	4.77	0.19	0.18	2.55	1.83	9.17	0.37	0.35	4.90
		Arrival with Break	**192**	29.09	2.898	11.728	0.205	4.638	2.79	0.28	1.13	0.02	0.45
		Straight In Arrival	**769**	27.17	2.498	11.118	0.215	4.828	10.45	0.96	4.27	0.08	1.86
		Transit	**4**										
		Total FA-18A/C	**9,617**						**48.41**	**15.33**	**17.53**	**0.68**	**10.59**
F/A-18E/F[1]	F414-GE-400		**3,147**										
		Start/Taxi/TO	**315**	209.67	16.41	31.66	0.58	7.9	32.97	2.58	4.98	0.09	1.24
		Touch and Go	**1,258**	0.47	9.01	0.07	0.22	3.04	0.30	5.67	0.04	0.14	1.91
		Arrival with Break	**63**	22.397	5.732	13.531	0.235	5.2	0.70	0.18	0.43	0.01	0.16
		Straight In Arrival	**252**	20.957	5.462	13.011	0.255	5.61	2.64	0.69	1.64	0.03	0.71
		Transit	**1**										
		Total FA-18E/F	**3,147**						**36.61**	**9.12**	**7.09**	**0.27**	**4.02**
F-14[2]	F110-GE-400		**582**										
		Start/Taxi/TO (assum	**58**	21.41	13.63	4.82	0.71	15.25	0.62	0.40	0.14	0.02	0.44
		Touch and Go	**233**	1.21	4.47	0.5	0.17	2.62	0.14	0.52	0.06	0.02	0.30
		Arrival with Break	**12**	8.87	3.03	2.10	0.29	7.10	0.05	0.02	0.01	0.00	0.04
		Straight In Arrival	**47**	8.05	4.53	1.95	0.34	7.28	0.19	0.11	0.05	0.01	0.17
		Transit	**0**										
		Total F-14	**582**						**1.00**	**1.04**	**0.26**	**0.05**	**0.96**
EA-6B[3]	J52-P-408A		**1,198**										
		Start/Taxi/TO	**120**	30.53	5.51	15.04	0.39	14.03	1.83	0.33	0.90	0.02	0.84
		Touch and Go	**479**	2.95	4.65	0.5	0.24	5.83	0.71	1.11	0.12	0.06	1.40
		Arrival with Break	**0**	19.812	5.426	8.793	0.372	12.367	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	**120**	19.972	5.526	8.723	0.402	13.357	1.20	0.33	0.52	0.02	0.80
		Total EA-6B	**1,198**						**3.73**	**1.77**	**1.54**	**0.10**	**3.04**
E-2[4]	T56-A-425/427		**603**										
		Start/Taxi/TO	**30**	8.08	3.83	5.56	0.23	2.29	0.12	0.06	0.08	0.00	0.03
		Touch and Go	**263**	0.5	2.85	0.11	0.13	1.26	0.07	0.37	0.01	0.02	0.17
		Arrival with Break	**0**	1.371	3.561	0.478	0.215	6.199	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	**30**	1.321	2.251	0.468	0.12	4.759	0.02	0.03	0.01	0.00	0.07
		Transit	**17**										
		Total E-2	**603**						**0.21**	**0.47**	**0.11**	**0.02**	**0.27**
C-2[5]	T56-A-425		**402**										
		Start/Taxi/TO	**8**	8.11	3.93	5.57	0.24	2.3	0.03	0.02	0.02	0.00	0.01
		Touch and Go	**0**	0.5	2.85	0.11	0.13	1.26	0.00	0.00	0.00	0.00	0.00
		GCA Box	**386**	0.8	4.2	0.18	0.19	1.9	0.15	0.81	0.03	0.04	0.37
		Straight In Arrival	**8**	1.321	2.251	0.468	0.12	1.225	0.01	0.01	0.00	0.00	0.00
		Total C2	402						**0.19**	**0.84**	**0.06**	**0.04**	**0.38**
P-3[6]	T56-A-16		**201**										
		Start/Taxi/TO	**2**	21.1	12.04	13.46	0.77	5.49	0.02	0.01	0.02	0.00	0.01
		Touch and Go	**0**	0.77	5.67	0.17	0.24	2.42	0.00	0.00	0.00	0.00	0.00
		GCA Box	**197**	1.13	8.7	0.26	0.37	3.69	0.11	0.85	0.03	0.04	0.36
		Straight In Arrival	**2**	16.4	9.17	11.13	0.56	5.29	0.02	0.01	0.01	0.00	0.01
		Total P3	201						**0.15**	**0.88**	**0.05**	**0.04**	**0.37**
C-9[7]	JT8D-9		**789**										
		Start/Taxi/TO	**355**	17.13	11.91	4.68	0.56	16.01	3.04	2.11	0.83	0.10	2.84
		Touch and Go	**0**	3.18	4.83	0.55	0.22	8.1	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	**355**	16.19	6.71	4.1	0.45	17.1	2.87	1.19	0.73	0.08	3.04
		GCA Box	**79**	5.77	7.2	1.09	0.35	12.87	0.23	0.28	0.04	0.01	0.51

Aircraft Type	Engine Model	Type of Operation	Baseline Total Number of "Operations"	CO	NOx	HC	SO2	PM10	CO	NOx	HC	SO2	PM10
		Total C-9	789						**6.14**	**3.59**	**1.60**	**0.19**	**6.39**
H-3[8]	T58-GE-402		**603**										
		Start/Taxi/TO	**268**	15.63	0.79	5.13	0.1	0.85	2.10	0.11	0.69	0.01	0.11
		Touch and Go	**30**	2.14	0.5	0.36	0.05	0.24	0.03	0.01	0.01	0.00	0.00
		Arrival	**268**	12.491	0.786	3.483	0.097	0.807	1.67	0.11	0.47	0.01	0.11
		Transits	**7**										
		Total H-3	603						**3.80**	**0.22**	**1.16**	**0.03**	**0.23**
H-60[9]	T700-GE-401C		**402**										
		Start/Taxi/TO	**184**	5.16	1.59	0.62	0.12	1.04	0.47	0.15	0.06	0.01	0.10
		Touch and Go	**4**	0.94	1.14	0.09	0.07	0.72	0.00	0.00	0.00	0.00	0.00
		Arrival	**184**	4.595	1.14	0.635	0.095	0.725	0.42	0.10	0.06	0.01	0.07
		Transits	**27**										
		Total H-60	402						**0.90**	**0.25**	**0.12**	**0.02**	**0.16**
AV-8B[10]	F402-RR-408		**201**										
		Start/Taxi/TO	**52**	14.652	2.044	0.916	0.206	5.574	0.38	0.05	0.02	0.01	0.15
		Touch and Go	**48**	4.39	7.33	0.18	0.35	5.08	0.11	0.18	0.00	0.01	0.12
		Arrival	**52**	21.92	3.35	1.33	0.33	8.76	0.57	0.09	0.03	0.01	0.23
		Arrival with Break	**0**	21.57	2.53	1.33	0.28	8.16	0.00	0.00	0.00	0.00	0.00
		Total AV-8B	201						**1.06**	**0.32**	**0.06**	**0.02**	**0.50**
S-3[11]	TF34-GE-400		**2,360**										
		Start/Taxi/TO	**236**	29.92	2.47	5.53	0.25	1.61	3.52	0.29	0.65	0.03	0.19
		Touch and Go	**943**	2.17	0.95	0.26	0.08	0.61	1.02	0.45	0.12	0.04	0.29
		Arrival with Break	**47**	12.905	2.081	2.172	0.199	1.511	0.30	0.05	0.05	0.00	0.04
		Straight In Arrival	**189**	12.325	1.561	2.122	0.169	1.291	1.16	0.15	0.20	0.02	0.12
		Transits	**3**										
		Total S-3	2,360						**6.01**	**0.93**	**1.03**	**0.09**	**0.63**
		TOTAL NAVY/MARINES	**20,105**										
Other Military													
B-1			**298**										
		Departure from Low Approach	**134**	0.708	13.5	0.032	0.787	0.781	0.05	0.91	0.00	0.05	0.05
		GCA Box	**134**	0.373	8.73	0.0168	0.415	0.342	0.03	0.59	0.00	0.03	0.02
		Transit	**30**										
		Total B-1	**298**						**0.07**	**1.49**	**0.00**	**0.08**	**0.08**
F-16			**298**										
		Touch and Go	**119**	1.25	9.06	0.096	0.964	1.25	0.07	0.54	0.01	0.06	0.07
		Arrival with Break	**24**	24.97	3.32	15.97	0.26	5.48	0.30	0.04	0.19	0.00	0.07
		Straight In Arrival	**6**	25.00	3.75	15.99	0.27	5.54	0.07	0.01	0.05	0.00	0.02
		Transit	**30**										
		Total F-16	**298**						**0.45**	**0.59**	**0.24**	**0.06**	**0.16**
T-38			**149**										
		Touch and Go	**60**	1.10	1.87	0.08	0.06	0.52	0.03	0.06	0.00	0.00	0.02
		Arrival with Break	**12**	9.05	2.19	5.43	0.14	2.49	0.05	0.01	0.03	0.00	0.01
		Straight In Arrival	**3**	8.69	2.05	5.28	0.12	2.17	0.01	0.00	0.01	0.00	0.00
		Transit	**15**										
		Total T-38	**149**						**0.10**	**0.07**	**0.04**	**0.00**	**0.03**
		TOTAL OTHER MILITARY	**745**										
Air Carrier													
SW-4[18]	PT6A-45		**3,263**										
		Start/Taxi/TO	**1,632**	0.75	0.49	0.12	0.07	0.08	0.61	0.40	0.10	0.06	0.06
		Straight In Arrival	**1,632**	1.14	0.67	0.12	0.12	0.15	0.93	0.54	0.10	0.10	0.12
		Total SW-4	**3,263**						**1.54**	**0.94**	**0.19**	**0.16**	**0.18**
		TOTAL AIR CARRIER	**3,263**										
Gen. Aviation													
Cessna 421[14]	TSIO-360C		**996**										

Aircraft Type	Engine Model	Type of Operation	Baseline Total Number of "Operations"	CO	NOx	HC	SO2	PM10	CO	NOx	HC	SO2	PM10
		Start/Taxi/TO	**486**	21.39	0.09	1.19	0.01	0.20	5.20	0.02	0.29	0.00	0.05
		Straight In Arrival	**486**	3.99	0.01	0.39	0.00	0.03	0.97	0.00	0.10	0.00	0.01
		Transits	**23**										
		Total Cessna 421	**996**						**6.17**	**0.02**	**0.39**	**0.00**	**0.05**
Piper Navajo[15]	TI0-540		**747**										
		Start/Taxi/TO	**362**	64.41	0.03	1.56	0.01	0.20	11.66	0.01	0.28	0.00	0.04
		Straight In Arrival	**362**	13.83	0.00	0.45	0.00	0.03	2.50	0.00	0.08	0.00	0.00
		Transits	**23**										
		Total Piper Navajo	**747**						**14.16**	**0.01**	**0.36**	**0.00**	**0.04**
Beech King[16]	PT6A-34B		**521**										
		Start/Taxi/TO	**261**	12.42	0.58	10.40	0.17	0.20	1.62	0.08	1.35	0.02	0.03
		Straight In Arrival	**261**	4.01	0.14	3.50	0.04	0.03	0.52	0.02	0.46	0.01	0.00
		Total Beech King	**521**						**2.14**	**0.09**	**1.81**	**0.03**	**0.03**
TOTAL GENERAL AVIATION			**2,264**										
		GRAND TOTAL	**26,377**	**Total NALF Emissions, tons per year, NAA**					**132.86**	**37.97**	**33.63**	**1.89**	**28.11**

Date: 13-May-2007

NOTES:

1 Start/Taxi/TO: Departure, AESO 9815 Rev E; Touch and Go: Touch and Go, AESO 9933B; Arrival with Break: Arrival with Break, AESO 9815 Rev E; Straight-In Arrival: Arrival, AESO 9815 Rev E

2 Start/Taxi/TO: Departure, AESO 9813 Rev G; Touch and Go: Touch and Go, AESO 9945 Rev B; Arrival with Break: Arrival with Break, AESO 9813 Rev G; Straight-In Arrival: Arrival, AESO 9813 Rev G

3 Start/Taxi/TO: Departure, AESO 9917 Rev B; Touch and Go: Touch and Go, AESO 9941 Rev A; Arrival with Break: Arrival with Break, AESO 9917 Rev B; Straight-In Arrival: Arrival, AESO 9917 Rev B

4 Start/Taxi/TO: Departure, AESO 9920 Rev B; Touch and Go: Touch and Go, AESO 9943 Rev B; Arrival with Break: Arrival with Break, AESO 9920 Rev B; Straight-In Arrival: Arrival, AESO 9920 Rev B

5 Start/Taxi/TO: Departure, AESO 9919 Rev B; Touch and Go: Touch and Go, AESO 9936 Rev B; GCA Box: GCA Box, AESO 9936 Rev B; Straight-In Arrival: Straight Arrival, AESO 9919 Rev B

6 Start/Taxi/TO: Departure, AESO 9911 Rev B; Touch and Go: Touch and Go, AESO 9948 Rev B; Straight-In Arrival: Straight Arrival, AESO 9911 Rev B; GCA Box: GCA Box, AESO 9948 Rev B

7 Start/Taxi/TO: Departure, AESO 9926; Straight-In Arrival: Arrival, AESO 9926; GCA Box: GCA Box, AESO 9942 Rev A, Touch and Go: Touch and Go, AESO 9942 Rev A

8 Start/Taxi/TO: Departure, AESO 9927 Rev A; Touch and Go: Touch and Go, AESO 9934 Rev B; Straight-In Arrival: Straight Arrival, AESO 9927 Rev A

9 Start/Taxi/TO: Departure, AESO 9929; Touch and Go: Touch and Go, AESO 9953; Straight-In Arrival: Straight Arrival, AESO 9929

10 Start/Taxi/TO: Conventional Takeoff, AESO 9913 Rev C; Arrival: Slow Landing without Break, AESO 9913 Rev C; Arrival with Break: Slow Landing with Break, AESO 9913 Rev C, Touch and Go: Touch and Go, AESO 9963 Rev A

11 Start/Taxi/TO: Departure, AESO 9915 Rev A; Touch and Go: Touch and Go, AESO 9954; Arrival with Break: Arrival with Break, AESO 9915 Rev A; Straight-In Arrival: Arrival, AESO 9915 Rev A

14 Straight In Arrival: Assumed 27% of time-in-mode for taxi operations is associated with arrival. Emission factors from AP-42, Volume IV, Table II-1-7, 501D22A, emissions for Idle X 27%, Approach.

Start/Taxi/TO: Assumed 73% of time-in-mode for taxi operations is associated with start/taxi/to. Emission factors from AP-42, Volume IV, Table II-1-7, TSIO-360C, emissions for Idle X 73%, takeoff, and climbout.

15 Straight In Arrival: Assumed 27% of time-in-mode for taxi operations is associated with arrival. Emission factors from AP-42, Volume IV, Table II-1-7, TSIO-360C, emissions for Idle X 27%, Approach.

Start/Taxi/TO: Assumed 73% of time-in-mode for taxi operations is associated with start/taxi/to. Emission factors from AP-42, Volume IV, Table II-1-7, TIO-540, emissions for Idle X 73%, takeoff, and climbout.

16 Straight In Arrival: Assumed 27% of time-in-mode for taxi operations is associated with arrival. Emission factors from AP-42, Volume IV, Table II-1-7, TIO-540, emissions for Idle X 27%, Approach.

17 Start/Taxi/TO: Assumed 73% of time-in-mode for taxi operations is associated with start/taxi/to. Emission factors from AP-42, Volume IV, Table II-1-7, PT6A-41, emissions for Idle X 73%, takeoff, and climbout.

Straight In Arrival: Assumed 27% of time-in-mode for taxi operations is associated with arrival. Emission factors from AP-42, Volume IV, Table II-1-7, PT6A-41, emissions for Idle X 27%, Approach.

Table C-8. Takeoffs/Landings from NALF San Clemente Island—Alternative 1

Aircraft Type	Engine Model	Type of Operation	Total Number of Operations	Emissions per Operation, lbs/operation CO	NOx	HC	SO2	PM10	Total Emissions, tons/year CO	NOx	HC	SO2	PM10
Navy/Marines													
F/A-18C/D[1]	F404-GE-400		9,617										
		Start/Taxi/TO	961	69.38	10.23	24.47	0.49	7.04	33.34	4.92	11.76	0.24	3.38
		Touch and Go	3,845	0.95	4.77	0.19	0.18	2.55	1.83	9.17	0.37	0.35	4.90
		Arrival with Break	192	29.09	2.898	11.728	0.205	4.638	2.79	0.28	1.13	0.02	0.45
		Straight In Arrival	769	27.17	2.498	11.118	0.215	4.828	10.45	0.96	4.27	0.08	1.86
		Transit	4										
		Total FA-18A/C	9,617						**48.41**	**15.33**	**17.53**	**0.68**	**10.59**
F/A-18E/F[1]	F414-GE-400		4,196										
		Start/Taxi/TO	419	209.67	16.41	31.66	0.58	7.9	43.96	3.44	6.64	0.12	1.66
		Touch and Go	1,678	0.47	9.01	0.07	0.22	3.04	0.39	7.56	0.06	0.18	2.55
		Arrival with Break	84	22.397	5.732	13.531	0.235	5.2	0.94	0.24	0.57	0.01	0.22
		Straight In Arrival	336	20.957	5.462	13.011	0.255	5.61	3.52	0.92	2.18	0.04	0.94
		Transit	2										
		Total FA-18	4,196						**48.81**	**12.16**	**9.45**	**0.36**	**5.37**
EA-6B[3]	J52-P-408A		1,141										
		Start/Taxi/TO	114	30.53	5.51	15.04	0.39	14.03	1.74	0.31	0.86	0.02	0.80
		Touch and Go	456	2.95	4.65	0.5	0.24	5.83	0.67	1.06	0.11	0.05	1.33
		Arrival with Break	0	19.812	5.426	8.793	0.372	12.367	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	114	19.972	5.526	8.723	0.402	13.357	1.14	0.31	0.50	0.02	0.76
		Total EA-6B	1,141						**3.55**	**1.69**	**1.47**	**0.10**	**2.89**
E-2[4]	T56-A-425/427		603										
		Start/Taxi/TO	30	8.08	3.83	5.56	0.23	2.29	0.12	0.06	0.08	0.00	0.03
		Touch and Go	263	0.5	2.85	0.11	0.13	1.26	0.07	0.37	0.01	0.02	0.17
		Arrival with Break	0	1.371	3.561	0.478	0.215	6.199	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	30	1.321	2.251	0.468	0.12	4.759	0.02	0.03	0.01	0.00	0.07
		Transit	17										
		Total E-2	603						**0.21**	**0.47**	**0.11**	**0.02**	**0.27**
C-2[5]	T56-A-425		421										
		Start/Taxi/TO	8	8.11	3.93	5.57	0.24	2.3	0.03	0.02	0.02	0.00	0.01
		Touch and Go	0	0.5	2.85	0.11	0.13	1.26	0.00	0.00	0.00	0.00	0.00
		GCA Box	404	0.8	4.2	0.18	0.19	1.9	0.16	0.85	0.04	0.04	0.38
		Straight In Arrival	8	1.321	2.251	0.468	0.12	1.225	0.01	0.01	0.00	0.00	0.01
		Total C2	421						**0.20**	**0.87**	**0.06**	**0.04**	**0.40**
P-3[5]	T56-A-16		210										
		Start/Taxi/TO	2	21.1	12.04	13.46	0.77	5.49	0.02	0.01	0.02	0.00	0.01
		Touch and Go	0	0.77	5.67	0.17	0.24	2.42	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	205	1.13	8.7	0.26	0.37	3.69	0.12	0.89	0.03	0.04	0.38
		GCA Box	2	16.4	9.17	11.13	0.56	5.29	0.02	0.01	0.01	0.00	0.01
		Total P3	210						**0.16**	**0.92**	**0.06**	**0.04**	**0.39**
C-9[6]	JT8D-9	338	751										
		Start/Taxi/TO	338	17.13	11.91	4.68	0.56	16.01	2.89	2.01	0.79	0.09	2.71
		Touch and Go	0	3.18	4.83	0.55	0.22	8.1	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	338	16.19	6.71	4.1	0.45	17.1	2.74	1.13	0.69	0.08	2.89
		GCA Box	75	5.77	7.2	1.09	0.35	12.87	0.22	0.27	0.04	0.01	0.48
		Total C-9	751						**5.85**	**3.42**	**1.52**	**0.18**	**6.08**
H-3[8]	T58-GE-402		402										
		Start/Taxi/TO	179	15.63	0.79	5.13	0.1	0.85	1.40	0.07	0.46	0.01	0.08
		Touch and Go	20	2.14	0.5	0.36	0.05	0.24	0.02	0.00	0.00	0.00	0.00
		Arrival	179	12.491	0.786	3.483	0.097	0.807	1.12	0.07	0.31	0.01	0.07
		Transits	5										
		Total C2	402						**2.53**	**0.15**	**0.77**	**0.02**	**0.15**
H-60[9]	T700-GE-401C		517										
		Start/Taxi/TO	236	5.16	1.59	0.62	0.12	1.04	0.61	0.19	0.07	0.01	0.12
		Touch and Go	5	0.94	1.14	0.09	0.07	0.72	0.00	0.00	0.00	0.00	0.00
		Arrival	236	4.595	1.14	0.635	0.095	0.725	0.54	0.13	0.08	0.01	0.09

Aircraft Type	Engine Model	Type of Operation	Total Number of Operations	Emissions per Operation, lbs/operation					Total Emissions, tons/year				
				CO	NOx	HC	SO2	PM10	CO	NOx	HC	SO2	PM10
		Transits	34										
		Total H-60	517						**1.15**	**0.33**	**0.15**	**0.03**	**0.21**
AV-8B[10]	F402-RR-408		764										
		Start/Taxi/TO	199	14.652	2.044	0.916	0.206	5.574	1.46	0.20	0.09	0.02	0.55
		Touch and Go	183	4.39	7.33	0.18	0.35	5.08	0.40	0.67	0.02	0.03	0.47
		Arrival	199	21.92	3.35	1.33	0.33	8.76	2.18	0.33	0.13	0.03	0.87
		Arrival with Break	0	21.57	2.53	1.33	0.28	8.16	0.00	0.00	0.00	0.00	0.00
		Total AV-8B	764						**4.03**	**1.21**	**0.24**	**0.09**	**1.89**
F-35	F135-PW-100		100										
		Start/Taxi/TO	0						0.00	0.00	0.00	0.00	0.00
		Touch and Go	50	0.94	22.88	0.19	0.91	4.33	0.02	0.57	0.00	0.02	0.11
		Arrival	0						0.00	0.00	0.00	0.00	0.00
		Transits	0										
		Total H-60	100						**0.02**	**0.57**	**0.00**	**0.02**	**0.11**
S-3[11]	TF34-GE-400		0										
		Start/Taxi/TO	0	29.92	2.47	5.53	0.25	1.61	0.00	0.00	0.00	0.00	0.00
		Touch and Go	0	2.17	0.95	0.26	0.08	0.61	0.00	0.00	0.00	0.00	0.00
		Arrival with Break	0	12.905	2.081	2.172	0.199	1.511	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	0	12.325	1.561	2.122	0.169	1.291	0.00	0.00	0.00	0.00	0.00
		Transits	0										
		Total S-3	0						**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Other Military													
KC-135[11]	F108-100		48										
		Departure from L	22	0.708	13.5	0.032	0.787	0.781	0.01	0.15	0.00	0.01	0.01
		GCA Box	22	0.373	8.73	0.0168	0.415	0.342	0.00	0.09	0.00	0.00	0.00
		Transit	5										
		Total KC-135	48						**0.01**	**0.24**	**0.00**	**0.01**	**0.01**
KC-10	CF6-50C2		100										
		Departure from L	45	20.98	49.41	2.53	2.54	0.33	0.47	1.11	0.06	0.06	0.01
		GCA Box	45	24.03	11.49	2.60	1.71	0.01	0.54	0.26	0.06	0.04	0.00
		Transit	10										
		Total KC-10	100						**1.01**	**1.37**	**0.12**	**0.10**	**0.01**
C-17	F117-PW-100		200										
		Start/Taxi/TO	100	23.54	64.03	2.24	1.52	0.02	1.18	3.20	0.11	0.08	0.00
		Straight In Arrival	100	25.09	17.40	2.44	1.10	0.01	1.25	0.87	0.12	0.05	0.00
		Total C-17	200						**2.43**	**4.07**	**0.23**	**0.13**	**0.00**
B-1	F108-100		398										
		Departure from Low Approach	179	0.708	13.5	0.032	0.787	0.781	0.06	1.21	0.00	0.07	0.07
		GCA Box	179	0.373	8.73	0.0168	0.415	0.342	0.03	0.78	0.00	0.04	0.03
		Transit	40										
		Total KC-135	398						**0.10**	**1.99**	**0.00**	**0.11**	**0.10**
E-3[12] or F-16	TF33-100A		315										
		Touch and Go	126	1.25	9.06	0.096	0.964	1.25	0.08	0.57	0.01	0.06	0.08
		Arrival with Break	25	24.97	3.32	15.97	0.26	5.48	0.31	0.04	0.20	0.00	0.07
		Straight In Arrival	6	25.00	3.75	15.99	0.27	5.54	0.08	0.01	0.05	0.00	0.02
		Transit	32										
		Total F-16	315						**0.47**	**0.62**	**0.26**	**0.06**	**0.17**
T-38			158										
		Touch and Go	63	1.10	1.87	0.08	0.06	0.52	0.03	0.06	0.00	0.00	0.02
		Arrival with Break	13	9.05	2.19	5.43	0.14	2.49	0.06	0.01	0.03	0.00	0.02
		Straight In Arrival	3	8.69	2.05	5.28	0.12	2.17	0.01	0.00	0.01	0.00	0.00
		Transit	16										
		Total T-38	158						**0.11**	**0.08**	**0.05**	**0.00**	**0.04**
Air Carrier													
SW-4[17]	PT6A-45		5,284										
		Start/Taxi/TO	2,642	0.75	0.49	0.12	0.07	0.08	1.00	0.65	0.15	0.10	0.10
		Straight In Arrival	2,642	1.14	0.67	0.12	0.12	0.15	1.50	0.88	0.16	0.16	0.20
		Total SW-4	5,284						**2.50**	**1.53**	**0.31**	**0.25**	**0.30**
Gen. Aviation													

Aircraft Type	Engine Model	Type of Operation	Total Number of Operations	Emissions per Operation, lbs/operation CO	NOx	HC	SO2	PM10	Total Emissions, tons/year CO	NOx	HC	SO2	PM10
Cessna 421[14]	TSIO-360C		1,424										
		Start/Taxi/TO	695	21.387	0.086943	1.1906	0.006083	0.196921	7.43	0.03	0.41	0.00	0.07
		Straight In Arrival	695	3.993	0.011157	0.3929	0.001577	0.026279	1.39	0.00	0.14	0.00	0.01
		Transits	34										
		Total Cessna 421	1,424						**8.82**	**0.03**	**0.55**	**0.00**	**0.08**
Piper Navajo[15]	TI0-540		1,067										
		Start/Taxi/TO	517	64.413	0.030849	1.5634	0.012659	0.196921	16.65	0.01	0.40	0.00	0.05
		Straight In Arrival	517	13.827	0.003841	0.4531	0.003174	0.026279	3.57	0.00	0.12	0.00	0.01
		Transits	33										
		Total Piper Navajo	1,067						**20.23**	**0.01**	**0.52**	**0.00**	**0.06**
Beech King[16]	PT6A-34B		744										
		Start/Taxi/TO	372	12.416	0.58223	10.397	0.1746	0.196921	2.31	0.11	1.93	0.03	0.04
		Straight In Arrival	372	4.0123	0.13557	3.4978	0.0436	0.026279	0.75	0.03	0.65	0.01	0.00
		Total Beech King	744						**3.06**	**0.13**	**2.58**	**0.04**	**0.04**
		Total Operation	**28460**	**Total NALF Emissions, tons per year, Alt 1**					**153.67**	**47.18**	**35.98**	**2.30**	**29.14**

Date: 13-May-2007

NOTES:

1 Start/Taxi/TO: Departure, AESO 9815 Rev E; Touch and Go: Touch and Go, AESO 9933B; Arrival with Break: Arrival with Break, AESO 9815 Rev E; Straight-In Arrival: Arrival, AESO 9815 Rev E

2 Start/Taxi/TO: Departure, AESO 9917 Rev B; Touch and Go: Touch and Go, AESO 9941 Rev A; Arrival with Break: Arrival with Break, AESO 9917 Rev B; Straight-In Arrival: Arrival, AESO 9917 Rev B

3 Start/Taxi/TO: Departure, AESO 9920 Rev B; Touch and Go: Touch and Go, AESO 9943 Rev B; Arrival with Break: Arrival with Break, AESO 9920 Rev B; Straight-In Arrival: Arrival, AESO 9920 Rev B

4 Start/Taxi/TO: Departure, AESO 9919 Rev B; Touch and Go: Touch and Go, AESO 9936 Rev B; GCA Box: GCA Box, AESO 9936 Rev B; Straight-In Arrival: Straight Arrival, AESO 9919 Rev B

5 Start/Taxi/TO: Departure, AESO 9911 Rev B; Touch and Go: Touch and Go, AESO 9948 Rev B; Straight-In Arrival: Straight Arrival, AESO 9911 Rev B; GCA Box: GCA Box, AESO 9948 Rev B

6 Start/Taxi/TO: Departure, AESO 9926; Straight-In Arrival: Arrival, AESO 9926; GCA Box: GCA Box, AESO 9942 Rev A, Touch and Go: Touch and Go, AESO 9942 Rev A

7 Start/Taxi/TO: Departure, AESO 9927 Rev A; Touch and Go: Touch and Go, AESO 9934 Rev B; Straight-In Arrival: Straight Arrival, AESO 9927 Rev A

8 Start/Taxi/TO: Departure, AESO 9929; Touch and Go: Touch and Go, AESO 9953; Straight-In Arrival: Straight Arrival, AESO 9929

9 Start/Taxi/TO: Conventional Takeoff, AESO 9913 Rev C; Arrival: Slow Landing without Break, AESO 9913 Rev C; Arrival with Break: Slow Landing with Break, AESO 9913 Rev C, Touch and Go: Touch and Go, AESO 9963 Rev A

10 Start/Taxi/TO: Departure, AESO 9915 Rev A; Touch and Go: Touch and Go, AESO 9954; Arrival with Break: Arrival with Break, AESO 9915 Rev A; Straight-In Arrival: Arrival, AESO 9915 Rev A

11 Departure from Low Approach: Departure, AESO Memorandum 2000-09 Rev B; GCA Box: GCA Box, AESO Memorandum 2000-10, Rev B.

12 To be Provided

13 Start/Taxi/TO: Assumed 73% of time-in-mode for taxi operations is associated with start/taxi/to. Emission factors from AP-42, Volume IV, Table II-1-7, 501D22A, emissions for Idle X 73%, takeoff, and climbout.
Straight In Arrival: Assumed 27% of time-in-mode for taxi operations is associated with arrival. Emission factors from AP-42, Volume IV, Table II-1-7, 501D22A, emissions for Idle X 27%, Approach.

14 Start/Taxi/TO: Assumed 73% of time-in-mode for taxi operations is associated with start/taxi/to. Emission factors from AP-42, Volume IV, Table II-1-7, TSIO-360C, emissions for Idle X 73%, takeoff, and climbout.
Straight In Arrival: Assumed 27% of time-in-mode for taxi operations is associated with arrival. Emission factors from AP-42, Volume IV, Table II-1-7, TSIO-360C, emissions for Idle X 27%, Approach.

15 Start/Taxi/TO: Assumed 73% of time-in-mode for taxi operations is associated with start/taxi/to. Emission factors from AP-42, Volume IV, Table II-1-7, TIO-540, emissions for Idle X 73%, takeoff, and climbout.
Straight In Arrival: Assumed 27% of time-in-mode for taxi operations is associated with arrival. Emission factors from AP-42, Volume IV, Table II-1-7, TIO-540, emissions for Idle X 27%, Approach.

16 Start/Taxi/TO: Assumed 73% of time-in-mode for taxi operations is associated with start/taxi/to. Emission factors from AP-42, Volume IV, Table II-1-7, PT6A-41, emissions for Idle X 73%, takeoff, and climbout.
Straight In Arrival: Assumed 27% of time-in-mode for taxi operations is associated with arrival. Emission factors from AP-42, Volume IV, Table II-1-7, PT6A-41, emissions for Idle X 27%, Approach.

17 Start/Taxi/TO: Assumed SW4 is represented by Fairchild SA-227 Metroliner, emissions from EDMS.

Table C-9. Takeoffs/Landings from NALF San Clemente Island—Alternative 2

Aircraft Type	Engine Model	Type of Operation	Total Number of Operations	Emissions per Operation, lbs/operation					Total Emissions, tons/year				
				CO	NOx	HC	SO2	PM10	CO	NOx	HC	SO2	PM10
		GRAND TOTAL	**25,120**										
Navy/Marines													
F/A-18C/D[1]	F404-GE-400		9,617										
		Start/Taxi/TO	961	69.38	10.23	24.47	0.49	7.04	33.34	4.92	11.76	0.24	3.38
		Touch and Go	3,845	0.95	4.77	0.19	0.18	2.55	1.83	9.17	0.37	0.35	4.90
		Arrival with Break	192	29.09	2.898	11.728	0.205	4.638	2.79	0.28	1.13	0.02	0.45
		Straight In Arrival	769	27.17	2.498	11.118	0.215	4.828	10.45	0.96	4.27	0.08	1.86
		Transit	4										
		Total FA-18	9,617						**48.41**	**15.33**	**17.53**	**0.68**	**10.59**
F/A-18E/F[1]	F414-GE-400		4,496										
		Start/Taxi/TO	449	209.67	16.41	31.66	0.58	7.9	47.11	3.69	7.11	0.13	1.77
		Touch and Go	1,798	0.47	9.01	0.07	0.22	3.04	0.42	8.10	0.06	0.20	2.73
		Arrival with Break	90	22.397	5.732	13.531	0.235	5.2	1.01	0.26	0.61	0.01	0.23
		Straight In Arrival	360	20.957	5.462	13.011	0.255	5.61	3.77	0.98	2.34	0.05	1.01
		Transit	2										
		Total FA-18	4,496						**52.30**	**13.03**	**10.12**	**0.38**	**5.75**
EA-6B[3]	J52-P-408A		1,255										
		Start/Taxi/TO	125	30.53	5.51	15.04	0.39	14.03	1.91	0.35	0.94	0.02	0.88
		Touch and Go	502	2.95	4.65	0.5	0.24	5.83	0.74	1.17	0.13	0.06	1.46
		Arrival with Break	0	19.812	5.426	8.793	0.372	12.367	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	125	19.972	5.526	8.723	0.402	13.357	1.25	0.35	0.55	0.03	0.84
		Total EA-6B	1,255						**3.91**	**1.86**	**1.62**	**0.11**	**3.18**
E-2[4]	T56-A-425/427		660										
		Start/Taxi/TO	33	8.08	3.83	5.56	0.23	2.29	0.13	0.06	0.09	0.00	0.04
		Touch and Go	288	0.5	2.85	0.11	0.13	1.26	0.07	0.41	0.02	0.02	0.18
		Arrival with Break	0	1.371	3.561	0.478	0.215	6.199	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	33	1.321	2.251	0.468	0.12	4.759	0.02	0.04	0.01	0.00	0.08
		Transit	18										
		Total E-2	660						**0.23**	**0.51**	**0.12**	**0.02**	**0.30**
C-2[5]	T56-A-425		460										
		Start/Taxi/TO	9	8.11	3.93	5.57	0.24	2.3	0.04	0.02	0.03	0.00	0.01
		Touch and Go	0	0.5	2.85	0.11	0.13	1.26	0.00	0.00	0.00	0.00	0.00
		GCA Box	442	0.8	4.2	0.18	0.19	1.9	0.18	0.93	0.04	0.04	0.42
		Straight In Arrival	9	1.321	2.251	0.468	0.12	1.225	0.01	0.01	0.00	0.00	0.01
		Total C2	460						**0.22**	**0.96**	**0.07**	**0.04**	**0.44**
P-3[5]	T56-A-16		229										
		Start/Taxi/TO	3	21.1	12.04	13.46	0.77	5.49	0.03	0.02	0.02	0.00	0.01
		Touch and Go	0	0.77	5.67	0.17	0.24	2.42	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	224	1.13	8.7	0.26	0.37	3.69	0.13	0.97	0.03	0.04	0.41
		GCA Box	3	16.4	9.17	11.13	0.56	5.29	0.02	0.01	0.01	0.00	0.01
		Total P3	229						**0.17**	**1.00**	**0.06**	**0.04**	**0.43**
C-9[6]	JT8D-9		826										
		Start/Taxi/TO	372	17.13	11.91	4.68	0.56	16.01	3.18	2.21	0.87	0.10	2.98
		Touch and Go	0	3.18	4.83	0.55	0.22	8.1	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	372	16.19	6.71	4.1	0.45	17.1	3.01	1.25	0.76	0.08	3.18
		GCA Box	83	5.77	7.2	1.09	0.35	12.87	0.24	0.30	0.05	0.01	0.53
		Total C-9	826						**6.43**	**3.76**	**1.68**	**0.20**	**6.69**
H-3[8]	T58-GE-402		431										
		Start/Taxi/TO	192	15.63	0.79	5.13	0.1	0.85	1.50	0.08	0.49	0.01	0.08
		Touch and Go	21	2.14	0.5	0.36	0.05	0.24	0.02	0.01	0.00	0.00	0.00
		Arrival	192	12.491	0.786	3.483	0.097	0.807	1.20	0.08	0.33	0.01	0.08
		Transits	5										
		Total C2	431						**2.72**	**0.16**	**0.83**	**0.02**	**0.16**
H-60[9]	T700-GE-401C		536										
		Start/Taxi/TO	245	5.16	1.59	0.62	0.12	1.04	0.63	0.19	0.08	0.01	0.13
		Touch and Go	5	0.94	1.14	0.09	0.07	0.72	0.00	0.00	0.00	0.00	0.00

Aircraft Type	Engine Model	Type of Operation	Total Number of Operations	Emissions per Operation, lbs/operation CO	NOx	HC	SO2	PM10	Total Emissions, tons/year CO	NOx	HC	SO2	PM10
		Arrival	245	4.595	1.14	0.635	0.095	0.725	0.56	0.14	0.08	0.01	0.09
		Transits	35										
		Total H-60	536						**1.20**	**0.34**	**0.15**	**0.03**	**0.22**
AV-8B[10]	F402-RR-408		1,146										
		Start/Taxi/TO	298	14.652	2.044	0.916	0.206	5.574	2.18	0.30	0.14	0.03	0.83
		Touch and Go	275	4.39	7.33	0.18	0.35	5.08	0.60	1.01	0.02	0.05	0.70
		Arrival	298	21.92	3.35	1.33	0.33	8.76	3.27	0.50	0.20	0.05	1.31
		Arrival with Break	0	21.57	2.53	1.33	0.28	8.16	0.00	0.00	0.00	0.00	0.00
		Total AV-8B	1,146						**6.05**	**1.81**	**0.36**	**0.13**	**2.83**
F-35	F135-PW-100		200										
		Start/Taxi/TO	0						0.00	0.00	0.00	0.00	0.00
		Touch and Go	100	0.94	22.88	0.19	0.91	4.33	0.05	1.14	0.01	0.05	0.22
		Arrival	0						0.00	0.00	0.00	0.00	0.00
		Transits	0										
		Total H-60	200						**0.05**	**1.14**	**0.01**	**0.05**	**0.22**
S-3[10]	TF34-GE-400		0										
		Start/Taxi/TO	0	29.92	2.47	5.53	0.25	1.61	0.00	0.00	0.00	0.00	0.00
		Touch and Go	0	2.17	0.95	0.26	0.08	0.61	0.00	0.00	0.00	0.00	0.00
		Arrival with Break	0	12.905	2.081	2.172	0.199	1.511	0.00	0.00	0.00	0.00	0.00
		Straight In Arrival	0	12.325	1.561	2.122	0.169	1.291	0.00	0.00	0.00	0.00	0.00
		Transits	0										
		Total S-3	0						**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Other Military													
KC-135[11]	F108-100		30										
		Departure from Lo	14	0.708	13.5	0.032	0.787	0.781	0.00	0.09	0.00	0.01	0.01
		GCA Box	14	0.373	8.73	0.0168	0.415	0.342	0.00	0.06	0.00	0.00	0.00
		Transit	3										
		Total KC-135	30						**0.01**	**0.15**	**0.00**	**0.01**	**0.01**
KC-10	CF6-50C2		100										
		Departure from Lo	45	20.98	49.41	2.53	2.54	0.33	0.47	1.11	0.06	0.06	0.01
		GCA Box	45	24.03	11.49	2.60	1.71	0.01	0.54	0.26	0.06	0.04	0.00
		Transit	10										
		Total KC-10	100						**1.01**	**1.37**	**0.12**	**0.10**	**0.01**
C-17	F117-PW-100		400										
		Start/Taxi/TO	200	23.54	64.03	2.24	1.52	0.02	2.35	6.40	0.22	0.15	0.00
		Straight In Arrival	200	25.09	17.40	2.44	1.10	0.01	2.51	1.74	0.24	0.11	0.00
		Total C-17	400						**4.86**	**8.14**	**0.47**	**0.26**	**0.00**
B-1	F108-100		426										
		Departure from Low Approach	192	0.708	13.5	0.032	0.787	0.781	0.07	1.29	0.00	0.08	0.07
		GCA Box	192	0.373	8.73	0.0168	0.415	0.342	0.04	0.84	0.00	0.04	0.03
		Transit	43						**0.10**	**2.13**	**0.00**	**0.12**	**0.11**
		Total B-1	426										
E-3[12] or F-16	TF33-100A		355										
		Touch and Go	142	1.25	9.06	0.096	0.964	1.25	0.09	0.64	0.01	0.07	0.09
		Arrival with Break	28	24.97	3.32	15.97	0.26	5.48	0.35	0.05	0.23	0.00	0.08
		Straight In Arrival	7	25.00	3.75	15.99	0.27	5.54	0.09	0.01	0.06	0.00	0.02
		Transit	36										
		Total F-16	355						**0.53**	**0.70**	**0.29**	**0.07**	**0.19**
T-38			178										
		Touch and Go	71	1.10	1.87	0.08	0.06	0.52	0.04	0.07	0.00	0.00	0.02
		Arrival with Break	14	9.05	2.19	5.43	0.14	2.49	0.06	0.02	0.04	0.00	0.02
		Straight In Arrival	4	8.69	2.05	5.28	0.12	2.17	0.02	0.00	0.01	0.00	0.00
		Transit	18										
		Total T-38	178						**0.12**	**0.09**	**0.05**	**0.00**	**0.04**
Air Carrier													
SW-4[17]	PT6A-45		6,838										
		Start/Taxi/TO	3,419	0.75	0.49	0.12	0.07	0.08	1.29	0.84	0.20	0.12	0.13
		Straight In Arrival	3,419	1.14	0.67	0.12	0.12	0.15	1.94	1.14	0.20	0.20	0.25
		Total SW-4	6,838						**3.23**	**1.98**	**0.40**	**0.33**	**0.39**

Aircraft Type	Engine Model	Type of Operation	Total Number of Operations	Emissions per Operation, lbs/operation					Total Emissions, tons/year				
				CO	NOx	HC	SO2	PM10	CO	NOx	HC	SO2	PM10
Gen. Aviation													
Cessna 421[14]	TSIO-360C		1,518										
		Start/Taxi/TO	741	21.387	0.086943	1.1906	0.006083	0.196921	7.93	0.03	0.44	0.00	0.07
		Straight In Arrival	741	3.993	0.011157	0.3929	0.001577	0.026279	1.48	0.00	0.15	0.00	0.01
		Transits	36										
		Total Cessna 421	1,518						**9.41**	**0.04**	**0.59**	**0.00**	**0.08**
Piper Navajo[15]	TI0-540		1,138										
		Start/Taxi/TO	551	64.413	0.030849	1.5634	0.012659	0.196921	17.76	0.01	0.43	0.00	0.05
		Straight In Arrival	551	13.827	0.003841	0.4531	0.003174	0.026279	3.81	0.00	0.12	0.00	0.01
		Transits	35										
		Total Piper Navajo	1,138						**21.57**	**0.01**	**0.56**	**0.00**	**0.06**
Beech King[16]	PT6A-34B		789										
		Start/Taxi/TO	395	12.416	0.58223	10.397	0.1746	0.196921	2.45	0.11	2.05	0.03	0.04
		Straight In Arrival	395	4.0123	0.13557	3.4978	0.0436	0.026279	0.79	0.03	0.69	0.01	0.01
		Total Beech King	789						**3.24**	**0.14**	**2.74**	**0.04**	**0.04**
			31628	**Total NALF Emissions, tons per year, Alt 2**					**165.78**	**54.63**	**37.75**	**2.65**	**31.72**

Date: 13-May-2007

NOTES:

1 Start/Taxi/TO: Departure, AESO 9815 Rev E; Touch and Go: Touch and Go, AESO 9933B; Arrival with Break: Arrival with Break, AESO 9815 Rev E; Straight-In Arrival: Arrival, AESO 9815 Rev E

2 Start/Taxi/TO: Departure, AESO 9917 Rev B; Touch and Go: Touch and Go, AESO 9941 Rev A; Arrival with Break: Arrival with Break, AESO 9917 Rev B; Straight-In Arrival: Arrival, AESO 9917 Rev B

3 Start/Taxi/TO: Departure, AESO 9920 Rev B; Touch and Go: Touch and Go, AESO 9943 Rev B; Arrival with Break: Arrival with Break, AESO 9920 Rev B; Straight-In Arrival: Arrival, AESO 9920 Rev B

4 Start/Taxi/TO: Departure, AESO 9919 Rev B; Touch and Go: Touch and Go, AESO 9936 Rev B; GCA Box: GCA Box, AESO 9936 Rev B; Straight-In Arrival: Straight Arrival, AESO 9919 Rev B

5 Start/Taxi/TO: Departure, AESO 9911 Rev B; Touch and Go: Touch and Go, AESO 9948 Rev B; Straight-In Arrival: Straight Arrival, AESO 9911 Rev B; GCA Box: GCA Box, AESO 9948 Rev B

6 Start/Taxi/TO: Departure, AESO 9926; Straight-In Arrival: Arrival, AESO 9926; GCA Box: GCA Box, AESO 9942 Rev A, Touch and Go: Touch and Go, AESO 9942 Rev A

7 Start/Taxi/TO: Departure, AESO 9927 Rev A; Touch and Go: Touch and Go, AESO 9934 Rev B; Straight-In Arrival: Straight Arrival, AESO 9927 Rev A

8 Start/Taxi/TO: Departure, AESO 9929; Touch and Go: Touch and Go, AESO 9953; Straight-In Arrival: Straight Arrival, AESO 9929

9 Start/Taxi/TO: Conventional Takeoff, AESO 9913 Rev C; Arrival: Slow Landing without Break, AESO 9913 Rev C; Arrival with Break: Slow Landing with Break, AESO 9913 Rev C, Touch and Go: Touch and Go, AESO 9963 Rev A

10 Start/Taxi/TO: Departure, AESO 9915 Rev A; Touch and Go: Touch and Go, AESO 9954; Arrival with Break: Arrival with Break, AESO 9915 Rev A; Straight-In Arrival: Arrival, AESO 9915 Rev A

11 Departure from Low Approach: Departure, AESO Memorandum 2000-09 Rev B; GCA Box: GCA Box, AESO Memorandum 2000-10, Rev B.

12 To be Provided

13 Start/Taxi/TO: Assumed 73% of time-in-mode for taxi operations is associated with start/taxi/to. Emission factors from AP-42, Volume IV, Table II-1-7, 501D22A, emissions for Idle X 73%, takeoff, and climbout.
Straight In Arrival: Assumed 27% of time-in-mode for taxi operations is associated with arrival. Emission factors from AP-42, Volume IV, Table II-1-7, 501D22A, emissions for Idle X 27%, Approach.

14 Start/Taxi/TO: Assumed 73% of time-in-mode for taxi operations is associated with start/taxi/to. Emission factors from AP-42, Volume IV, Table II-1-7, TSIO-360C, emissions for Idle X 73%, takeoff, and climbout.
Straight In Arrival: Assumed 27% of time-in-mode for taxi operations is associated with arrival. Emission factors from AP-42, Volume IV, Table II-1-7, TSIO-360C, emissions for Idle X 27%, Approach.

15 Start/Taxi/TO: Assumed 73% of time-in-mode for taxi operations is associated with start/taxi/to. Emission factors from AP-42, Volume IV, Table II-1-7, TIO-540, emissions for Idle X 73%, takeoff, and climbout.
Straight In Arrival: Assumed 27% of time-in-mode for taxi operations is associated with arrival. Emission factors from AP-42, Volume IV, Table II-1-7, TIO-540, emissions for Idle X 27%, Approach.

16 Start/Taxi/TO: Assumed 73% of time-in-mode for taxi operations is associated with start/taxi/to. Emission factors from AP-42, Volume IV, Table II-1-7, PT6A-41, emissions for Idle X 73%, takeoff, and climbout.
Straight In Arrival: Assumed 27% of time-in-mode for taxi operations is associated with arrival. Emission factors from AP-42, Volume IV, Table II-1-7, PT6A-41, emissions for Idle X 27%, Approach.

17 Start/Taxi/TO: Assumed SW4 is represented by Fairchild SA-227 Metroliner, emissions from EDMS.

Table C-10. SOCAL Ordnance Expenditures—No Action Alternative

NOTE: Units of Measure (UOM) for ordnance rounds are 1 each (ea.) and for Demolitions and Other Ordnance are in pounds Net Explosive Weight (NEW).								Emission Factor (lb per lb or lb per item)							Emissions, tons/year						
Ordnance Group	AQ Data	Ordnance Type	Fate	Quantity Fired	Consolidated Nos.	NEW ea.	UOM/ Cum NEW	CO2	CO	Nox	PM10	PM2.5	SO2	Lead	CO2	CO	Nox	PM10	PM2.5	SO2	Lead
BOMB		CBU MK20 ROCKEYE	Clusters Explode Underwater	13		99	ea.														
	No Data	GBU32I JDAM	Clusters Explode Underwater	9		385	ea.														
	No Data	LGTR	Rocket fires Inert warhead	103		0	ea.														
		MK76	Only small spotting charge	1,496		Neg.	ea.														
	No Data	BDU 48	Only small spotting charge	93		Neg.	ea.														
		MK82 HE	31 in water; 383 on land	418		192	ea.		0.3184						0	12.77676	0	0	0	0	0
	No Data	GBU12 500 lb	6 in water; 6 on land	12		192	ea.														
	NA	MK82 INERT	No emissions	18		0	ea.														
	No Data	BDU 45		162		0	ea.														
		MK83 HE		116		445	ea.		0.1482						0	3.825042	0	0	0	0	0
	No Data	GBU 16	14 in water; 14 on land	28		445	ea.														
	NA	MK83 INERT		93		0	ea.														
		Total:		2,561	0																
OTHER ORD	No AQ data	Type		No.		NEW															
	CNAP & SPAWAR	EER/IEER AN/SQQ-110	Explode deep in water			4.2	0	1.2	0.0044	0.011				0.00004	0	0	0	0	0	0	0
	No Data	BLASTING CAP MK11	On Land only	1,113		Neg.	0														
		Detonator		120																	
	No Data	FIRING DEVICE	2 in water; 48 on land	54		Neg.	0														
	No Data	FUSE	6 in water; 94 on land	1,080		Neg.	0														
		GRENADE SIMULATOR	Land	290		0.0813	23.6	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.007427	0.000248	7.42676E-05	0.000248	0.000177	1.41462E-06	1.65E-06
		Grenades	Land	896		0.0813	72.8	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.022946	0.000765	0.000229461	0.000765	0.000546	4.37069E-06	5.1E-06
		Haversacks		75		20.0000	1500.0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04							
		K143 Antipersonnel Mine		124																	
	No Data	M1A2 BANGALORE TORP	Land	109		10.00	1090								0	0	0	0	0	0	0
		M7 BANDOLEER MK57 (Claymore mine)	Land	40		8.16	326.4		0.15108						0	0.024656	0	0	0	0	0
	AP-42	M112 DEMO CHARGE	Land	105		1.20	126	7.90E-01	2.60E-02	7.90E-03	2.60E-02	1.90E-02		1.70E-04	0.04977	0.001638	0.0004977	0.001638	0.001197	0	1.07E-05
	No Data	M700 BLASTING FUSE	Land	1,000		0.001	1														
	No Data	MK20 Cable Cutter	Land	69		0.0028	0.2														
	No Data	MK22 Projectile Unit	Land	105		Neg.	Neg.														
	No Data	MK36 M0 DEMO CHARGE	Land	30		4.10	123								0	0	0	0	0	0	0
	No Data	MK75 CHARGE	In Shallow water	105		50.00	5,250								0	0	0	0	0	0	0
	No Data	MK84 [86] EOD Shaped Charge	On Land only	109		0.08	8.72								0	0	0	0	0	0	0
	No Data	MK120 NONELEC DET (ft)	On Land only	512		0.00001	0.0073														
	No Data	MK123 NONELEC DET (ft)	On Land only	2,120		0.00001	0.0303														
	No Data	MK138 DEMO CHG ASSEMBLY	In water			20.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	MK140 FLEXIBLE CHARGE	On Land only	150		0.04	6.6														
	No Data	PBXN-109 TEST Det Cord	On Land only	16		0.0060	0.096														
	No Data	SIGNAL MK 18(G950) SMOKE	On Land only	355		0.23	82.786														
	No Data	C4 1.25 LB	98 in water; 19,156 on land	19,260		1.25	24075	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	7.58E+00	0.252788	0.07583625	0.252788	0.180563	0.0014445	0.001685
	No Data	C4 5 LB	On Land only			5.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0

Ordnance Group	AQ Data	Ordnance Type	Fate	Quantity Fired	Consolidated Nos.	NEW ea.	UOM/ Cum NEW	CO2	CO	Nox	PM10	PM2.5	SO2	Lead	CO2	CO	Nox	PM10	PM2.5	SO2	Lead
	No Data	C4 15 LB	On Land only	20		15.00	300	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	9.45E-02	0.00315	0.000945	0.00315	0.00225	0.000018	0.000021
	No Data	C4 40 LB	On Land only	3,600		40.00	144000	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	4.54E+01	1.512	0.4536	1.512	1.08	0.00864	0.01008
	No Data	C4 100 LB	On Land only	400		100.00	40000	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	12.6	0.42	0.126	0.42	0.3	0.0024	0.0028
	No Data	C4 300 LB	On Land only	12,260		1.00	12260	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	3.8619	0.12873	0.038619	0.12873	0.09195	0.0007356	0.000858
	No Data	C4 500 LB	On Land only	15,100		1.00	15100	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	4.7565	0.15855	0.047565	0.15855	0.11325	0.000906	0.001057
	No Data	TNT Blocks 0.5 lbd	On Land only	885		1.00	885		0.398							0.176115					
	No Data	DEMO SHEET	On Land only	263		6.00	1578														
	No Data	DETONATING CORD	3000 ft in water; 10300 land	34,000		0.006	204														
	No Data	DEMO CHARGE	Land	30		5.00	150														
	AP-42	SIMULATED ARTILLERY	M110 Land	210		0.1375	28.875	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.009096	0.000303	9.09563E-05	0.000303	0.000217	1.7325E-06	2.02E-06
		Totals		**94,605**			**247,192**														
GUNFIRE (Large)	AP-42	155MM HE		238			ea.	6.51	2.35E+01	1.43E+00	0.496	0.2418		2.26E-03	0.77469	2.794215	0.169694	0.059024	0.028774	0	0.000269
	AP-42	155MM ILL		8			ea.	1.8	2.62E-02	9.40E-02	3	3		5.80E-05	0.0072	0.000105	0.000376	0.012	0.012	0	2.32E-07
		122 MM		40																	
5"/54		5"/54 BLP	BLP is INERT	5,178			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.041424	0.05178	0	0.003107	0.002408	0	1.55E-05
		5"/54 HCVT+32 (EOD)		195			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.00156	0.00195	0	0.000117	9.07E-05	0	5.85E-07
		5"/54 HECVT	1700 in water; 2242 on land	2,442			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.019536	0.02442	0	0.001465	0.001136	0	7.33E-06
		5"/54 HEPD		85			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.00068	0.00085	0	0.000051	3.95E-05	0	2.55E-07
		5"/54 HEVT		183			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.001464	0.00183	0	0.00011	8.51E-05	0	5.49E-07
		5"/54 ILL		110			ea.	1.50E-02	1.40E-02	3.60E-04	9.20E-04	7.60E-04		1.30E-06	0.000825	0.00077	0.0000198	5.06E-05	4.18E-05	0	7.15E-08
		5"54/54 VTNF		50			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.0004	0.0005	0	0.00003	2.33E-05	0	1.5E-07
5"/62		5"/62		631			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.005048	0.00631	0	0.000379	0.000293	0	1.89E-06
		5"/62 HE-MFF		84			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.000672	0.00084	0	5.04E-05	3.91E-05	0	2.52E-07
		5"/62 HECVT	100 in water; 768 on land	831			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.006648	0.00831	0	0.000499	0.000386	0	2.49E-06
		5"/62 HEET		8			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.000064	0.00008	0	4.8E-06	3.72E-06	0	2.4E-08
		5"/62 KEET		37			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.000296	0.00037	0	2.22E-05	1.72E-05	0	1.11E-07
60mm	AP-42	60MM		234			ea.	2.90E-01	3.00E-02	4.20E-03	3.20E-02	1.70E-02		2.30E-04	0.03393	0.00351	0.0004914	0.003744	0.001989	0	2.69E-05
		60MM WP					ea.	2.90E-01	3.00E-02	4.20E-03	3.20E-02	1.70E-02		2.30E-04	0	0	0	0	0	0	0
76mm		76MM BLP	INERT	1,534			ea.	1.44E-02	1.80E-02		1.08E-03	8.37E-04		5.40E-06	0.011045	0.013806	0	0.000828	0.000642	0	4.14E-06
	AP-42	81MM HE		303			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.002424	0.00303	0	0.000182	0.000141	0	9.09E-07
	AP-42	81MM ILL		18			ea.	1.50E-02	1.40E-02	3.60E-04	9.20E-04	7.60E-04		1.30E-06	0.000135	0.000126	0.00000324	8.28E-06	6.84E-06	0	1.17E-08
CAS	No data	GAU-17 30mm					ea.														
		Total:		**12,209**																	
GUNFIRE (small)	AMW 114,1125	20MM	Fired by aircraft at low alt.	1,429,225			ea.														
		25MM	Fired by ship	55,309			ea.														
	No Data	30MM EFV Main Gun	Fired on land or sea	1,425			ea.														
	AP-42	40MM	NSW on land	4,260			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0.000554	0.000746	0.00007668	5.54E-05	4.9E-05	0	0.001427
	AP-42	40MM HE	NSW on land	745			ea.	6.60E-02	7.00E-03	1.60E-03	1.30E-02	6.60E-03		7.30E-05	0.024585	0.002608	0.000596	0.004843	0.002459	0	2.72E-05
	No Data	40MM ILL	NSW on land	352			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	4.58E-05	6.16E-05	0.000006336	4.58E-06	4.05E-06	0	0.000118
	AP-42	40MM PRACTICE	NSW on land	2,548			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0.000331	0.000446	0.000045864	3.31E-05	2.93E-05	0	0.000854
	AP-42	.45 CAL	NSW and USMC	5,730			ea.	2.20E-04	2.60E-04	8.10E-06	3.70E-05	3.10E-05		1.20E-05	0.00063	0.000745	2.32065E-05	0.000106	8.88E-05	0	3.44E-05
	AP-42	5.56	NSW and USMC	1,457,152			ea.	8.70E-04	1.60E-03	8.50E-05	3.90E-05	2.80E-05		5.10E-06	0.633861	1.165722	0.06192896	0.028414	0.0204	0	0.003716
	AP-42	5.56 BLANK	NSW and USMC	2,450			ea.	2.30E-04	2.80E-04	2.00E-05	6.90E-06	2.00E-06		9.70E-07	0.000282	0.000343	0.0000245	8.45E-06	2.45E-06	0	1.19E-06
	AP-42	.50CAL	NSW and USMC	262,957			ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0.67054	1.446264	0.1577742	0.040758	0.024981	0	0.001709
		.50CAL	USCG	12,000			ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0.0306	0.066	0.0072	0.00186	0.00114	0	0.000078
	AP-42	.50CAL BLANK	NSW and USMC	10,000			ea.	2.10E-03	1.80E-03	2.80E-05	9.80E-05	8.80E-05		1.20E-05	0.0105	0.009	0.00014	0.00049	0.00044	0	0.00006
	AP-42	7.62	NSW and USMC	110,440			ea.	1.20E-03	2.30E-03	9.70E-05	5.10E-05	3.80E-05		4.90E-06	0.066264	0.127006	0.00535634	0.002816	0.002098	0	0.000271
		7.62	USCG	21,000			ea.	1.20E-03	2.30E-03	9.70E-05	5.10E-05	3.80E-05		4.90E-06	0.0126	0.02415	0.0010185	0.000536	0.000399	0	5.15E-05
	AP-42	9MM	NSW and USMC	1,060,000			ea.	2.00E-04	3.10E-04	1.50E-05	2.40E-05	2.00E-05		6.80E-06	0.106	0.1643	0.00795	0.01272	0.0106	0	0.003604
	No Data	.300 WIN MAG	Environmental Contractors				ea.	2.00E-04	3.10E-04	1.50E-05	2.40E-05	2.00E-05		6.80E-06	0	0	0	0	0	0	0
	No Data	.223 Rifle Rounds	Environmental Contractors				ea.	6.80E-05	7.20E-05	3.10E-06	2.60E-06	1.90E-06		1.80E-06	0	0	0	0	0	0	0
	No Data	.22 Magnum	Environmental Contractors				ea.	7.50E-05	8.00E-05	5.00E-06	3.40E-06	2.60E-06		1.90E-06	0	0	0	0	0	0	0
	AP-42	.22 Long Rifle	Environmental Contractors				ea.	6.80E-05	7.20E-05	3.10E-06	2.60E-06	1.90E-06		1.80E-06	0	0	0	0	0	0	0
		12 Guage Shotgun	Environmental Contractors				ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0	0	0	0	0	0	0
		Total:		**4,435,593**																	
MINE SHAPE	AP-42	M18A1		105			ea.	1.6	2.00E-02	1.80E-02	4.90E-02	2.60E-02		5.70E-05	0.084	0.00105	0.000945	0.002573	0.001365	0	2.99E-06
		MK76		64			ea.														
		MK62		12			ea.	No emissions													
		Total:		**181**																	
MISSILE		AGM-114B	Fired at low altitude	14			ea.														
		AGM-65 Maverick		3																	
		AGM-84		7																	
		AIM-120	Fired well above 3,000 ft	4			ea.														
		AIM-7	Fired well above 3,000 ft	7			ea.														
		AIM-9	Fired well above 3,000 ft	5			ea.														
		BGM-71E TOW-A	Fired at ground level	1			ea.														
		GBU-9		9																	
		HARM		2																	
AW 25		NSM	Fired at ocean surface				ea.														
		JSOW	No emissions	3			ea.														
		Japanese Missile Tests					ea.														
		Tactical Tomahawk					ea.														
		Seasparrow Missile		2																	
		SLAM ER		1																	
		SM2 or equivalent	Fired from ship-to-air	5			ea.														
		Total:		**63**																	
ROCKET		2.75" RKT		353			ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0.079425	0.009884	0.00125315	0.010767	0.006707	0	0.000212
		2.75" RKT HE					ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		2.75" RKT I	INERT Warhead				ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		Total:		**353**																	

Ordnance Group	AQ Data	Ordnance Type	Fate	Quantity Fired	Consolidated Nos.	NEW ea.	UOM/ Cum NEW	CO2	CO	Nox	PM10	PM2.5	SO2	Lead	CO2	CO	Nox	PM10	PM2.5	SO2	Lead
FLARES		**FLARES****		**647**			**ea.**														
SMOKE		MK58 Marine Location Marker		8			ea.	1	1.30E-02	1.20E-02	3.20E-02	1.70E-02	6.10E-05	3.80E-05	0.004	0.000052	0.000048	0.000128	0.000068	0.000000244	1.52E-07
		SMOKE GRENADE		76			ea.	1	1.30E-02	1.20E-02	3.20E-02	1.70E-02	6.10E-05	3.80E-05	0.038	0.000494	0.000456	0.001216	0.000646	0.000002318	1.44E-06
		Total:		**84**																	
TORPEDO	NA	MK30	No emissions	235			ea.														
	NA	MK39	No emissions	992			ea.														
	NA	MK46	No emissions	8			ea.														
	NA	MK46-HOVER	No emissions				ea.														
	NA	MK46-LAMPS	No emissions				ea.														
	NA	MK-46-REX-FLYIN	No emissions				ea.														
	NA	MK46-REX-HOVER	No emissions				ea.														
	NA	MK46-REX-LAMPS	No emissions				ea.														
	NA	MK46-EXTORP	No emissions	66			ea.														
	NA	MK50-REX-FLYIN	No emissions	12			ea.														
	NA	MK50-REX-LAMPS	No emissions				ea.														
	NA	REXTORP-46	No emissions	98			ea.														
	NA	REXTORP-50	No emissions	16			ea.														
	NA	MK46-REX-SVTT	No emissions	12			ea.														
	NA	MK46-SVTT	No emissions				ea.														
	NA	MK46-VLA	No emissions				ea.														
	NA	REXTORP	No emissions				ea.														
	NA	MK48-ADCAP	No emissions	69			ea.														
	NA	MK48-ER	No emissions				ea.														
	NA	MK48-STD	No emissions				ea.														
	NA	MK54	No emissions	2			ea.														
		SSN	No emissions	58			ea.														
		Total:		**1,568**																	
		GRAND TOTAL ROUNDS		**4,547,864**																	
		GRAND TOTAL POUNDS NEW					**247,192**														
													SOCAL/SCI		76.97	25.12	1.15	2.66	1.89	0.01	0.03
													SOCAL/SD		0.04	0.09	0.01	0.00	0.00	0.00	0.00

Date: 13-May-2007

Table C-11. SOCAL Ordnance Expenditures—Alternative 1

NOTE: Units of Measure (UOM) for ordnance rounds are 1 each (ea.) and for Demolitions and Other Ordnance are in pounds Net Explosive Weight (NEW).								Emission Factor (lb per lb or lb per item)							Emissions, tons/year						
Ordnance Group	**AQ Data**	**Ordnance Type**	**Fate**	**Quantity Fired**	**Consolidated Nos.**	**NEW ea.**	**UOM/ Cum NEW**	**CO2**	**CO**	**Nox**	**PM10**	**PM2.5**	**SO2**	**Lead**	**CO2**	**CO**	**Nox**	**PM10**	**PM2.5**	**SO2**	**Lead**
BOMB		CBU MK20 ROCKEYE	Clusters Explode Underwater	14		99	ea.														
	No Data	GBU32I JDAM	Clusters Explode Underwater	10		385	ea.														
	No Data	LGTR	Rocket fires Inert warhead	226		0	ea.														
		MK76	Only small spotting charge	1,675		Neg.	ea.														
	No Data	BDU 48	Only small spotting charge	105		Neg.	ea.														
		MK82 HE	31 in water; 383 on land	478		192	ea.		0.3184						0	14.61074	0	0	0	0	0
	No Data	GBU12 500 lb	6 in water; 6 on land	13		192	ea.														
	NA	MK82 INERT	No emissions	20		0	ea.														
	No Data	BDU 45		181		0	ea.														
		MK83 HE		134		445	ea.		0.1482						0	4.418583	0	0	0	0	0
	No Data	GBU 16	14 in water; 14 on land	31		445	ea.														
	NA	MK83 INERT		105		0	ea.														
		Total:		**2,992**	**0**																
OTHER ORD	**No AQ data**	**Type**		**No.**		**NEW**															
	CNAP & SPAWAR	EER/IEER AN/SQQ-110	Explode deep in water			4.2	0	1.2	0.0044	0.011				0.00004	0	0	0	0	0	0	0
	No Data	BLASTING CAP MK11	On Land only	2,156		Neg.	0														
		Detonator		240																	
	No Data	FIRING DEVICE	2 in water; 48 on land	91		Neg.	0														
	No Data	FUSE	6 in water; 94 on land	1,728		Neg.	0														
		GRENADE SIMULATOR	Land	460		0.0813	37.4	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.01178	0.000393	0.000117804	0.000393	0.00028	2.24388E-06	2.62E-06
		Grenades	Land	1,787		0.0813	145.3	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.045764	0.001525	0.000457642	0.001525	0.00109	8.71699E-06	1.02E-05
		Haversacks		88		20.0000	1760.0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04							
		K143 Antipersonnel Mine		240																	
	No Data	M1A2 BANGALORE TORP	Land	248		10.00	2480								0	0	0	0	0	0	0
		M7 BANDOLEER MK57 (Claymore mine)	Land	68		8.16	554.88		0.15108						0	0.041916	0	0	0	0	0
	AP-42	M112 DEMO CHARGE	Land	158		1.20	189.6	7.90E-01	2.60E-02	7.90E-03	2.60E-02	1.90E-02		1.70E-04	0.074892	0.002465	0.00074892	0.002465	0.001801	0	1.61E-05
	No Data	M700 BLASTING FUSE	Land	1,506		0.001	1.506														
	No Data	MK20 Cable Cutter	Land	163		0.0028	0.5														
	No Data	MK22 Projectile Unit	Land	158		Neg.	Neg.														
	No Data	MK36 M0 DEMO CHARGE	Land	45		4.10	184.5								0	0	0	0	0	0	0
	No Data	MK75 CHARGE	In Shallow water	217		50.00	10,850								0	0	0	0	0	0	0
	No Data	MK84 [86] EOD Shaped Charge	On Land only	166		0.08	13.28								0	0	0	0	0	0	0
	No Data	MK120 NONELEC DET (ft)	On Land only	771		0.00001	0.0110														
	No Data	MK123 NONELEC DET (ft)	On Land only	3,192		0.00001	0.0456														
	No Data	MK138 DEMO CHG ASSEMBLY	In water			20.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	MK140 FLEXIBLE CHARGE	On Land only	226		0.04	9.944														
		MK258		360																	
	No Data	PBXN-109 TEST Det Cord	On Land only	30		0.0060	0.18														
	No Data	SIGNAL MK 18(G950) SMOKE	On Land only	530		0.23	123.596														
	No Data	C4 1 LB		415		1.00	415	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	1.31E-01	0.004358	0.00130725	0.004358	0.003113	0.0000249	2.91E-05

Ordnance Group	AQ Data	Ordnance Type	Fate	Quantity Fired	Consolidated Nos.	NEW ea.	UOM/ Cum NEW	CO2	CO	Nox	PM10	PM2.5	SO2	Lead	CO2	CO	Nox	PM10	PM2.5	SO2	Lead
	No Data	C4 1.25 LB	98 in water; 19,156 on land	31,872		1.25	39840	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	1.25E+01	0.41832	0.125496	0.41832	0.2988	0.0023904	0.002789
	No Data	C4 5 LB	On Land only			5.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	C4 15 LB	On Land only	40		15.00	600	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	1.89E-01	0.0063	0.00189	0.0063	0.0045	0.000036	0.000042
	No Data	C4 40 LB	On Land only	3,762		40.00	150480	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	4.74E+01	1.58004	0.474012	1.58004	1.1286	0.0090288	0.010534
	No Data	C4 100 LB	On Land only	500		100.00	50000	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	15.75	0.525	0.1575	0.525	0.375	0.003	0.0035
	No Data	C4 300 LB	On Land only	12,896		1.00	12896	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	4.06224	0.135408	0.0406224	0.135408	0.09672	0.00077376	0.000903
	No Data	C4 500 LB	On Land only	15,863		1.00	15863	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	4.996845	0.166562	0.04996845	0.166562	0.118973	0.00095178	0.00111
	No Data	TNT Blocks 0.5 lbd	On Land only	925		1.00	925		0.398							0.184075					
	No Data	DEMO SHEET	On Land only	462		6.00	2772														
	No Data	DETONATING CORD	3000 ft in water; 10300 land	74,500		0.006	447														
	No Data	DEMO CHARGE	Land	57		5.00	285														
	AP-42	SIMULATED ARTILLERY	M110 Land	316		0.1375	43.45	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.013687	0.000456	0.000136868	0.000456	0.000326	0.000002607	3.04E-06
		Totals		**156,236**			**290,917**														
GUNFIRE (Large)	AP-42	155MM HE		1,101			ea.	6.51	2.35E+01	1.43E+00	0.496	0.2418		2.26E-03	3.583755	12.92618	0.785013	0.273048	0.133111	0	0.001246
	AP-42	155MM ILL		57			ea.	1.8	2.62E-02	9.40E-02	3	3		5.80E-05	0.0513	0.000747	0.002679	0.0855	0.0855	0	1.65E-06
		122 MM		40																	
5"/54		5"/54 BLP	BLP is INERT	5,822			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.046576	0.05822	0	0.003493	0.002707	0	1.75E-05
		5"/54 HCVT+32 (EOD)		207			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.001656	0.00207	0	0.000124	9.63E-05	0	6.21E-07
		5"/54 HECVT	1700 in water; 2242 on land	2,585			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.02068	0.02585	0	0.001551	0.001202	0	7.76E-06
		5"/54 HEPD		90			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.00072	0.0009	0	0.000054	4.19E-05	0	2.7E-07
		5"/54 HEVT		195			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.00156	0.00195	0	0.000117	9.07E-05	0	5.85E-07
		5"/54 ILL		117			ea.	1.50E-02	1.40E-02	3.60E-04	9.20E-04	7.60E-04		1.30E-06	0.000878	0.000819	0.00002106	5.38E-05	4.45E-05	0	7.61E-08
		5"54/54 VTNF		53			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.000424	0.00053	0	3.18E-05	2.46E-05	0	1.59E-07
5"/62		5"/62		1,136			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.009088	0.01136	0	0.000682	0.000528	0	3.41E-06
		5"/62 HE-MFF		70			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.00056	0.0007	0	0.000042	3.26E-05	0	2.1E-07
		5"/62 HECVT	100 in water; 768 on land	814			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.006512	0.00814	0	0.000488	0.000379	0	2.44E-06
		5"/62 HEET		3			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.000024	0.00003	0	1.8E-06	1.4E-06	0	9E-09
		5"/62 KEET		15			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.00012	0.00015	0	0.000009	6.98E-06	0	4.5E-08
60mm	AP-42	60MM		245			ea.	2.90E-01	3.00E-02	4.20E-03	3.20E-02	1.70E-02		2.30E-04	0.035525	0.003675	0.0005145	0.00392	0.002083	0	2.82E-05
		60MM WP					ea.	2.90E-01	3.00E-02	4.20E-03	3.20E-02	1.70E-02		2.30E-04	0	0	0	0	0	0	0
76mm		76MM BLP	INERT	1,872			ea.	1.44E-02	1.80E-02		1.08E-03	8.37E-04		5.40E-06	0.013478	0.016848	0	0.001011	0.000783	0	5.05E-06
	AP-42	81MM HE		324			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.002592	0.00324	0	0.000194	0.000151	0	9.72E-07
	AP-42	81MM ILL		21			ea.	1.50E-02	1.40E-02	3.60E-04	9.20E-04	7.60E-04		1.30E-06	0.000158	0.000147	0.00000378	9.66E-06	7.98E-06	0	1.37E-08
		122MM Main Tank Gun		120																	
CAS	No data	GAU-17 30mm					ea.														
		Total:		**14,887**																	
GUNFIRE (small)	AMW 114,1125	20MM	Fired by aircraft at low alt.	1,906,588			ea.														
		25MM	Fired by ship	61,479			ea.														
	No Data	30MM EFV Main Gun	Fired on land or sea	2,759			ea.														
	AP-42	40MM	NSW on land	5,880			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0.000764	0.001029	0.00010584	7.64E-05	6.76E-05	0	0.00197
	AP-42	40MM HE	NSW on land	833			ea.	6.60E-02	7.00E-03	1.60E-03	1.30E-02	6.60E-03		7.30E-05	0.027489	0.002916	0.0006664	0.005415	0.002749	0	3.04E-05
	No Data	40MM ILL	NSW on land	422			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	5.49E-05	7.39E-05	0.000007596	5.49E-06	4.85E-06	0	0.000141
	AP-42	40MM PRACTICE	NSW on land	2,771			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0.00036	0.000485	0.000049878	3.6E-05	3.19E-05	0	0.000928
	AP-42	.45 CAL	NSW and USMC	6,869			ea.	2.20E-04	2.60E-04	8.10E-06	3.70E-05	3.10E-05		1.20E-05	0.000756	0.000893	2.78195E-05	0.000127	0.000106	0	4.12E-05
	AP-42	5.56	NSW and USMC	2,800,472			ea.	8.70E-04	1.60E-03	8.50E-05	3.90E-05	2.80E-05		5.10E-06	1.218205	2.240378	0.11902006	0.054609	0.039207	0	0.007141
	AP-42	5.56 BLANK	NSW and USMC	3,689			ea.	2.30E-04	2.80E-04	2.00E-05	6.90E-06	2.00E-06		9.70E-07	0.000424	0.000516	0.00003689	1.27E-05	3.69E-06	0	1.79E-06
	AP-42	.50CAL	NSW and USMC	305,988			ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0.780269	1.682934	0.1835928	0.047428	0.029069	0	0.001989
		.50CAL	USCG	15,059			ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0.0384	0.082825	0.0090354	0.002334	0.001431	0	9.79E-05
	AP-42	.50CAL BLANK	NSW and USMC	10,000			ea.	2.10E-03	1.80E-03	2.80E-05	9.80E-05	8.80E-05		1.20E-05	0.0105	0.009	0.00014	0.00049	0.00044	0	0.00006
	AP-42	7.62	NSW and USMC	190,240			ea.	1.20E-03	2.30E-03	9.70E-05	5.10E-05	3.80E-05		4.90E-06	0.114144	0.218776	0.00922664	0.004851	0.003615	0	0.000466
		7.62	USCG	21,000			ea.	1.20E-03	2.30E-03	9.70E-05	5.10E-05	3.80E-05		4.90E-06	0.0126	0.02415	0.0010185	0.000536	0.000399	0	5.15E-05
	AP-42	9MM	NSW and USMC	2,118,024			ea.	2.00E-04	3.10E-04	1.50E-05	2.40E-05	2.00E-05		6.80E-06	0.211802	0.328294	0.01588518	0.025416	0.02118	0	0.007201
	No Data	.300 WIN MAG	Environmental Contractors				ea.	2.00E-04	3.10E-04	1.50E-05	2.40E-05	2.00E-05		6.80E-06	0	0	0	0	0	0	0
	No Data	.223 Rifle Rounds	Environmental Contractors				ea.	6.80E-05	7.20E-05	3.10E-06	2.60E-06	1.90E-06		1.80E-06	0	0	0	0	0	0	0
	No Data	.22 Magnum	Environmental Contractors				ea.	7.50E-05	8.00E-05	5.00E-06	3.40E-06	2.60E-06		1.90E-06	0	0	0	0	0	0	0
	AP-42	.22 Long Rifle	Environmental Contractors				ea.	6.80E-05	7.20E-05	3.10E-06	2.60E-06	1.90E-06		1.80E-06	0	0	0	0	0	0	0
		12 Guage Shotgun	Environmental Contractors				ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0	0	0	0	0	0	0
		Total:		**7,452,073**																	
MINE SHAPE	AP-42	M18A1		132			ea.	1.6	2.00E-02	1.80E-02	4.90E-02	2.60E-02		5.70E-05	0.1056	0.00132	0.001188	0.003234	0.001716	0	3.76E-06
		MK76		64			ea.														
		MK62		12			ea.	No emissions													
		Total:		**208**																	
MISSILE		AGM-114B	Fired at low altitude	16			ea.														
		AGM-65 Maverick		6																	
		AGM-84		10																	
		AIM-120	Fired well above 3,000 ft	4			ea.														
		AIM-7	Fired well above 3,000 ft	7			ea.														
		AIM-9	Fired well above 3,000 ft	5			ea.														
		BGM-71E TOW-A	Fired at ground level	1			ea.														
		GBU-9		9																	
		HARM		4																	
		NSM	Fired at ocean surface	1			ea.														
AW 25		JSOW	No emissions	5			ea.														
		Japanese Missile Tests		5			ea.														
		Tactical Tomahawk		2			ea.														
		Seasparrow Missile		8																	
		SLAM ER		2																	
		Stinger		51																	
		SM2 or equivalent	Fired from ship-to-air	7			ea.														
		Total:		**143**																	

Ordnance Group	AQ Data	Ordnance Type	Fate	Quantity Fired	Consolidated Nos.	NEW ea.	UOM/ Cum NEW	CO2	CO	Nox	PM10	PM2.5	SO2	Lead	CO2	CO	Nox	PM10	PM2.5	SO2	Lead
ROCKET		2.75" RKT		396			ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0.0891	0.011088	0.0014058	0.012078	0.007524	0	0.000238
		2.75" RKT HE					ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		2.75" RKT I	INERT Warhead				ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		Total:		**396**																	
FLARES		**FLARES****		**962**			**ea.**														
SMOKE		MK58 Marine Location Marker		8			ea.	1	1.30E-02	1.20E-02	3.20E-02	1.70E-02	6.10E-05	3.80E-05	0.004	0.000052	0.000048	0.000128	0.000068	0.000000244	1.52E-07
		SMOKE GRENADE		120			ea.	1	1.30E-02	1.20E-02	3.20E-02	1.70E-02	6.10E-05	3.80E-05	0.06	0.00078	0.00072	0.00192	0.00102	0.00000366	2.28E-06
		Total:		**128**																	
TORPEDO	NA	MK30	No emissions	601			ea.														
	NA	MK39	No emissions	1,406			ea.														
	NA	MK46	No emissions	8			ea.														
	NA	MK46-HOVER	No emissions				ea.														
	NA	MK46-LAMPS	No emissions				ea.														
	NA	MK-46-REX-FLYIN	No emissions				ea.														
	NA	MK46-REX-HOVER	No emissions				ea.														
	NA	MK46-REX-LAMPS	No emissions				ea.														
	NA	MK46-EXTORP	No emissions	85			ea.														
	NA	MK50-REX-FLYIN	No emissions	12			ea.														
	NA	MK50-REX-LAMPS	No emissions				ea.														
	NA	REXTORP-46	No emissions	124			ea.														
	NA	REXTORP-50	No emissions	20			ea.														
	NA	MK46-REX-SVTT	No emissions	14			ea.														
	NA	MK46-SVTT	No emissions				ea.														
	NA	MK46-VLA	No emissions				ea.														
	NA	REXTORP	No emissions				ea.														
	NA	MK48-ADCAP	No emissions	84			ea.														
	NA	MK48-ER	No emissions				ea.														
	NA	MK48-STD	No emissions				ea.														
	NA	MK54	No emissions	1			ea.														
		SSN	No emissions	89			ea.														
		Total:		**2,444**																	
		GRAND TOTAL ROUNDS		**7,630,469**																	
		GRAND TOTAL POUNDS NEW					**290,917**														
													SOCAL/SCI		91.62481	39.65623	1.972609576	3.366984	2.362794	0.016223112	0.040467
													SOCAL/SD		0.051	0.106975	0.0100539	0.00287	0.00183	0	0.000149

Date: 13-May-2007

Table C-12. SOCAL Ordnance Expenditures—Alternative 2

NOTE: Units of Measure (UOM) for ordnance rounds are 1 each (ea.) and for Demolitions and Other Ordnance are in pounds Net Explosive Weight (NEW).								Emission Factor (lb per lb or lb per item)							Emissions, tons/year						
Ordnance Group	**AQ Data**	**Ordnance Type**	**Fate**	**Quantity Fired**	**Consolidated Nos.**	**NEW ea.**	**UOM/ Cum NEW**	**CO2**	**CO**	**Nox**	**PM10**	**PM2.5**	**SO2**	**Lead**	**CO2**	**CO**	**Nox**	**PM10**	**PM2.5**	**SO2**	**Lead**
BOMB		CBU MK20 ROCKEYE	Clusters Explode Underwater	16		99	ea.														
	No Data	GBU32I JDAM	Clusters Explode Underwater	10		385	ea.														
	No Data	LGTR	Rocket fires Inert warhead	238		0	ea.														
		MK76	Only small spotting charge	1,854		Neg.	ea.														
	No Data	BDU 48	Only small spotting charge	117		Neg.	ea.														
		MK82 HE	31 in water; 383 on land	534		192	ea.		0.3184						0	16.32246	0	0	0	0	0
	No Data	GBU12 500 lb	6 in water; 6 on land	13		192	ea.														
	NA	MK82 INERT	No emissions	22		0	ea.														
	No Data	BDU 45		199		0	ea.														
		MK83 HE		147		445	ea.		0.1482						0	4.847252	0	0	0	0	0
	No Data	GBU 16	14 in water; 14 on land	32		445	ea.														
	NA	MK83 INERT		116		0	ea.														
		Total:		**3,298**	**0**																
OTHER ORD	**No AQ data**	**Type**		**No.**		**NEW**															
	CNAP & SPAWAR	EER/IEER AN/SQQ-110	Explode deep in water			4.2	0	1.2	0.0044	0.011				0.00004	0	0	0	0	0	0	0
	No Data	BLASTING CAP MK11	On Land only	2,565		Neg.	0														
		Detonator		288																	
	No Data	FIRING DEVICE	2 in water; 48 on land	105		Neg.	0														
	No Data	FUSE	6 in water; 94 on land	2,076		Neg.	0														
		GRENADE SIMULATOR	Land	561		0.0813	45.6	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.014367	0.000479	0.000143669	0.000479	0.000342	2.73656E-06	3.19E-06
		Grenades	Land	2,143		0.0813	174.2	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.054881	0.001829	0.000548812	0.001829	0.001307	1.04536E-05	1.22E-05
		Haversacks		105		20.0000	2100.0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04							
		K143 Antipersonnel Mine		288																	
	No Data	M1A2 BANGALORE TORP	Land	277		10.00	2770								0	0	0	0	0	0	0
		M7 BANDOLEER MK57 (Claymore mine)	Land	77		8.16	628.32		0.15108						0	0.047463	0	0	0	0	0
	AP-42	M112 DEMO CHARGE	Land	206		1.20	247.2	7.90E-01	2.60E-02	7.90E-03	2.60E-02	1.90E-02		1.70E-04	0.097644	0.003214	0.00097644	0.003214	0.002348	0	2.1E-05
	No Data	M700 BLASTING FUSE	Land	1,965		0.001	1.965														
	No Data	MK20 Cable Cutter	Land	181		0.0028	0.5														
	No Data	MK22 Projectile Unit	Land	206		Neg.	Neg.														
	No Data	MK36 M0 DEMO CHARGE	Land	59		4.10	241.9								0	0	0	0	0	0	0
	No Data	MK75 CHARGE	In Shallow water	244		50.00	12,200								0	0	0	0	0	0	0
	No Data	MK84 [86] EOD Shaped Charge	On Land only	214		0.08	17.12								0	0	0	0	0	0	0
	No Data	MK120 NONELEC DET (ft)	On Land only	1,006		0.00001	0.0144														
	No Data	MK123 NONELEC DET (ft)	On Land only	4,165		0.00001	0.0595														
	No Data	MK138 DEMO CHG ASSEMBLY	In water			20.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	MK140 FLEXIBLE CHARGE	On Land only	295		0.04	12.98														
		MK258		360																	
	No Data	PBXN-109 TEST Det Cord	On Land only	30		0.0060	0.18														
	No Data	SIGNAL MK 18(G950) SMOKE	On Land only	686		0.23	159.9752														
	No Data	C4 1 LB		830		1.00	830	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	2.61E-01	0.008715	0.0026145	0.008715	0.006225	0.0000498	5.81E-05

Ordnance Group	AQ Data	Ordnance Type	Fate	Quantity Fired	Consolidated Nos.	NEW ea.	UOM/ Cum NEW	CO2	CO	Nox	PM10	PM2.5	SO2	Lead	CO2	CO	Nox	PM10	PM2.5	SO2	Lead
	No Data	C4 1.25 LB	98 in water; 19,156 on land	37,403		1.25	46753.75	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	1.47E+01	0.490914	0.147274313	0.490914	0.350653	0.002805225	0.003273
	No Data	C4 5 LB	On Land only			5.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	C4 15 LB	On Land only	48		15.00	720	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	2.27E-01	0.00756	0.002268	0.00756	0.0054	0.0000432	5.04E-05
	No Data	C4 40 LB	On Land only	4,385		40.00	175400	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	5.53E+01	1.8417	0.55251	1.8417	1.3155	0.010524	0.012278
	No Data	C4 100 LB	On Land only	1,000		100.00	100000	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	31.5	1.05	0.315	1.05	0.75	0.006	0.007
	No Data	C4 300 LB	On Land only	15,000		1.00	15000	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	4.725	0.1575	0.04725	0.1575	0.1125	0.0009	0.00105
	No Data	C4 500 LB	On Land only	18,459		1.00	18459	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	5.814585	0.19382	0.05814585	0.19382	0.138443	0.00110754	0.001292
	No Data	TNT Blocks 0.5 lbd	On Land only	1,078		1.00	1078		0.398							0.214522					
	No Data	DEMO SHEET	On Land only	546		6.00	3276														
	No Data	DETONATING CORD	3000 ft in water; 10300 land	85,000		0.006	510														
	No Data	DEMO CHARGE	Land	57		5.00	285														
	AP-42	SIMULATED ARTILLERY	M110 Land	413		0.1375	56.7875	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.017888	0.000596	0.000178881	0.000596	0.000426	3.40725E-06	3.98E-06
		Totals		**182,321**			**380,969**														
GUNFIRE (Large)	AP-42	155MM HE		1,504			ea.	6.51	2.35E+01	1.43E+00	0.496	0.2418		2.26E-03	4.89552	17.65756	1.072352	0.372992	0.181834	0	0.001702
	AP-42	155MM ILL		75			ea.	1.8	2.62E-02	9.40E-02	3	3		5.80E-05	0.0675	0.000983	0.003525	0.1125	0.1125	0	2.18E-06
		122 MM		80																	
5"/54		5"/54 BLP	BLP is INERT	5,901			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.047208	0.05901	0	0.003541	0.002744	0	1.77E-05
		5"/54 HCVT+32 (EOD)		216			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.001728	0.00216	0	0.00013	0.0001	0	6.48E-07
		5"/54 HECVT	1700 in water; 2242 on land	2,881			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.023048	0.02881	0	0.001729	0.00134	0	8.64E-06
		5"/54 HEPD		94			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.000752	0.00094	0	5.64E-05	4.37E-05	0	2.82E-07
		5"/54 HEVT		202			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.001616	0.00202	0	0.000121	9.39E-05	0	6.06E-07
		5"/54 ILL		122			ea.	1.50E-02	1.40E-02	3.60E-04	9.20E-04	7.60E-04		1.30E-06	0.000915	0.000854	0.00002196	5.61E-05	4.64E-05	0	7.93E-08
		5"54/54 VTNF		55			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.00044	0.00055	0	0.000033	2.56E-05	0	1.65E-07
5"/62		5"/62		1,139			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.009112	0.01139	0	0.000683	0.00053	0	3.42E-06
		5"/62 HE-MFF		77			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.000616	0.00077	0	4.62E-05	3.58E-05	0	2.31E-07
		5"/62 HECVT	100 in water; 768 on land	860			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.00688	0.0086	0	0.000516	0.0004	0	2.58E-06
		5"/62 HEET		4			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.000032	0.00004	0	2.4E-06	1.86E-06	0	1.2E-08
		5"/62 KEET		21			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.000168	0.00021	0	1.26E-05	9.77E-06	0	6.3E-08
60mm	AP-42	60MM		285			ea.	2.90E-01	3.00E-02	4.20E-03	3.20E-02	1.70E-02		2.30E-04	0.041325	0.004275	0.0005985	0.00456	0.002423	0	3.28E-05
		60MM WP					ea.	2.90E-01	3.00E-02	4.20E-03	3.20E-02	1.70E-02		2.30E-04	0	0	0	0	0	0	0
76mm		76MM BLP	INERT	1,881			ea.	1.44E-02	1.80E-02		1.08E-03	8.37E-04		5.40E-06	0.013543	0.016929	0	0.001016	0.000787	0	5.08E-06
	AP-42	81MM HE		489			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.003912	0.00489	0	0.000293	0.000227	0	1.47E-06
	AP-42	81MM ILL		22			ea.	1.50E-02	1.40E-02	3.60E-04	9.20E-04	7.60E-04		1.30E-06	0.000165	0.000154	0.00000396	1.01E-05	8.36E-06	0	1.43E-08
		122MM Main Tank Gun		160																	
CAS	No data	GAU-17 30mm					ea.														
		Total:		**16,068**																	
GUNFIRE (small)	AMW 114,1125	20MM	Fired by aircraft at low alt.	1,909,274			ea.														
		25MM	Fired by ship	61,553			ea.														
	No Data	30MM EFV Main Gun	Fired on land or sea	3,681			ea.														
	AP-42	40MM	NSW on land	7,380			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0.000959	0.001292	0.00013284	9.59E-05	8.49E-05	0	0.002472
	AP-42	40MM HE	NSW on land	901			ea.	6.60E-02	7.00E-03	1.60E-03	1.30E-02	6.60E-03		7.30E-05	0.029733	0.003154	0.0007208	0.005857	0.002973	0	3.29E-05
	No Data	40MM ILL	NSW on land	422			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	5.49E-05	7.39E-05	0.000007596	5.49E-06	4.85E-06	0	0.000141
	AP-42	40MM PRACTICE	NSW on land	3,090			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0.000402	0.000541	0.00005562	4.02E-05	3.55E-05	0	0.001035
	AP-42	.45 CAL	NSW and USMC	6,869			ea.	2.20E-04	2.60E-04	8.10E-06	3.70E-05	3.10E-05		1.20E-05	0.000756	0.000893	2.78195E-05	0.000127	0.000106	0	4.12E-05
	AP-42	5.56	NSW and USMC	3,391,607			ea.	8.70E-04	1.60E-03	8.50E-05	3.90E-05	2.80E-05		5.10E-06	1.475349	2.713286	0.144143298	0.066136	0.047482	0	0.008649
	AP-42	5.56 BLANK	NSW and USMC	4,814			ea.	2.30E-04	2.80E-04	2.00E-05	6.90E-06	2.00E-06		9.70E-07	0.000554	0.000674	0.00004814	1.66E-05	4.81E-06	0	2.33E-06
	AP-42	.50CAL	NSW and USMC	334,687			ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0.853452	1.840779	0.2008122	0.051876	0.031795	0	0.002175
		.50CAL	USCG	19,647			ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0.0501	0.108059	0.0117882	0.003045	0.001866	0	0.000128
	AP-42	.50CAL BLANK	NSW and USMC	10,000			ea.	2.10E-03	1.80E-03	2.80E-05	9.80E-05	8.80E-05		1.20E-05	0.0105	0.009	0.00014	0.00049	0.00044	0	0.00006
	AP-42	7.62	NSW and USMC	261,202			ea.	1.20E-03	2.30E-03	9.70E-05	5.10E-05	3.80E-05		4.90E-06	0.156721	0.300382	0.012668297	0.006661	0.004963	0	0.00064
		7.62	USCG	21,000			ea.	1.20E-03	2.30E-03	9.70E-05	5.10E-05	3.80E-05		4.90E-06	0.0126	0.02415	0.0010185	0.000536	0.000399	0	5.15E-05
	AP-42	9MM	NSW and USMC	2,515,859			ea.	2.00E-04	3.10E-04	1.50E-05	2.40E-05	2.00E-05		6.80E-06	0.251586	0.389958	0.018868943	0.03019	0.025159	0	0.008554
	No Data	.300 WIN MAG	Environmental Contractors				ea.	2.00E-04	3.10E-04	1.50E-05	2.40E-05	2.00E-05		6.80E-06	0	0	0	0	0	0	0
	No Data	.223 Rifle Rounds	Environmental Contractors				ea.	6.80E-05	7.20E-05	3.10E-06	2.60E-06	1.90E-06		1.80E-06	0	0	0	0	0	0	0
	No Data	.22 Magnum	Environmental Contractors				ea.	7.50E-05	8.00E-05	5.00E-06	3.40E-06	2.60E-06		1.90E-06	0	0	0	0	0	0	0
	AP-42	.22 Long Rifle	Environmental Contractors				ea.	6.80E-05	7.20E-05	3.10E-06	2.60E-06	1.90E-06		1.80E-06	0	0	0	0	0	0	0
		12 Guage Shotgun	Environmental Contractors				ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0	0	0	0	0	0	0
		Total:		**8,551,986**																	
MINE SHAPE	AP-42	M18A1		164			ea.	1.6	2.00E-02	1.80E-02	4.90E-02	2.60E-02		5.70E-05	0.1312	0.00164	0.001476	0.004018	0.002132	0	4.67E-06
		MK76		68			ea.														
		MK62		13			ea.	No emissions													
		Total:		**245**																	
MISSILE		AGM-114B	Fired at low altitude	16			ea.														
		AGM-65 Maverick		6																	
		AGM-84		10																	
		AIM-120	Fired well above 3,000 ft	4			ea.														
		AIM-7	Fired well above 3,000 ft	7			ea.														
		AIM-9	Fired well above 3,000 ft	5			ea.														
		BGM-71E TOW-A	Fired at ground level	1			ea.														
		GBU-9		9																	
		HARM		4																	
		NSM	Fired at ocean surface	1			ea.														
AW 25		JSOW	No emissions	10			ea.														
		Japanese Missile Tests		10			ea.														
		Tactical Tomahawk		2			ea.														
		Seasparrow Missile		12																	
		SLAM ER		2																	
		Stinger		68																	
		SM2 or equivalent	Fired from ship-to-air	7			ea.														
		Total:		**174**																	

Ordnance Group	AQ Data	Ordnance Type	Fate	Quantity Fired	Consolidated Nos.	NEW ea.	UOM/ Cum NEW	CO2	CO	Nox	PM10	PM2.5	SO2	Lead	CO2	CO	Nox	PM10	PM2.5	SO2	Lead
ROCKET		2.75" RKT		488			ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0.1098	0.013664	0.0017324	0.014884	0.009272	0	0.000293
		2.75" RKT HE					ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		2.75" RKT I	INERT Warhead				ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		Total:		**488**																	
FLARES		**FLARES****		**1,135**			**ea.**														
SMOKE		MK58 Marine Location Marker		10			ea.	1	1.30E-02	1.20E-02	3.20E-02	1.70E-02	6.10E-05	3.80E-05	0.005	0.000065	0.00006	0.00016	0.000085	0.000000305	1.9E-07
		SMOKE GRENADE		120			ea.	1	1.30E-02	1.20E-02	3.20E-02	1.70E-02	6.10E-05	3.80E-05	0.06	0.00078	0.00072	0.00192	0.00102	0.00000366	2.28E-06
		Total:		**130**																	
TORPEDO	NA	MK30	No emissions	602			ea.														
	NA	MK39	No emissions	1,409			ea.														
	NA	MK46	No emissions	8			ea.														
	NA	MK46-HOVER	No emissions				ea.														
	NA	MK46-LAMPS	No emissions				ea.														
	NA	MK-46-REX-FLYIN	No emissions				ea.														
	NA	MK46-REX-HOVER	No emissions				ea.														
	NA	MK46-REX-LAMPS	No emissions				ea.														
	NA	MK46-EXTORP	No emissions	85			ea.														
	NA	MK50-REX-FLYIN	No emissions	12			ea.														
	NA	MK50-REX-LAMPS	No emissions				ea.														
	NA	REXTORP-46	No emissions	126			ea.														
	NA	REXTORP-50	No emissions	20			ea.														
	NA	MK46-REX-SVTT	No emissions	14			ea.														
	NA	MK46-SVTT	No emissions				ea.														
	NA	MK46-VLA	No emissions				ea.														
	NA	REXTORP	No emissions				ea.														
	NA	MK48-ADCAP	No emissions	84			ea.														
	NA	MK48-ER	No emissions				ea.														
	NA	MK48-STD	No emissions				ea.														
	NA	MK54	No emissions	2			ea.														
		SSN	No emissions	89			ea.														
		Total:		**2,451**																	
		GRAND TOTAL ROUNDS		**8,758,296**																	
		GRAND TOTAL POUNDS NEW					**380,969**														
													SOCAL/SCI		120.8916	48.26435	2.585025836	4.437102	3.111851	0.021450327	0.050923
													SOCAL/SD		0.0627	0.132209	0.0128067	0.003581	0.002265	0	0.000179

Date: 13-May-2007

Table C-13. Ground Vehicle Operations - No Action Alternative

Scenario	Type Training	Days	Ground Vehicles	Number	Engine Load	Hours per day	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10	Emissions (lbs) CO	Nox	HC	Sox	PM
Training Exercises																
1	Air Combat Maneuvers		None													
2	Air Defense Exercise		None													
3	S-A Missiles		None													
4	S-A Gunnery Exercise		None													
5	A-A Missiles		None													
6	Helicopter ASW TRACKEX		None													
7	MPA ASW TRACKEX		None													
8	Helicopter ASW TORPEX		None													
9	MPA ASW TORPEX		None													
10	Surface Ship ASW TRACKEX		None													
11	Surface Ship ASW TORPEX		None													
12	Surface Ship Integrated ASW		None													
13	Sub ASW Trackex		None													
14	Sub ASW TORPEX		None													
15	VBSS		None													
16	A-S MISSILEX		None													
17	A-S BOMBEX		None													
18	A-S GUNEX		None													
19	S-S GUNEX		None													
20	SINKEX		None													
21	NSFS		None													
22	EFEX	3	5-ton Truck	12	80%	8	0.04	0.06	0.01	0.00	0.01	12.71	18.65	2.46	0.05	1.75
		3	HMMWV	2	65%	8	0.04	0.06	0.01	0.00	0.01	2.12	3.11	0.41	0.01	0.29
23	Battalion Landing	0	LAV	20		8	0.04	0.06	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
		0	FAV	12		8	0.04	0.06	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
		0	HMMWV	2		8	0.04	0.06	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
		0	7-ton Truck	8		8	0.12	0.44	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00
		0	M-1 Tank	4		8	0.12	0.44	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00
24	USMC Stinger	0	LAV	0		5	0.04	0.06	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
25	Amphibious Landings & Raids															
25A	Recon Mission		None													

Scenario	Type Training	Days	Ground Vehicles	Number	Engine Load	Hours per day	Emissions Factors (lb/hr)					Emissions (lbs)				
Training Exercises							CO	NOx	HC	SOx	PM10	CO	Nox	HC	Sox	PM
25B	Helicopter Assault	0	FAV	0	Idle	1										
					65%	4	0.04	0.06	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
25C	Armored Operations	0	HMMWV	0	Idle	2	0.06	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					65%	3	0.04	0.06	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
			M1	0	Idle	1	0.06	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					60%	2	0.12	0.44	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00
25D	Amphibious Landings & Raids	1	HMMWV	2	Idle	2	0.06	0.17	0.01	0.00	0.00	0.23	0.66	0.03	0.00	0.01
					65%	3	0.04	0.06	0.01	0.00	0.01	0.26	0.39	0.05	0.00	0.04
			5-ton Trucks		Idle	1	0.06	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					80%	1	0.04	0.06	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
25E	Amphibious Assault		None													
25F	Combat Engineer Ops	1	HMMWV	0	Idle	2	0.06	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					65%	3	0.04	0.06	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
			5-ton Trucks	2	Idle	1	0.06	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					80%	1	0.04	0.06	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
25G	Amphibious Assault Vehicle Ops															
25H	EFV	1	HMMWV	0	Idle	2	0.06	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					65%	3	0.04	0.06	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
			5-ton Trucks	0	Idle	1	0.06	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					80%	1	0.04	0.06	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
			Refueler			1	0.12	0.44	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00
25I	Assault Amphibian School	5	7-ton Truck	0	Idle	1	0.06	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					80%	1	0.12	0.44	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00
			HMMWV	0	Idle	2	0.06	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					65%	3	0.04	0.06	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
26	Ambphibious Operations CPAAA															
26A	Amphibious Operations		None													
26B	Amphibious Ops		None													
26C	Amphibious Ops		None													
26D	Amphibious Ops		None													
26E	Amphibious Ops		None													
26F	Amphibious Warfare		None													
26G	Amphibious Ops		None													
27	Elec Combat		None													
28A	Sm Obj Avoidance		None													
29	Mine Neutralization		None													
30	Mining Exercise		None													
31	NSWC Land Demolition		None													

Scenario	Type Training	Days	Ground Vehicles	Number	Engine Load	Hours per day	Emissions Factors (lb/hr)					Emissions (lbs)				
Training Exercises							CO	NOx	HC	SOx	PM10	CO	Nox	HC	Sox	PM
32	NSWC UW Demo		None													
33	Mat Weave		None													
34	NSWC Small Arms		None													
35	NSWC Land Nav	1	Pickup Truck	99		6	0.30	0.03	0.02	0.00	0.00	180.82	15.14	9.47	0.17	0.54
36	NSW UAV Operationa		None													
37	Insertion/Extraction		None													
38	NSW Boat Operations		None													
39	NSWG-1 Platoon Ops		None													
40	Direct Action		None													
41	Bombing Exercise - Land		None													
42	CSAR		None													
43	EOD Outside SHOBA		None													
44	USCG Ops		None													
45	NALF Airfield		None													
46	Ship Torpedo Test		None													
47	UUV		None													
48	Sonobuoy QA/QC		None													
49	Ocean Engineering		None													
50	MM Mine Location		None													
51	Missile Flight Test		None													
52	NUWC UW Acoustic		None													
53	Other Tests		None													
	Total						**Total Ground Vehicle Emissions, tons**					0.09807741	0.0189756	0.006208	0.000112	0.001312

Table C-14. Ground Vehicle Operations - Alternative 1

Scenario	Type Training	Days	Ground Vehicles	Number	Engine Load	Hours per day	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10	Emissions (lbs) CO	Nox	HC	Sox	PM
Training Exercises																
1	Air Combat Maneuvers		None													
2	Air Defense Exercise		None													
3	S-A Missiles		None													
4	S-A Gunnery Exercise		None													
5	A-A Missiles		None													
6	Helicopter ASW TRACKEX		None													
7	MPA ASW TRACKEX		None													
8	Helicopter ASW TORPEX		None													
9	MPA ASW TORPEX		None													
10	Surface Ship ASW TRACKEX		None													
11	Surface Ship ASW TORPEX		None													
12	Surface Ship Integrated ASW		None													
13	Sub ASW Trackex		None													
14	Sub ASW TORPEX		None													
15	VBSS		None													
16	A-S MISSILEX		None													
17	A-S BOMBEX		None													
18	A-S GUNEX		None													
19	S-S GUNEX		None													
20	SINKEX		None													
21	NSFS		None													
22	EFEX	3	5-ton Truck	14	80%	8	0.04	0.06	0.01	0.00	0.01	14.83	21.76	2.87	0.06	2.04
		3	HMMWV	2	65%	8	0.04	0.06	0.01	0.00	0.01	2.12	3.11	0.41	0.01	0.29
23	Battalion Landing	4	LAV	20		8	0.04	0.06	0.01	0.00	0.01	28.25	41.45	5.47	0.11	3.88
		4	FAV	12		8	0.04	0.06	0.01	0.00	0.01	16.95	24.87	3.28	0.06	2.33
		4	HMMWV	2		8	0.04	0.06	0.01	0.00	0.01	2.83	4.14	0.55	0.01	0.39
		4	7-ton Truck	8		8	0.12	0.44	0.01	0.00	0.02	31.46	111.78	3.72	0.20	4.61
		4	M-1 Tank	4		8	0.12	0.44	0.01	0.00	0.02	15.73	55.89	1.86	0.10	2.31
24	USMC Stinger	1	LAV	3		5	0.04	0.06	0.01	0.00	0.01	0.66	0.97	0.13	0.00	0.09
25	Amphibious Landings & Raids															
25A	Recon Mission		None													

Scenario	Type Training	Days	Ground Vehicles	Number	Engine Load	Hours per day	Emissions Factors (lb/hr)					Emissions (lbs)				
Training Exercises							CO	NOx	HC	SOx	PM10	CO	Nox	HC	Sox	PM
25B	Helicopter Assault	1	FAV	32	Idle	1	0.06	0.17	0.01	0.00	0.00	1.86	5.29	0.22	0.00	0.07
					65%	4	0.04	0.06	0.01	0.00	0.01	5.65	8.29	1.09	0.02	0.78
25C	Armored Operations	1	HMMWV	12	Idle	2	0.06	0.17	0.01	0.00	0.00	1.39	3.97	0.17	0.00	0.05
					65%	3	0.04	0.06	0.01	0.00	0.01	1.59	2.33	0.31	0.01	0.22
			M1	12	Idle	1	0.06	0.17	0.01	0.00	0.00	0.70	1.99	0.08	0.00	0.03
					60%	2	0.12	0.44	0.01	0.00	0.02	2.95	10.48	0.35	0.02	0.43
25D	Amphibious Landings & Raids	1	HMMWV	18	Idle	2	0.06	0.17	0.01	0.00	0.00	2.09	5.96	0.25	0.00	0.08
					65%	3	0.04	0.06	0.01	0.00	0.01	2.38	3.50	0.46	0.01	0.33
			5-ton Trucks	36	Idle	1	0.06	0.17	0.01	0.00	0.00	2.09	5.96	0.25	0.00	0.08
					80%	1	0.04	0.06	0.01	0.00	0.01	1.59	2.33	0.31	0.01	0.22
25E	Amphibious Assault		None													
25F	Combat Engineer Ops	1	HMMWV	3	Idle	2	0.06	0.17	0.01	0.00	0.00	0.35	0.99	0.04	0.00	0.01
					65%	3	0.04	0.06	0.01	0.00	0.01	0.40	0.58	0.08	0.00	0.05
			5-ton Trucks	1	Idle	1	0.06	0.17	0.01	0.00	0.00	0.06	0.17	0.01	0.00	0.00
					80%	1	0.04	0.06	0.01	0.00	0.01	0.04	0.06	0.01	0.00	0.01
25G	Amphibious Assault Vehicle Ops															
25H	EFV	1	HMMWV	4	Idle	2	0.06	0.17	0.01	0.00	0.00	0.46	1.32	0.06	0.00	0.02
					65%	3	0.04	0.06	0.01	0.00	0.01	0.53	0.78	0.10	0.00	0.07
			5-ton Trucks	2	Idle	1	0.06	0.17	0.01	0.00	0.00	0.12	0.33	0.01	0.00	0.00
					80%	1	0.04	0.06	0.01	0.00	0.01	0.09	0.13	0.02	0.00	0.01
			Refueler	1		1	0.12	0.44	0.01	0.00	0.02	0.12	0.44	0.01	0.00	0.02
25I	Assault Amphibian School	5	7-ton Truck	10	Idle	1	0.06	0.17	0.01	0.00	0.00	2.90	8.27	0.35	0.00	0.11
					80%	1	0.12	0.44	0.01	0.00	0.02	6.15	21.83	0.73	0.04	0.90
			HMMWV	10	Idle	2	0.06	0.17	0.01	0.00	0.00	5.80	16.55	0.70	0.01	0.22
					65%	3	0.04	0.06	0.01	0.00	0.01	6.62	9.71	1.28	0.02	0.91
			Refueler	10		1	0.12	0.44	0.01	0.00	0.02	6.15	21.83	0.73	0.04	0.90
26	Ambphibious Operations CPAAA															
26A	Amphibious Operations		None													
26B	Amphibious Ops		None													
26C	Amphibious Ops		None													
26D	Amphibious Ops		None													
26E	Amphibious Ops		None													
26F	Amphibious Warfare		None													
26G	Amphibious Ops		None													
27	Elec Combat		None													
28A	Sm Obj Avoidance		None													
29	Mine Neutralization		None													
30	Mining Exercise		None													

Scenario	Type Training	Days	Ground Vehicles	Number	Engine Load	Hours per day	Emissions Factors (lb/hr)					Emissions (lbs)				
Training Exercises							CO	NOx	HC	SOx	PM10	CO	Nox	HC	Sox	PM
31	NSWC Land Demolition		None													
32	NSWC UW Demo		None													
33	Mat Weave		None													
34	NSWC Small Arms		None													
35	NSWC Land Nav	1	Pickup Truck	118		6	0.30	0.03	0.02	0.00	0.00	215.53	18.05	11.28	0.20	0.64
36	NSW UAV Operationa		None													
37	Insertion/Extraction		None													
38	NSW Boat Operations		None													
39	NSWG-1 Platoon Ops		None													
40	Direct Action		None													
41	Bombing Exercise - Land		None													
42	CSAR		None													
43	EOD Outside SHOBA		None													
44	USCG Ops		None													
45	NALF Airfield		None													
46	Ship Torpedo Test		None													
47	UUV		None													
48	Sonobuoy QA/QC		None													
49	Ocean Engineering		None													
50	MM Mine Location		None													
51	Missile Flight Test		None													
52	NUWC UW Acoustic		None													
53	Other Tests		None													
	Total						**Total Ground Vehicle Emissions, tons**					0.19021591	0.2075521	0.018598	0.000467	0.01105

Table C-15. Ground Vehicle Operations - Alternative 2

Scenario	Type Training	Days	Ground Vehicles	Number	Engine Load	Hours per day	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10	Emissions (lbs) CO	Nox	HC	Sox	PM
Training Exercises																
1	Air Combat Maneuvers		None													
2	Air Defense Exercise		None													
3	S-A Missiles		None													
4	S-A Gunnery Exercise		None													
5	A-A Missiles		None													
6	Helicopter ASW TRACKEX		None													
7	MPA ASW TRACKEX		None													
8	Helicopter ASW TORPEX		None													
9	MPA ASW TORPEX		None													
10	Surface Ship ASW TRACKEX		None													
11	Surface Ship ASW TORPEX		None													
12	Surface Ship Integrated ASW		None													
13	Sub ASW Trackex		None													
14	Sub ASW TORPEX		None													
15	VBSS		None													
16	A-S MISSILEX		None													
17	A-S BOMBEX		None													
18	A-S GUNEX		None													
19	S-S GUNEX		None													
20	SINKEX		None													
21	NSFS		None													
22	EFEX	3	5-ton Truck	16	80%	8	0.04	0.06	0.01	0.00	0.01	16.95	24.87	3.28	0.06	2.33
		3	HMMWV	3	65%	8	0.04	0.06	0.01	0.00	0.01	3.18	4.66	0.62	0.01	0.44
23	Battalion Landing	4	LAV	40		8	0.04	0.06	0.01	0.00	0.01	56.51	82.89	10.93	0.21	7.76
		4	FAV	24		8	0.04	0.06	0.01	0.00	0.01	33.91	49.74	6.56	0.13	4.66
		4	HMMWV	4		8	0.04	0.06	0.01	0.00	0.01	5.65	8.29	1.09	0.02	0.78
		4	7-ton Truck	16		8	0.12	0.44	0.01	0.00	0.02	62.93	223.55	7.45	0.40	9.23
		4	M-1 Tank	8		8	0.12	0.44	0.01	0.00	0.02	31.46	111.78	3.72	0.20	4.61
24	USMC Stinger	1	LAV	4		5	0.04	0.06	0.01	0.00	0.01	0.88	1.30	0.17	0.00	0.12
25	Amphibious Landings & Raids															
25A	Recon Mission		None													

Scenario	Type Training	Days	Ground Vehicles	Number	Engine Load	Hours per day	Emissions Factors (lb/hr)					Emissions (lbs)				
Training Exercises							**CO**	**NOx**	**HC**	**SOx**	**PM10**	**CO**	**Nox**	**HC**	**Sox**	**PM**
25B	Helicopter Assault	1	FAV	48	Idle	1	0.06	0.17	0.01	0.00	0.00	2.78	7.94	0.34	0.00	0.10
					65%	4	0.04	0.06	0.01	0.00	0.01	8.48	12.43	1.64	0.03	1.16
25C	Armored Operations	1	HMMWV	16	Idle	2	0.06	0.17	0.01	0.00	0.00	1.86	5.29	0.22	0.00	0.07
					65%	3	0.04	0.06	0.01	0.00	0.01	2.12	3.11	0.41	0.01	0.29
			M1	16	Idle	1	0.06	0.17	0.01	0.00	0.00	0.93	2.65	0.11	0.00	0.03
					60%	2	0.12	0.44	0.01	0.00	0.02	3.93	13.97	0.47	0.02	0.58
25D	Amphibious Landings & Raids	1	HMMWV	24	Idle	2	0.06	0.17	0.01	0.00	0.00	2.78	7.94	0.34	0.00	0.10
					65%	3	0.04	0.06	0.01	0.00	0.01	3.18	4.66	0.62	0.01	0.44
			5-ton Trucks	48	Idle	1	0.06	0.17	0.01	0.00	0.00	2.78	7.94	0.34	0.00	0.10
					80%	1	0.04	0.06	0.01	0.00	0.01	2.12	3.11	0.41	0.01	0.29
25E	Amphibious Assault		None													
25F	Combat Engineer Ops	1	HMMWV	6	Idle	2	0.06	0.17	0.01	0.00	0.00	0.70	1.99	0.08	0.00	0.03
					65%	3	0.04	0.06	0.01	0.00	0.01	0.79	1.17	0.15	0.00	0.11
			5-ton Trucks	2	Idle	1	0.06	0.17	0.01	0.00	0.00	0.12	0.33	0.01	0.00	0.00
					80%	1	0.04	0.06	0.01	0.00	0.01	0.09	0.13	0.02	0.00	0.01
25G	Amphibious Assault Vehicle Ops															
25H	EFV	1	HMMWV	8	Idle	2	0.06	0.17	0.01	0.00	0.00	0.93	2.65	0.11	0.00	0.03
					65%	3	0.04	0.06	0.01	0.00	0.01	1.06	1.55	0.21	0.00	0.15
			5-ton Trucks	4	Idle	1	0.06	0.17	0.01	0.00	0.00	0.23	0.66	0.03	0.00	0.01
					80%	1	0.04	0.06	0.01	0.00	0.01	0.18	0.26	0.03	0.00	0.02
			Refueler	2		1	0.12	0.44	0.01	0.00	0.02	0.25	0.87	0.03	0.00	0.04
25I	Assault Amphibian School	5	7-ton Truck	15	Idle	1	0.06	0.17	0.01	0.00	0.00	4.35	12.41	0.52	0.01	0.16
					80%	1	0.12	0.44	0.01	0.00	0.02	9.22	32.75	1.09	0.06	1.35
			HMMWV	15	Idle	2	0.06	0.17	0.01	0.00	0.00	8.70	24.82	1.05	0.01	0.33
					65%	3	0.04	0.06	0.01	0.00	0.01	9.93	14.57	1.92	0.04	1.36
			Refueler	15		1	0.12	0.44	0.01	0.00	0.02	9.22	32.75	1.09	0.06	1.35
26	Ambphibious Operations CPAAA															
26A	Amphibious Operations		None													
26B	Amphibious Ops		None													
26C	Amphibious Ops		None													
26D	Amphibious Ops		None													
26E	Amphibious Ops		None													
26F	Amphibious Warfare		None													
26G	Amphibious Ops		None													
27	Elec Combat		None													
28A	Sm Obj Avoidance		None													
29	Mine Neutralization		None													
30	Mining Exercise		None													

Scenario	Type Training	Days	Ground Vehicles	Number	Engine Load	Hours per day	Emissions Factors (lb/hr)					Emissions (lbs)				
Training Exercises							**CO**	**NOx**	**HC**	**SOx**	**PM10**	**CO**	**Nox**	**HC**	**Sox**	**PM**
31	NSWC Land Demolition		None													
32	NSWC UW Demo		None													
33	Mat Weave		None													
34	NSWC Small Arms		None													
35	NSWC Land Nav	1	Pickup Truck	118		6	0.30	0.03	0.02	0.00	0.00	215.53	18.05	11.28	0.20	0.64
36	NSW UAV Operationa		None													
37	Insertion/Extraction		None													
38	NSW Boat Operations		None													
39	NSWG-1 Platoon Ops		None													
40	Direct Action		None													
41	Bombing Exercise - Land		None													
42	CSAR		None													
43	EOD Outside SHOBA		None													
44	USCG Ops		None													
45	NALF Airfield		None													
46	Ship Torpedo Test		None													
47	UUV		None													
48	Sonobuoy QA/QC		None													
49	Ocean Engineering		None													
50	MM Mine Location		None													
51	Missile Flight Test		None													
52	NUWC UW Acoustic		None													
53	Other Tests		None													
	Total						**Total Ground Vehicle Emissions, tons**					0.25185605	0.3605397	0.028176	0.000757	0.019352

Table C-16. Total Emissions within 3 nm - SOCAL OPAREA (conformity)

No Action Alternative	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Aircraft–Operations	1.13	1.76	0.12	0.10	1.14	1.13
Surface Ships	8.69	12.84	3.22	7.22	1.16	3.61
NALF	132.86	37.97	33.63	1.89	28.11	27.83
Ordnance	25.12	1.15	0.00	0.01	2.66	1.89
Total	**167.80**	**53.72**	**36.97**	**9.23**	**33.08**	**34.46**
Alternative 1						
Aircraft–Operations	9.11	9.73	0.85	0.57	5.61	5.55
Surface Ships	10.90	17.35	4.88	10.34	4.13	4.09
NALF	153.67	47.18	35.98	2.30	29.14	28.85
Ordnance	39.66	1.97	0.00	0.02	3.37	2.36
Total	**213.34**	**76.23**	**41.72**	**13.22**	**42.24**	**40.85**
Alternative 2						
Aircraft–Operations	11.10	11.63	1.06	0.68	6.50	6.43
Surface Ships	12.09	19.82	5.99	12.03	5.51	7.34
NALF	165.78	54.63	37.75	2.65	31.72	31.40
Ordnance	48.26	2.59	0.00	0.02	4.44	3.11
Total	**237.23**	**88.67**	**44.80**	**15.37**	**48.17**	**48.29**
Increases over Baseline						
Alternative 1	45.54	22.51	4.74	3.99	9.17	6.39
Alternative 2	69.43	34.94	7.82	6.14	15.09	13.83
De Minimus Limits	**100.00**	**10.00**	**10.00**	**100.00**	**70.00**	**100.00**
Alternative 1 Above De Minimis?	NO	YES	NO	NO	NO	NO
Alternative 2 Above De Minimis?	NO	YES	NO	NO	NO	NO

SCAQMD SIP Budget—FY06

Aircraft - Operations	4.57	5.66	0.48	0.31	3.39
Surface Ships	17.94	29.05	10.66	6.13	1.16
Ordnance	21.2	0.07	0.01	0	0.26
NALF Aircraft	333.15	55.71	106.43	3.66	61.35
Total	**376.66**	**90.49**	**117.58**	**10.10**	**66.16**
Alt 1 Above 2006 Emissions Budget?	NO	NO	NO	YES	NO
Alt 2 Above 2006 Emissions Budget?	NO	NO	NO	YES	NO

Appendix D

This Page Intentionally Left Blank

LIST OF TABLES

This Page Intentionally Left Blank

Table D-1. Amount of Vegetation and Wildlife Habitat within Individual Operations Areas on SCI, Description of Potential Impacts of Existing and Proposed Operations, Applicable Mitigation Measures, and Impact Significance. Evaluation of Impact Significance for the No Action Alternative is Based on Comparison with the Baseline.

<table>
<tr><th>Operations Area[1]</th><th>Amount of Resource[1]</th><th>Description of Impacts</th><th>Applicable Mitigation Measures and Impact Significance[2,3]</th></tr>
<tr><td>IMPACT AREA I
2,346.4 ac</td><td>Vegetation Types (acreage)
Coastal Strand: None
Coastal Salt Marsh: 19.3 ac
Delineated wetland 0.5 ac
Island Woodland: 43.5 ac
Disturbed: 440.5 ac
Grassland: 1.0 ac
MDS Cholla Phase: 932.3 ac
MDS Lycium Phase: 511.6 ac
MDS Prickly Pear-Cholla Phase: 397.7 ac</td><td>Existing patterns of disturbance from ordnance impacts and fire would be expected to continue under the no-action alternative, given the long history of similar use as a range for incoming heavy ordnance including naval bombardment, aerial bombardment, conventional artillery and mortars, and live-fire involving small arms. Under no action, Impact Area I receives about 6% of the large caliber ordnance used in SHOBA including about 199 bombs (mostly inert practice bombs), 244 large caliber artillery rounds and 138 2.75-inch rockets fired from helicopters at low altitude. Currently portions of the Impact Area where targets have most frequently been placed are highly disturbed by ordnance and frequent fires. The disturbance level decreases with distance from the target areas as exposure to incoming ordnance and fires decreases. This applies to all the habitats listed at left. Island Woodland, a sensitive community, is additionally protected from frequent fire or ordnance impact by distance from targets and topography. Targets are not placed in the area mapped as Coastal Salt Marsh, including the delineated wetland.

Continued use as an impact area would not be expected to substantially change the condition of vegetation and wildlife habitat given the existing condition and long history of disturbance.

The increases in ordnance associated with Alternatives 1 and 2 (11% and 21% increase in bombs, 31% and 47% increase in large caliber artillery rounds, and 28% and 57% increase in rockets, respectively) would not be expected to substantially change the existing intensity and patterns of disturbance within Impact Area I because the majority of this ordnance would fall into areas already highly disturbed by incoming ordnance. Moreover, improvements in weapons systems would be expected to lead to a higher percentage of ordnance hitting the intended target and fewer stray rounds.

<table><tr><th></th><th>Impact Area I
Baseline</th><th>Alt 1</th><th>Alt 2</th></tr><tr><td>Bombs</td><td>199</td><td>221</td><td>241</td></tr><tr><td>Artillery</td><td>244</td><td>319</td><td>359</td></tr><tr><td>Rockets</td><td>138</td><td>176</td><td>217</td></tr><tr><td>Total</td><td>581</td><td>716</td><td>817</td></tr></table></td><td>Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2.
G-M-1*
G-M-3*
G-M-4
G-M-5
G-M-6*
G-M-7
G-M-9
*CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them.

No Action: Impacts are less than significant.
Alternative 1: Impacts would be less than significant with mitigation.
Alternative 2: Impacts would be less than significant with mitigation</td></tr>
</table>

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

<table>
<tr><th>Operations Area[1]</th><th>Amount of Resource[1]</th><th>Description of Impacts</th><th>Applicable Mitigation Measures and Impact Significance[2,3]</th></tr>
<tr><td>IMPACT AREA II
1,112.9 ac</td><td>Vegetation Types (acreage)
Coastal Strand: 7.1 ac
Island Woodland: 10.1 ac
MDS Cholla Phase: 448.5 ac
MDS Lycium Phase: 572.2 ac
MDS Prickly Pear Phase: 28.0 ac
Stabilized sand Dunes: 46.9 ac</td><td>Existing patterns of disturbance from ordnance impacts and fire would be expected to continue, given the long history of similar use as a range for incoming heavy ordnance including naval bombardment, aerial bombardment, conventional artillery and mortars, and live-fire involving small arms. Impact Area II includes Impact Area IIA, the "bomb box", where the use of large live bombs (500-2,000 lb) is permitted. Under No Action, Impact Area II (including IIA) receives ~94% of the large caliber ordnance used in SHOBA, including 2,453 bombs, 7,572 artillery rounds, 168 rockets, and 174 mortar rounds. Most of the bombs and nearly all of the rockets go into Impact Area IIA, which is very highly disturbed by ordnance impacts and frequent fires as are adjacent portions of Impact Area II where targets have most frequently been placed. The disturbance level decreases with increasing distance from the target areas as exposure to incoming ordnance and fires decreases. This applies to all the habitats listed at left. Island Woodland, a sensitive community, is additionally protected from frequent fire or ordnance impact by distance from targets and topography.

Continued use as an impact area would not be expected to substantially change the condition of vegetation and wildlife habitat given the existing condition of the site and long history of disturbance.

The increases in ordnance associated with Alternatives 1 and 2 (11% and 21% increase in bombs, 31% and 47% increase in large caliber artillery rounds, and 28% and 57% increase in rockets, respectively) would not be expected to substantially change the existing intensity and patterns of disturbance within Impact Area II because the majority of this ordnance would fall into areas already highly disturbed by incoming ordnance. Moreover, improvements in weapons systems would be expected to lead to a higher percentage of ordnance hitting the intended target and fewer stray rounds.

<table>
<tr><td></td><td colspan="3">Impact Area II (incl IIA)</td></tr>
<tr><td></td><td>Baseline</td><td>Alt 1</td><td>Alt 2</td></tr>
<tr><td>Bombs</td><td>2,453</td><td>2,715</td><td>2,968</td></tr>
<tr><td>Artillery</td><td>7,572</td><td>9,926</td><td>11,141</td></tr>
<tr><td>Rockets</td><td>168</td><td>215</td><td>264</td></tr>
<tr><td>Totals</td><td>10,193</td><td>12,856</td><td>14,373</td></tr>
</table>
</td><td>Applicable mitigation measures and Impact significance are as described for Impact Area I above.</td></tr>
<tr><td>NALF AVMA
264.8ac</td><td>Vegetation Types (acreage)
Coastal Strand: 5.1 ac
Disturbed: 240.1 ac
MDS Lycium Phase: 26.1 ac</td><td>Surface disturbance of the AVMA by tracked vehicles in Alternatives 1 and 2 would lead to reduction of vegetation in general; replacement of native shrubs such as boxthorn (Lycium californicum) by non-native annual grasses and weeds; and disturbance of soils, leading to an increase in wind and water erosion and opportunities for establishment of invasive species. Native vegetation includes MDS Lycium (along the southern boundary) and Coastal strand (at the egress from West Cove) vegetation types. Some further degradation of existing coastal strand and disturbed habitat is likely to result from USMC amphibious landings involving LCACs (if they run</td><td>Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2.
G-M-1
G-M-3</td></tr>
</table>

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		up into existing vegetation) and heavy tracked and wheeled vehicles including AAVs, EFVs, tanks and wheeled vehicles (if they run over vegetated areas while egressing from the beach).The majority of the AVMA has been disturbed by past grading and these portions would be less substantially affected by tracked vehicle use, except that the movements of tracked vehicles in this AVMA are likely to spread an infestation of veldt grass (*Ehrharta calycina*) that has been noted in this area southward on the Island if the current aggressive treatment of veldt grass is not effective. Designation of this AVMA is part of Alternatives 1 and 2. Alternative 1. The AVMA could be used by tracked vehicles during approximately 43 (42 USMC Amphibious plus 1 USMC Battalion Landing) operations per year. Alternative 2. The AVMA could be used by tracked vehicles during approximately 63 (61 USMC Amphibious plus 2 USMC Battalion Landing) operations per year. Greater impacts than for Alternative 1 due to the 47% increase in operations using the AVMA, compared to Alternative 1.	G-M-4 AVMC-M-1 AVMC-M-2 AVMC-M-3 AVMC-M-4 AVMC-M-5 AVMC-M-6 AVMC-M-7 AVMC-M-9 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Old Rifle Range AVMA 200.3 ac	Vegetation Types (acreage) Disturbed: 62.6 ac Grassland: 0.5 ac MDS Lycium Phase: 137.2 ac	Surface disturbance of the AVMA by tracked vehicles in Alternatives 1 and 2 would inhibit ecosystem recovery and lead to reduction of vegetation in general; replacement of native shrubs such as boxthorn (*Lycium californicum)* by non-native annual grasses and weeds; and disturbance of soils, leading to an increase in wind and water erosion. The western boundary of the AVMA contains steep slopes prone to erosion. Drainages previously determined to be under Corps of Engineers jurisdiction cross the AVMA and would be affected by vehicular activity and may require grading to enable vehicular passage. Native vegetation is MDS Lycium (along the southern boundary). Portions of the AVMA have been disturbed by past grading and other activities (development and use as a firing range) and these portions would be less substantially affected by tracked vehicle use. Designation of this AVMA is part of Alternatives 1 and 2. Alternatives 1 and 2: Operations would be as described above for NALF AVMA.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 AVMC-M-1 AVMC-M-2 AVMC-M-3 AVMC-M-4 AVMC-M-5 AVMC-M-6 AVMC-M-7 No Action: No Impact Alternatives 1 and 2: As described above for NALF AVMA, impacts would be less than significant with mitigation.

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
VC-3 AVMA 587.8 ac	Vegetation Types (acreage) Disturbed: 309.8 ac Grassland: 275.5 ac MDS Prickly Pear-Cholla Phase: 2.5 ac Vernal pool wetland: 0.3 ac	Surface disturbance of the AVMA by tracked vehicles in Alternatives 1 and 2 would inhibit ecosystem recovery and lead to reduction of vegetation in general and disturbance of soils, leading to an increase in wind and water erosion and susceptibility to invasive species. Over half of the AVMA has been disturbed by past grading and other uses, including aerial bombardment in the 1930s or 1940s, and would be less substantially affected by tracked vehicle use. The tiny vernal pool wetlands in the southern portion of the AVMA are probably artifacts of the former use of the area for bombing; tracked vehicle activity could adversely affect these pools by crushing or uprooting plants and increasing turbidity. Under some conditions, tracked vechicles may expand the pools by compacting soils and creating new ruts. The movements of tracked vehicles after departing from this AVMA are likely to spread localized infestations of invasive species including salsify (*Tragopogon porrifolius*) and smilo grass (*Piptatherum miliaceum*) to other parts of the island . Designation of this AVMA is part of Alternatives 1 and 2. Alternatives 1 and 2: Operations would be as described above for NALF AVMA	Applicable Mitigation Measures as listed for Old Rifle Range AVMA (above) No Action: No Impact Alternatives 1 and 2: Impacts would be less than significant with mitigation.
AVMC in SHOBA 72.2 ac	Vegetation Types (acreage) Disturbed: 0.9 ac Grassland: 9.1 ac MDS Cholla Phase: 6.7 ac MDS Prickly Pear-Cholla Phase: 9.6 ac	Operation of the AVMC in SHOBA in Alternatives 1 and 2 would have localized impacts on roadside vegetation and habitat including erosion, deposition of dust on vegetation, and spread of invasive plant species. The impacts would be localized along the sides of the AVMC, where invasive species would be detectable and treatable. Frequency of use would be up to approximately 43 times per year in Alternative 1 and up to 63 times per year in Alternative 2. (Construction of the route would be addressed in a separate environmental document and permitted separately).	Applicable Mitigation Measures as listed for Old Rifle Range AVMA (above) No Action: No Impact Alternative 1: Impacts from use of the route during operations would be less than significant with mitigation. Alternative 2: Impacts from use of the route during operations would be less than significant with mitigation.
Island Airfield AMP (AMP-A) 20.2 ac	Vegetation Types (acreage) Disturbed: 20.2 ac	Maneuvering of tracked and wheeled vehicles and howitzers for simulated attacks would inhibit ecosystem recovery, maintain soil and vegetation in disturbed condition, maintain conditions favorable to establishment or spread of invasive plant species, including veldt grass. Existing condition of site is disturbed. Designation of the AMP is part of Alternatives 1 and 2. Alternative 1: Artillery maneuvering during 3-day exercises up to 6 times per year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering during 3-day exercises up to 8 times per year plus 2 USMC Battalion Landings.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 AVMC-M-1 AVMC-M-2 AVMC-M-3 AVMC-M-4 AVMC-M-5

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
			AVMC-M-6 AVMC-M-7 AVMC-M-8 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Old Rifle Range (ORR) AMP (AMP-B) 25.4 ac	Vegetation Types (acreage) Disturbed: 20.6 ac MDS Lycium Phase: 4.7 ac	Maneuvering of wheeled and tracked vehicles and placement of howitzers for simulated attack coupled with use of the overlapping AVMA in Alternatives 1 and 2 is expected to inhibit ecosystem recovery and cause reduction of vegetation in general; replacement of native shrubs such as boxthorn (*Lycium californicum*) by non-native annual grasses and weeds; and disturbance of soils, leading to an increase in wind and water erosion. Designation of the AMP is part of Alternatives 1 and 2. Frequency of use is as described for Island Airfield AMP (AMP A) above.	Applicable conservation measures and Impact significance are as described for Island Airfield AMP (AMP A) above.
Self Help AMP (AMP-C) 5.5 ac	Vegetation Types (acreage) Disturbed: 2.1 ac Grassland: 3.4 ac	Maneuvering of wheeled and tracked vehicles and placement of howitzers for simulated attack in Alternatives 1 and 2 is expected to cause reduction of vegetative cover in general and disturbance of soils, leading to an increase in wind and water erosion especially near an existing drainage head on the east side of the AMP. This small site is previously disturbed and lacks perennial vegetation. Periodic use of the AMP by vehicles would inhibit ecosystem recovery by causing soil and vegetation to remain in disturbed condition and maintaining conditions favorable to establishment or spread of invasive plant species. Designation of the AMP is part of Alternatives 1 and 2. Frequency of use is as described for Island Airfield AMP (AMP A) above.	Applicable conservation measures and Impact significance are as described for Island Airfield AMP (AMP A) above.
Old Airfield AMP (AMP-D) 6.2 ac	Vegetation Types (acreage) Disturbed: 3.9 ac Grassland: 2.3 ac	Maneuvering of wheeled and tracked vehicles and placement of howitzers for simulated attack in Alternatives 1 and 2 is expected to cause reduction of vegetative cover in general and disturbance of soils, leading to an increase in wind and water erosion. This small site is previously disturbed owing to its location on one arm of the historic VC-3 runway and lacks native perennial vegetation. Periodic use of the AMP by vehicles would cause soil and vegetation to remain in disturbed condition and maintain conditions favorable to establishment or spread invasive plant species including salsify (*Tragopogon porrifolius*) and smilo grass (*Piptatherum miliaceum*), which are established onsite and have the potential to be carried to other parts of the island through vehicle and foot traffic. Designation of the AMP is part of Alternatives 1 and 2. Frequency of use is as described for Island Airfield AMP (AMP A) above.	Applicable conservation measures and Impact significance are as described for Island Airfield AMP (AMP A) above.
AFP-1 SHOBA 34.1 ac	Vegetation Types (acreage) AFP-1: MDS -Cholla Phase: 34.1 ac	Maneuvering of heavy wheeled and tracked vehicles, including tanks, and digging in of recoil spades on howitzers is expected to cause a reduction in vegetation cover in general, a reduction	Implementation of the SCI Wildland Fire Management Plan is

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		in native shrub cover and biomass, replacement of native shrubs with non-native grasses and weeds, and to maintain the vegetation and soils on site in disturbed condition, subject to wind and water erosion, and establishment of invasive plant species. Portions of the 34-acre site have been previously affected by vehicles and equipment. Less than significant impacts for No Action due to small size and existing condition of site. No Action: 5 operations per year from this general area. Designation of this AFP is included in Alternatives 1 and 2. Alternative 1. Artillery maneuvering during 3-day USMC artillery exercises up to 6 times per year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering during 3-day USMC artillery exercises up to 8 times per year plus 2 USMC Battalion Landings.	part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 G-M-9 AVMC-M-1 AVMC-M-2 AVMC-M-3 AVMC-M-4 AVMC-M-5 AVMC-M-6 AVMC-M-7 AVMC-M-8 No Action: Impacts are less than significant. Alternative 1. Impacts would be less than significant with mitigation. Alternative 2. Impacts would be less than significant with mitigation.
AFP-6 SHOBA 124.2 ac	Vegetation Types (acreage) Grassland 123.3 ac; MDS -Cholla Phase: 1 ac Vernal pool wetland: 0.4 ac	Maneuvering of heavy wheeled and tracked vehicles, including tanks, and maneuvering and digging in of recoil spades on howitzers in Alternatives 1 and 2 is expected to cause a reduction in vegetation cover in general, a reduction in grass cover and biomass, and to maintain the vegetation and soils on site in disturbed condition, subject to wind and water erosion and establishment of invasive plant species. Vehicle activity in the AFP could adversely affect the small vernal pools by crushing or uprooting plants and increasing turbidity. Under some conditions, tracked or wheeled vehicle use may expand the pools somewhat by compacting soils and creating new ruts that could retain water. Impacts would be less than significant with mitigation. No action: Designation of this AFP is included in Alternatives 1 and 2. Alternative 1. Artillery maneuvering during 3-day USMC artillery exercises up to 6 times per year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering during 3-day USMC artillery exercises up to 8 times per year plus 2 USMC Battalion Landings.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4, G-M-9 AVMC-M-1 AVMC-M-2 AVMC-M-3 AVMC-M-4 AVMC-M-5 AVMC-M-6

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
			AVMC-M-7 AVMC-M-8 No Action: No impact. This site was not included in the No Action Alternative. Alternative 1. Impacts would be less than significant with mitigation. Alternative 2. Impacts would be less than significant with mitigation.
TAR 1—Demolition Range Northeast Point 1.8 ac	Vegetation Types (acreage) Disturbed: 1.4 ac Stabilized sand dunes: 0.4 ac	Light disturbance of vegetation and soils by small groups on foot except for a small area (<0.25 ac) used for demolitions and safety bunker. Sandy soils, gently sloping terrain, and small disturbance area have low potential for erosion. Invasive species may establish around the margins of the disturbed are where they would be localized, detectable, and treatable. Less than significant impacts given light disturbance outside demolitions area, small size and existing condition of the site for No Action. No Action: 23 ops/yr. This TAR has been previously established. Alternative 1: 28 ops/yr. Alternative 2: 30 ops/yr. For Alternatives 1 and 2, with application of mitigation measures, the potential for disturbance of vegetation and soils but impacts would remain low for the reasons stated above despite the increased tempo of operations.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: 23 operations/yr. Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 2—Graduation Beach Underwater Demolition Range 13.8 ac	Vegetation Types (acreage) Disturbed: 13.2 ac	Disturbance of onshore vegetation and soils would be from small groups on foot similar to historical use. Most of the activity at this TAR would occur on the beach and in the water. Impacts of No Action are less than significant. Baseline use = 5 ops/yr. Designation of this TAR is part of Alternatives 1 and 2. Alternative 1: 24 ops/yr. Alternative 2: 30 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 3—BUD/S Beach Underwater Demolition Range 4.1 ac	Vegetation Types (acreage) Disturbed with coastal strand and possibly some coastal dune. Quantitative data not available for this site.	This site has a long history of frequent high level NSW training activity and is adjacent to two permanent manned NSW facilities that use it for training. Native vegetation is somewhat disturbed. There would be additional disturbance by small groups on foot plus site improvements in Alternatives 1 and 2, which include erosion control on the access road and the demolition area, communication line telephone, maintenance of a demolition preparation area, and a demolition staging area. Some potential for establishment of invasive species but should be readily detectable and treatable given small size, accessibility, and frequent use of site. Most of the activity at this TAR would occur on the beach and in the water. Baseline use = 82 ops/yr. Designation of this TAR is part of Alternatives 1 and 2. Alternative 1: 82 ops/yr. Alternative 2: 95 NSW and 4 USMC Amphibious ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 4—Whale Point/Castle Rock 27.1 ac	Vegetation Types (acreage) Disturbed: 15.4 ac MDS Lycium Phase: 11.7 ac	Ongoing and proposed operations would be expected to gradually degrade the MDS Lycium Phase habitat due to direct impacts resulting from frequent use by small groups on foot coupled with use of demolitions, flares, pyrotechnics, and small arms (including tracers). Indirect impacts associated with spread of invasive species that increase in response to disturbance of vegetation and soils and frequent small fires would also expected to adversely affect the MDS Lycium Phase habitat, because the dominant species regenerates slowly after fire or other disturbance and short fire return intervals are likely to cause long-term loss (DoN 2005, Draft FMP BA). Implementation of the SCI Wildland Fire Management Plan as described herein would be expected to reduce impacts of future operations under Alternatives 1 and 2. No Action: Baseline use = 222 ops/yr. This TAR has been previously established. Alternative 1: 240 ops/yr. Alternative 2: 300 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts on vegetation are significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 5— West Cove Amphibious Assault Training Area 2.1 ac	Vegetation Types (acreage) Coastal strand: 2.1 ac[1]	NSW activities would have minimal impact due to their infrequent occurrence and low intensity nature. Some further degradation of existing coastal strand and disturbed habitat is likely to result from USMC amphibious landings involving LCACs (if they run up into existing vegetation) and heavy tracked and wheeled vehicles including AAVs, EFVs, tanks and wheeled vehicles (if they run over vegetated areas while egressing from the beach). Existing use is for amphibious landings and extractions and access to NALF AVMA, which overlaps West Cove. Movements of vehicles and personnel from this TAR to other parts of the Island are likely to spread an infestation of veldt grass (*Ehrharta calycina*) that has been noted in this area and has been the target of weed treatments for several years. Baseline use = 10 ops/yr incl. 10 USMC Amphibious. Designation of this TAR is part of Alternatives 1 and 2. Alternative 1: 25ops/yr (incl. 17 USMC Amphibious). Alternative 2: 55 ops/yr (incl. 44 USMC Amphibious).	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 AVMC-M-9 For amphibious landings measures listed above for NALF AVMA are also applicable. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 6—White House Training Area 3.3 ac	Vegetation Types (acreage) MDS *Lycium* Phase: 3.3 ac	Minimal disturbance to native vegetation and soils is anticipated in Alternatives 1 and 2. Site has existing developed features and access road. Some amount of disturbed vegetation is present and not reflected in the vegetation types data. Baseline use = 0 ops/yr. Designation of this TAR is part of Alternatives 1 and 2. Alternative 1: 8 ops/yr. Alternative 2: 10 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 9—Photo Lab Training Area 26.3 ac	Vegetation Types (acreage) Disturbed: 23.5 ac Grassland: 2.8 ac	Physical disturbance to vegetation and habitat from continuing operations in the No-Action Alternative would be minimal (small groups on foot). Constructed roads and paths already exist between buildings. Use of breaching charges would be confined to designated currently disturbed areas. Baseline use = 23 ops/yr. Designation of this TAR is part of Alternatives 1 and 2. Alternative 1: 32 ops/yr. Alternative 2: 44 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 10—Demolition Range West 54.9 ac	Vegetation Types (acreage) Disturbed 29.6 ac MDS Lycium Phase: 25.3 ac Stabilized sand dune: 0.1 ac Salt marsh wetland: 0.14 ac	Development and use of the TAR would be concentrated in previously disturbed parts of the site, some of which have partially revegetated with native species. The proposed facility at this TAR would include a 200 ft^2 (19 m^2) personnel safety bunker and a 1,000 ft^2 (93 m^2) range building. The area of disturbance including demolitions area would be limited to a 10,000 ft^2 (930 m^2) area. Outside of the demolition areas operations would be by small groups on foot. Some potential for invasive species to establish on the site and along the access road and to spread into undisturbed MDS-Lycium and stabilized dune vegetation. Potential for wildland fires originating onsite, spreading into contiguous MDS-Lycium habitat to the north and south of TAR 10 has been addressed in the SCI Wildland Fire Management Plan and BA, with effective measures designed to minimize spread of fire beyond the TAR and avoid type conversion of habitat (see above). Assuming implementation of the Wildland Fire Management Plan as described herein and confining construction and concentrated human activities to existing disturbed areas, impacts on vegetation would be less than significant in Alternatives 1 and 2. Baseline use = 3 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 20 ops/yr. Alternative 2: 20 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 11—Surveillance Training Area 8.8 ac	Vegetation Types (acreage) Maritime sage scrub: 8.8 ac	Low disturbance of vegetation based on infrequent use by small groups on foot only, with helicopter insertion. Moderate potential for wildland fire ignition associated with use of flares and ordnance. Low potential for introduction and spread of invasive species due to small groups and relatively infrequent use, however sensitive plant communities and T/E plant populations are present on site and in surrounding area and could be adversely affected by an introduction of invasive species. Less than significant impacts for Alternatives 1 and 2 assuming implementation of the Wildland Fire Management Plan as described herein. Baseline use = 4 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 17 ops/yr. Alternative 2: 22 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 12—Radar Site Training Area 5.1 ac	Vegetation Types (acreage) Grassland: 4.9 ac Maritime sage scrub: 0.2 ac	Low impacts on vegetation and soils caused by infrequent foot traffic by small groups in Alternatives 1 and 2. Low to moderate potential for introduction and spread of invasive species. Low risk of wildland fire ignition. Baseline use = 11 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 12 ops/yr. Alternative 2: 17 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 13—Randall Radar Site Training Area 17.1 ac	Vegetation Types (acreage) Disturbed: 6.4 ac Grassland: 7.4 ac MDS Prickly Pear: 0.1 ac Maritime sage scrub: 3.6 ac	Low impacts on vegetation and soils caused by infrequent foot traffic by small groups. Use of flares, illumination rounds, and pyrotechnics creates a moderate risk of igniting a wildland fire. Live-fire would be indoors only. Less than significant impacts for Alternatives 1 and 2 assuming implementation of the Wildland Fire Management Plan as described herein. Baseline use = 29 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 31 ops/yr. Alternative 2: 52 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 14— VC-3 Onshore Parachute Drop Zone "Twinky" 338.7 ac	Vegetation Types (acreage) Disturbed: 5.2 ac Grassland: 324.9 ac MDS Prickly Pear: 8.6 ac	Low disturbance of vegetation caused by NSW activities based on use by small groups on foot only, some with helicopter insertion. Existing vegetation reflects substantial disturbance from past activities. Moderate potential for wildland fire ignition associated with use of flares and ordnance. Low potential for introduction and spread of invasive species due to small groups and relatively infrequent use. No sensitive species or vegetation types known from the site. Less than significant impacts for Alternatives 1 and 2 assuming implementation of the Fire Plan. Baseline use = 20 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 30 ops/yr. Alternative 2: 68 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 15— VC-3 Airfield Training Area 770.8 ac	Vegetation Types (acreage) Disturbed: 368.7 ac Grassland: 397.1 ac MDS Prickly Pear: 5.1 ac Vernal pool wetland: 0.3 ac	Low disturbance of vegetation caused by NSW activities based on use by small groups on foot only, with helicopter or land insertion. Existing vegetation reflects substantial disturbance from past activities. Moderate potential for wildland fire ignition associated with use of flares and ordnance high potential for spread under high and extreme FDRS. Low potential for introduction and spread of invasive species due to small groups and relatively infrequent use. Except for a small area of vernal pool wetlands in the southern tip of the TAR and overlying VC-3 AVMA (see above), no sensitive species or sensitive vegetation types are known from the site. The vernal pools would not be adversely affected (see text). Less than significant impacts for Alternatives 1 and 2 assuming implementation of the Wildland Fire Management Plan as described herein. Baseline use = 20 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 25 ops/yr. Alternative 2: 94 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 16—South VC-3 (Missile Impact Range) 54.2 ac	Vegetation Types (acreage) Grassland: 54.0 ac	Existing condition of grassland habitat is disturbed as a result of use as a missile target area, including grading and the construction and rearrangement of very large scale targets. Additional proposed activities, including vehicle traffic, use as a missile target, and use during Battalion Landings would be expected to have little additional impact on the habitat at this site. Less than significant impacts for Alternatives 1 and 2 assuming implementation of the Wildland Fire Management Plan as described herein. Baseline use = 25 ops/yr. This TAR has been previously established. Alternative 1: 41 ops/yr. Alternative 2: 52 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 17— Eel Point Tactical Training Range 11.9 ac	Vegetation Types (acreage) Disturbed: 4.7 ac MDS Lycium Phase: 7.2 ac	Outside of existing disturbed areas where demolitions would occur, disturbance of vegetation and soils would be limited to small groups on foot using tactical environmental movement. Low disturbance of vegetation, soils, and crusts would result from the foot traffic. There is a moderate potential for invasive species to spread following the foot traffic and into the surrounding undisturbed MDS Lycium vegetation. Potential for wildland fires originating onsite to spread into contiguous MDS-Lycium habitat to the north or to the south of TAR 17 has been addressed in the SCI Fire Management Plan and BA, with effective measures designed to minimize spread of fire beyond the TAR and avoid type conversion of habitat. Assuming implementation of the Wildland Fire Management Plan as described herein and confining most activities including demolitions and flare use to existing disturbed areas, impacts on vegetation would be less than significant in Alternatives 1 and 2. Baseline use = 15 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 31 ops/yr. Alternative 2: 40 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 18—Close Quarter Battle Training Complex 0.64 ac	Vegetation Types (acreage) Disturbed: 0.6 ac	Development and use of site in Alternatives 1 and 2 would impact disturbed vegetation and habitat only. Baseline use = 0 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 25 ops/yr. Alternative 2: 30 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 19—Simulated POW Camp and SAM Site 2.4 ac	Vegetation Types (acreage) Disturbed: 2.4 ac	Development and use of site in Alternatives 1 and 2 would impact disturbed vegetation and habitat only. Baseline use = 0 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 10 ops/yr. Alternative 2: 10 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 20—Pyramid Cove Training Area 167.2 ac	Vegetation Types (acreage) Coastal salt marsh: 11.6 ac Disturbed: 155.6 ac The coastal marsh is evidently mapped on the basis of vegetation and appears to be very infrequently flooded and lacking surface water. It is dominated by native salt marsh plant species due to the presence of saturated saline soils.	Impacts would be less than significant for No Action given the levels of existing disturbance in Impact Area I, including the portion designated as TAR 20. Ship to shore live-fire from small boats and other live-fire from people on foot would be expected to increase and vegetation and habitat would be expected to remain in similar condition or experience an incremental increase in disturbance as a result of ordnance use, fire, and foot traffic in Alternatives 1 and 2. Minimal impacts on the salt marsh habitat, which is low-lying and set back from the beach, would be expected from ordnance and fire. Vehicle traffic, including mounted patrol operations, would be confined to existing roads. Baseline use = 44 ops/yr. (This TAR is located in SHOBA Impact Area I where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 50 ops/yr. Alternative 2: 60 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-3* G-M-4, G-M-9 TAR-M-1* *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 21—Horse Beach Cove Training Area and Horse Beach Cove Amphibious Landing and Embarkation Area. 88.1 ac	Vegetation Types (acreage) Coastal salt marsh: 7.6 ac Island Woodland: 0.2 ac MDS Lycium Phase: 80.3 ac The coastal salt marsh in TAR 21 is the second largest mapped on SCI	TAR 21. Frequent use by small groups on foot with live firing has caused localized disturbance to vegetation in frequently used areas and routes. There is a moderate potential to introduce and spread invasive species related to the types and frequency of operations conducted in and proposed for TAR 21. Increased fire frequency resulting from the intensification of uses may lead to changes in vegetation (possibly leading to type conversion) under No Action and in Alternatives 1 and 2. The Wildland Fire Management Plan does not provide for ground based fire suppression within SHOBA. Amphibious Landing and Embarkation: Direct impacts of vehicular traffic on vegetation would be localized between the beach and the egress road, but vehicle traffic could significantly affect coastal salt marsh and coastal strand/foredune vegetation while maneuvering between beach and egress road in Alternatives 1 and 2. No amphibious landings are conducted under No Action. Baseline use = 79 ops/yr. (This TAR is located in SHOBA Impact Area I where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.) Alternative 1: 91 ops/yr. including 81 NSW, 10 USMC Amphibious and 1 USMC Battalion Landing.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-3* G-M-4, G-M-7, G-M-9 TAR-M-1* AVMC-M-3 AVMC-M-4 AVMC-M-5 AVMC-M-7 AVMC-M-10 *CRNSW policy prohibiting access for natural resource surveys or

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		Alternative 2: 102 ops/yr. including 90 NSW, 10 USMC Amphibious and 2 USMC Battalion Landing.	management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts on vegetation are significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: 102 ops/yr. including 90 NSW, 10 USMC Amphibious and 2 USMC Battalion Landing. Impacts would be less than significant with mitigation.
TAR 22—China Cove Training Area 289 ac	Vegetation Types (acreage) Island Woodland: 0.1 ac MDS Cholla Phase: 22.3 ac MDS Lycium Phase: 229.6 ac Stabilized sand dunes: 37.0 ac	Most of the land area of TAR 22 is disturbed, a result of a long history of Naval artillery and aerial bombardment and other live-fire training. Proposed uses in Alternatives 1 and 2 would incrementally add to the existing disturbance, primarily as a result of ordnance use, demolition activities, fire, and foot traffic by platoon-sized groups (12-15). Entry to the site by swimming for many of the operations minimizes the potential for introducing or spreading invasive species. Stabilized sand dunes above beach are in relatively good condition despite evidence of ordnance and training impacts. Baseline use = 96 ops/yr including 33 NSW ops/yr. and 63 Non-NSW Naval ops/yr. (This TAR is located in SHOBA Impact Area II and contains Impact Area IIA, where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.) Alternative 1: 200 ops/yr. including 33 NSW, 6 USMC Amphibious, 1 USMC Battalion Landing and 160 other naval operations. Alternative 2: 220 ops/yr. including 40 NSW, 16 USMC Amphibious, 2 USMC Battalion Landing and 162 other naval operations. (Other naval operations include naval artillery and air-to-ground ordnance delivery into overlapping Impact Area II and IIA (which are included above under Impact Area II).	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1*, G-M-3* G-M-4, G-M-7, G-M-9 TAR-M-1* *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts on vegetation are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Infantry	Vegetation Types (acreage)	Foot traffic has a moderate potential for localized physical disturbance of the vegetation and soils over an	Implementation of the SCI

Table D-1 (continued). Amount of Vegetation and Wildlife Habitat Within Individual Operations Areas on SCI

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
Operations Area 8,815.3 ac	Coastal strand: 4.5 ac Coastal salt marsh: 4.0 ac Island woodland: 3.2 ac Disturbed: 974.5 ac Grassland: 6351.4 ac MDS-Cholla Phase: 550.6 ac MDS Lycium Phase: 311.1 ac MDS Prickly Pear/Cholla phase: 435.6 ac MDS Prickly Pear Phase: 179.6 ac Vernal pool wetland 2.1 ac	extensive area, especially on sloping surfaces and when soils are wet. Grassland habitat, which constitutes the majority (~72%) of the Infantry Operations Area, has comparatively low botanical sensitivity. Habitat classified as disturbed constitutes another 11% of the Infantry Operations Area, however much of this disturbed habitat is incorporated into overlapping operations areas such as TARs and AVMAs addressed above. Because of the infrequency and dispersed nature of the foot traffic, direct impacts on vegetation and soils are expected to be temporary and less than significant. Island woodland, coastal strand and coastal salt marsh communities have high botanical sensitivity. The coastal strand and coastal salt marsh communities are in overlapping portions of Impact Area I and TAR 21. The Island woodland occurs in canyons mostly around the periphery of the IOA particularly on the edge of the eastern escarpment where the community is unlikely to be affected by foot traffic because of the terrain. Foot traffic spread over a large area has the potential to introduce or spread invasive plant species, an indirect impact. The large size and remoteness of parts of the Infantry Operations Area will make beginning infestations of invasive species difficult to detect when they are localized and most treatable. The large number of personnel and equipment involved in the Battalion Landing Operations and their dispersal over the island make introductions and spreading of invasive species almost unavoidable. The consequences of a particular introduction are not entirely predictable, however there are many documented cases of landscape transformations with serious ecological impacts resulting from introductions, most notably on islands. Baseline use = 0 ops/yr, Battalion-sized landings have occurred on SCI in the past, but not during the baseline year. Foot traffic by individuals and groups is permitted within the IOA and elsewhere on the Island under the No Action Alternative. Alternative 1: 1 USMC Battalion-sized landing per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road. 2 USMC Battalion-sized landings per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road. Alternative 2: 2 USMC Battalion-sized landings per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road.:	Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 G-M-9 AVMC-M-1 AVMC-M-2 AVMC-M-4 AVMC-M-7 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Note:

1. Vegetation acreage based on the classification and mapping by Sward and Cohen (1980). Resource acreage totals are approximate and may not agree with operations area total due to rounding and other factors associated with the GIS data layers.
2. Impact significance conclusion is based on discussion in "Description of Impacts" column and is assessed assuming application of mitigation measures identified in this document. Impact significance of No Action is based on condition of the resource existing in 2004 and continuance of operations at baseline levels.
3. Impact significance assessment assumes mitigation for Alternatives 1 and 2.

Table D-2. Occurrence of San Clemente Island Indian Paintbrush Within Individual Operations Areas on SCI, Description of Potential Impacts of Existing and Proposed Operations, and Impact Significance. Evaluation of Impact Significance for the No Action Alternative is Based on Comparison with the Baseline

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
IMPACT AREA I	SCI Indian paintbrush: 52 of 335 occurrences on SCI (15.5% of SCI total occurrences), 2034 of 14,064 individuals on SCI (14.5% of SCI total individuals). Nearly all of Impact Area I occurrences are in Horse Beach Canyon	Impact Area I contains about 15% of the known SCI Indian paintbrush on SCI. The occurrences of these plants are mainly in Horse Beach Canyon and are generally away from target locations and somewhat shielded by topography, minimizing potential for ordnance hits. Since removal of non-native herbivores from the Island, SCI Indian paintbrush has been increasing in abundance in this area despite ongoing use of live ordnance. Effect of fire on SCI Indian paintbrush is unknown but indications are that it might benefit from occasional fire. Under No Action, Impact Area I receives about 6% of the large caliber ordnance used in SHOBA, and the increases with Alternatives 1 and 2 are as described in Table D-1. Increased use of large ordnance in Alternatives 1 and 2 would have minimal effects on this species based on the increase of the plants during ongoing operations, adaptation to fire, distance from frequently used targets and topographic shielding. Implementation of the Navy Access Policy applying to Impact Areas I and II and TARS 20, 21, and 22 will preclude future direct monitoring of this endangered plant species and its habitat in these locations.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-3* G-M-4 G-M-5 G-M-6* G-M-7 G-M-9 *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant. Alternative 2: Impacts would be less than significant.
IMPACT AREA II	SCI Indian paintbrush: 3 of 335 SCI occurrences (0.9% of SCI total occurrences) with 43 individuals (0.3% of 14,064 SCI total individuals). These are located in China Canyon.	Existing patterns of disturbance from ordnance impacts and fire would be expected to continue, given the long history of similar use. This species is located in China Canyon where there is some topographic shielding, and it is not near targets, reducing the likelihood of a direct hit or near miss by ordnance. This species is increasing in abundance in SHOBA. As described in Table D-1, Impact Area II (including IIA) would receive about 94 % of the incoming large caliber ordnance in SHOBA and the increases with Alternatives 1 and 2 are as described in Table D-1. Heavy use of Impact Area II would have no adverse effects on this species based on the likelihood that the existing occurrences would persist or expand.	Applicable conservation measures and Impact significance are as described for Impact Area I above.

Table D-2 (continued). Occurrence of San Clemente Island Indian Paintbrush Within Individual Operations Areas on SCI

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
NALF AVMA	SCI Indian paintbrush: 6 of 335 SCI occurrences (1.8% of SCI total occurrences) with a total of 6 individuals (0.04% of 14,064 SCI total individuals) are clustered a short distance inland of the TAR 5 boundary. The location of each individual was recorded as a separate occurrence in this survey rather than as a single location with six individuals at one location as has been the more common practice.	The six Indian paintbrush plants in this AVMA are newly discovered and are located in a cluster with 3 other sensitive species (discussed in Table D-10) a short distance inland of the egress from TAR 5. At this location, surface disturbance of the AVMA by tracked vehicles in Alternatives 1 and 2 could lead to damage to or elimination of these plants from this area. Protection of the localized area containing the paintbrush can be addressed through development of the erosion control plan (AVMC-M-3), briefing of maneuver area boundaries prior to conducting operations in these areas (AVMC-M-4), and continuing to use the existing route for ingress and egress from the beach at West Cove (AVMC-M-9), as appropriate. Tracked vehicle use in this AVMA is likely to spread an infestation of veldt grass (*Ehrharta calycina*) within the AVMA and southward on the Island if the current aggressive treatment of veldt grass is not effective. Designation of this AVMA is part of Alternatives 1 and 2. Alternative 1. The AVMA could be used by tracked vehicles during approximately 43 (42 USMC Amphibious plus 1 USMC Battalion Landing) operations per year. Alternative 2. The AVMA could be used by tracked vehicles during approximately 63 (61 USMC Amphibious plus 2 USMC Battalion Landing) operations per year.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 AVMC-M-1 AVMC-M-2 AVMC-M-3 AVMC-M-4 AVMC-M-5 AVMC-M-6 AVMC-M-7 AVMC-M-9 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
AFP-1 SHOBA	SCI Indian paintbrush: 1 of 335 SCI occurrences (0.3% of SCI total occurrences) with 28 individuals (0.2% of 14,064 SCI total individuals). These are located in the central portion of the AFP near the Ridge road.	Maneuvering of heavy wheeled and tracked vehicles, including tanks, and digging in of recoil spades on howitzers are likely to adversely affect individuals in this population through the physical effects of vehicle activity and possibly by spread of invasive species facilitated by the activity. Portions of this 34-acre site had been disturbed previously by grading and off-road tracked vehicle and artillery activity. The paintbrush occurrences appear to be in operationally accessible portions of the site but outside of the previously used portions of the site. Depending on the specifics of the site, protection of the localized area containing the paintbrush could potentially be addressed as part of development of the erosion control plan (AVMC-M-3) and/or briefing of maneuver area boundaries prior to conducting operations in these areas (AVMC-M-4). Less than significant impacts for No Action due to small size and previous disturbance of site and the small proportion of the SCI Indian Paintbrush population represented on site (<<1 percent). No Action: 5 operations per year from this general area. Designation of this AFP is included in Alternatives 1 and 2. Alternative 1. Artillery maneuvering during 3-day USMC artillery exercises up to 6 times per	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 G-M-9 AVMC-M-1 AVMC-M-2 AVMC-M-3 AVMC-M-4 AVMC-M-5

Table D-2 (continued). Occurrence of San Clemente Island Indian Paintbrush Within Individual Operations Areas on SCI

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering during 3-day USMC artillery exercises up to 8 times per year plus 2 USMC Battalion Landings.	AVMC-M-6 AVMC-M-7 AVMC-M-8 No Action: Impacts are less than significant. Alternative 1. Impacts would be less than significant with mitigation. Alternative 2. Impacts would be less than significant with mitigation.
TAR 21—Horse Beach Cove Training Area and Horse Beach Cove Amphibious Landing and Embarkation Area.	SCI Indian paintbrush: 1 of 335 occurrences on SCI (0.3% of SCI total occurrences), 3 of 14,064 individuals on SCI (0.02% of SCI total individuals). About 15% of SCI total individuals/occurrences of SCI Indian paintbrush are located in Horse Beach Canyon, in Impact Area I upstream from this TAR.	TAR 21. Occurrences of this species are primarily inland of the TAR boundary and are associated with the floodplain, hill slopes, or canyon walls of Horse Beach Canyon. Frequent foot traffic by small groups, ordnance use, and demolitions could directly affect this species. These effects would be localized to the specific activity areas. There is a moderate potential to introduce and spread invasive species related to the frequency of operations in TAR 21. Ship to shore live firing, tracers, use of flares and other devices have the potential to ignite fires that could spread north of the TAR boundary into areas occupied by this species, which appears able to survive periodic fire by reproduction from seed. Repeated fires at a short interval could adversely affect this species by killing plants before its seed bank has been replenished. Horse Beach Canyon upstream from the TAR 21 boundary supports about 15% of the SCI total occurrences of the SCI Indian paintbrush. The Wildland Fire Management Plan does not provide for ground-based fire suppression within SHOBA. Fires would be unlikely to spread far beyond the TAR boundary in an up-canyon direction due to the gentle elevational gradient of the lower canyon coupled with the direction of prevailing NW or NE winds under high and very high FDRS (DoN 2006), which would be opposed to spreading of fire in an up-canyon direction. Increased use in Alternatives 1 and 2 would increase the potential for adverse effects on this species. Amphibious Landing and Embarkation: Direct impacts of vehicular traffic on vegetation would be localized between the beach and the egress road where the SCI Indian paintbrush is not known to occur, so vehicular traffic associated with amphibious exercises would have less than significant impact on the species. Associated activity is as described above for TAR 21. Baseline use = 79 ops/yr. This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2. Alternative 1: 91 ops/yr. including 81 NSW, 10 USMC Amphibious and 1 USMC Battalion Landing. Alternative 2: 102 ops/yr. including 90 NSW, 10 USMC Amphibious and 2 USMC Battalion Landing.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-3* G-M-4 G-M-5 G-M-6* G-M-7 G-M-9 AVMC-M-1 AVMC-M-2* AVMC-M-3* AVMC-M-4 AVMC-M-5 AVMC-M-7 AVMC-M-10 TAR-M-1* *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them.

Table D-2 (continued). Occurrence of San Clemente Island Indian Paintbrush Within Individual Operations Areas on SCI

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
			No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-2 (continued). Occurrence of San Clemente Island Indian Paintbrush Within Individual Operations Areas on SCI

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 22—China Cove Training Area	SCI Indian paintbrush: 1 of 335 occurrences on SCI (0.3% of SCI total occurrences), 23 of 14,064 individuals on SCI (0.16% of SCI total individuals).	The single location within TAR 22 is within Impact Area II at the eastern boundary of the TAR, where it is unlikely to be affected by activities. The plants are located in China Canyon near the TAR boundary where they are afforded some topographic shielding and are not in proximity with target areas, reducing the likelihood of a direct hit or near miss by ordnance. This species is increasing in abundance in SHOBA despite historic and ongoing bombardment, ordnance use and wildland fire. Effect of fire on SCI Indian paintbrush would be as described above. Activities within the TAR under No Action apparently have not adversely affected this species due to the distance of the plants from the TAR and topographic shielding that makes direct ordnance impacts unlikely, even after the long exposure of these populations to similar activities. Increased use of the TAR 22 in Alternatives 1 and 2 would increase the potential for effects on this species. Baseline use = 96 ops/yr including 33 NSW ops/yr. and 63 Non-NSW Naval ops/yr. (This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.) Alternative 1: 200 ops/yr. including 33 NSW, 6 USMC Amphibious, 1 USMC Battalion Landing and 160 other naval operations. Alternative 2: 220 ops/yr. including 40 NSW, 16 USMC Amphibious, 2 USMC Battalion Landing and 162 other naval operations (naval artillery and air-to-ground ordnance into overlapping Impact Area II and IIA (covered under Impact Area II).	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-3* G-M-4 G-M-5 G-M-6* G-M-7 G-M-9 TAR-M-1* *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Infantry Operations Area	SCI Indian paintbrush: 53 of 335 SCI 1998-2007 occurrences identified (15.8% of SCI total occurrences), 808 of 14,064 individuals on SCI (5.75% of SCI total individuals).	About 16% of the known occurrences of SCI Indian paintbrush on SCI are located in the Infantry Operations Area, where there would be an increase in dispersed foot traffic associated with Battalion Landings under Alternatives 1 and 2. Surveys of the 8,815-ac area have been recently completed with over 50 additional populations of this species located within the boundaries of the IOA. SCI Indian paintbrush is a small shrub and is unlikely to be adversely affected by occasional foot traffic. Any effects of foot traffic on a local occurrence of this species would be dispersed (because the Marines would be spread out), minor (trampled leaves or broken branches), infrequent (up to twice per year, generally less) and temporary. Because of the dispersion of the Marines and the small effect that the foot travel would have on plants, it is not expected that the direct effects of foot travel on this species would be substantial or significant.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 G-M-9 AVMC-M-1

Table D-2 (continued). Occurrence of San Clemente Island Indian Paintbrush Within Individual Operations Areas on SCI

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		However, the potential for introduction or spread of invasive species as a result of dispersed battalion landing foot traffic is not discountable and adverse consequences from such an event on endangered plant species are reasonably foreseeable. Baseline use: Battalion-sized landings have occurred on SCI in the past, but not during the baseline year. Foot traffic by individuals and groups is permitted within the IOA and elsewhere on the Island under the No Action Alternative. Alternative 1: 1 USMC Battalion landing per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road. Alternative 2: 2 USMC Battalion-sized landings per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road.	AVMC-M-2 AVMC-M-4 AVMC-M-7 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Note:
1. See text for an explanation of the 1998-2007 rare plant data. Under “amount of resource” resources (e.g., occurrences and numbers of individuals) occurring in overlapping operations areas are reported for each of the overlapping areas, enabling the effects of the differing operations in the overlapping areas to be assessed.
2. Impact significance conclusion is based on discussion in “Description of Impacts” column and is assessed assuming application of mitigation measures identified in this document.
3. Impact significance assessment assumes mitigation for Alternatives 1 and 2.

Table D-3. Occurrence of San Clemente Island larkspur within or near individual operations areas on SCI, description of potential impacts of existing and proposed operations, and impact significance. Evaluation of impact significance for the no action alternative is based on comparison with the baseline.

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TARs 14 & 15	No populations documented in these TARs but substantial populations are located on the eastern side and downslope from TARs 14 and 15.	No direct effect. Modeled fires under moderate Fire Danger Rating System conditions with southwest winds 5 mph (without implementing Wildland Fire Management Plan (DoN 2005) precautions and countermeasures referenced in Section 2-x and summarized below) spread into SCI larkspur habitat during nighttime hours, affecting up to 24 occurrences and 5,000 individuals 12 hours after ignition. This would be unlikely given implementation of the measures specified in the plan, because the fire would originate and burn initially in grassland habitat in moderate, accessible terrain in which fire suppression is most feasible. During the conditions when fire would be most likely, the SCI larkspur exists as dormant underground storage roots that resprout the following rainy season. This species, which is most prevalent in grassland habitats, may benefit from the removal of competing vegetation and thatch caused by periodic fire. The grassland habitat of the larkspur also recovers rapidly after fire. These model results do not take into account precautions and countermeasures specified in the SCI Wildland Fire Management Plan, which incorporates a series of increasing precautions and fire suppression measures related to increasing FDRS ratings, including having a fully equipped and staffed fire truck positioned within line of sight of the TAR and action area and having the ability to be on scene and pumping water within 10 minutes of an ignition report, whenever any type of incendiary ordnance is used and at higher danger ratings imposing restrictions on the use of demolitions or other flame or heat producing ordnance, including flares, tracers, and pyrotechnics, during daytime hours except under specific conditions. Increased operations in TARs 14 and 15 under Alternatives 1 and 2 would increase the potential for fires that could adversely affect the species. Even with the resiliency of the plants and their habitat with regard to fire, implementation of the SCI Fire Management Plan would be necessary to reduce those effects. Designation of TARs 14 and 15 is part of Alternatives 1 and 2 TAR 14: Baseline use = 20 ops/yr. Alternative 1: 30 ops/yr. Alternative 2: 68 ops/yr. TAR 15: Baseline use = 20 ops/yr. Alternative 1: 25 ops/yr. Alternative 2: 94 ops/yr.	Fire Management Plan Implementation G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1. Impacts would be less than significant with mitigation. Alternative 2. Impacts would be less than significant with mitigation.

Table D-3 (continued). Occurrence of San Clemente Island larkspur within or near individual operations areas on SCI.

Operations Area[1]	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
Infantry Operations Area	SCI larkspur: 7 of 38 1998-2007 occurrences on SCI (18.4% of SCI total 1998-2006 occurrences), 284 of 7,389 individuals on SCI (3.8% of SCI total individuals); 12 of 46 pre-1998 historic SCI occurrences (26.1% SCI total historic occurrences) totaling 13.3 of 87 pre-1998 SCI acres (15.3%).	Less than 20% of known occurrences of this endangered plant species on SCI are within the Infantry Operations Area, where they would be exposed to dispersed foot traffic associated with Battalion Landings up to 2 times per year under Alternatives 1 and 2. Surveys of the 8,815-ac area were recently completed and 5 new occurrences totaling 59 individuals were located within the IOA. Any effects of foot traffic on a local population of this plant species would be dispersed (because the Marines would be spread out), minor (damaged leaves or flower stems), infrequent (up to twice per year, generally less) and temporary. SCI larkspur would be affected only during its winter-spring season of growth when foliage is above ground. The rest of the year they exist as dormant storage roots and dormant seed. Because of the dispersion of the Marines and the small effect that the foot travel would have on individual plants, it is not expected that the direct effects of foot travel on this species would be substantial. However, the potential for introduction or spread of invasive species as a result of dispersed battalion landing foot traffic is not discountable, and adverse consequences from such an event on this species in the Infantry Operations Area are reasonably foreseeable. Baseline use: none. Battalion-sized landings have occurred on SCI in the past, but are not considered part of the baseline. Foot traffic by individuals and groups is permitted within the IOA and elsewhere on the Island under the No Action Alternative. Alternative 1: 1 USMC Battalion-sized landing per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road. Alternative 2: 2 USMC Battalion-sized landings per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 AVMC-M-1 AVMC-M-2 AVMC-M-4 AVMC-M-7 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Notes:
1. See text for an explanation of the 1998-2007 rare plant data and pre-1998 "historical" data used in the analysis.
2. Impact significance conclusion is based on discussion in "Description of Impacts" column and is assessed assuming application of mitigation measures identified in this document.
3. Impact significance assessment assumes mitigation for Alternatives 1 and 2.

Table D-4. Occurrence of San Clemente Island broom within or near individual operations areas on SCI, description of potential impacts of existing and proposed operations, and impact significance. Evaluation of impact significance for the no action alternative is based on comparison with the baseline.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 11: Surveillance Training Area	SCI broom: 9 of 147 occurrences on SCI (6.1% of SCI total occurrences); 878 of 9674 individuals on SCI (9.1% of SCI total individuals) About 12 additional occurrences are in the general vicinity of the TAR.	Operations in No Action likely result in temporary damage to some individuals as a result of trampling and use of flares and pyrotechnics. Some potential exists for spreading of invasive species into habitat associated with the foot traffic. Fire originating as a result of operations could affect 10% or more of the Island population. Seedling establishment of this short-lived subshrub is fire-stimulated and the species also establishes from seed after minor disturbances. Burned plants are generally killed outright by fire. Increasing the number of operations in Alternatives 1 and 2 would increase the potential for effects on this species. Baseline use = 4 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 17 ops/yr. Alternative 2: 22 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3. G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Infantry Operations Area	SCI broom: 14 of 147 1998-2007 occurrences on SCI (9.5% of SCI total 1998-2007 occurrences), 241 of 9674 individuals on SCI (2.5% of SCI total individuals).	Less than 10% of known occurrences and 2.5 % of known individuals of SCI broom on SCI are located in the Infantry Operations Area, where they would be exposed to dispersed foot traffic associated with Battalion Landings up to 2 times per year. SCI broom is a small shrub and is unlikely to be affected by occasional foot traffic. Any effects of foot traffic on a local population of this species would be dispersed (because the Marines would be spread out), minor (damaged leaves or broken branches), infrequent (up to twice per year, generally less) and temporary. Because of the dispersion of the Marines and the small effect that the foot travel would have on plants, it is expected that the direct effects of occasional foot travel on this species would be minor. However, as described above, the potential for introduction or spread of invasive species as a result of dispersed battalion landing foot traffic is not discountable and adverse consequences from such an event on this plant species are reasonably foreseeable.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 AVMC-M-1 AVMC-M-2 AVMC-M-4 AVMC-M-7 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-4 (continued). Occurrence of San Clemente Island broom within or near individual operations areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		Baseline Use: none. Battalion-sized landings have occurred on SCI in the past, but are not considered part of the baseline. Foot traffic by individuals and groups is permitted within the IOA and elsewhere on the Island under the No Action Alternative. Alternative 1: 1 USMC Battalion-sized landing per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road. Alternative 2: 2 USMC Battalion-sized landings per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road.	

Note:
1. See text for an explanation of the 1998-2007 rare plant data and pre-1998 "historical" data used in the analysis.
2. Impact significance conclusion is based on discussion in "Description of Impacts" column and is assessed assuming application of mitigation measures identified in this document.
3. Impact significance assessment assumes mitigation for Alternatives 1 and 2.

Table D-5. Occurrence of San Clemente Island Bush Mallow Within or Near Individual Operations Areas on SCI, Description of Potential Impacts of Existing and Proposed Operations, and Impact Significance. Evaluation of Impact Significance for the No Action Alternative is Based on Comparison with the Baseline.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
IMPACT AREA I	SCI bush mallow: 54 of 80 occurrences on SCI (67.5% of SCI total occurrences), 864 of 1591individuals on SCI (54.3% of SCI total individuals) Nearly all of the Impact Area I occurrences are in Horse Beach Canyon	The occurrences of these plants are mainly in Horse Beach Canyon and are generally away from targets for naval artillery and air-ground ordnance and somewhat shielded by topography, minimizing potential for ordnance hits. SCI bush mallow is increasing in abundance in this area despite ongoing use of live ordnance. Evidence is that occasional fire is beneficial to bush mallow. Under baseline conditions, Impact Area I receives about 6% of the large caliber ordnance used in SHOBA and the increases with Alternatives 1 and 2 are as described in Table D-1. Increased use of large ordnance in Alternatives 1 and 2 would have minimal effects on this species based on the increase of the plants during ongoing operations, adaptation to fire, distance from heavy ordnance targets currently in use, and topographic shielding. Implementation of the Navy Access Policy applying to Impact Areas I and II and TARS 20, 21, and 22 will preclude future direct monitoring of this endangered plant species and its habitat in these locations.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-3* G-M-4 G-M-5 G-M-6* G-M-7 G-M-9 *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-5 (continued). Occurrence of San Clemente Island Bush Mallow Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
IMPACT AREA II	SCI bush mallow: 2 of 80 SCI occurrences (2.5% of SCI total occurrences) with 78 of 1591 individuals (4.9% of SCI total individuals). These plants are located in China Canyon.	Existing patterns of disturbance from ordnance impacts and fire would be expected to continue, given the long history of similar use. The known occurrences for this species in Impact Area II are in China Canyon where the plants are afforded some topographic shielding and are not in proximity with target areas, reducing the likelihood of a direct hit or near miss by ordnance. This species is increasing in abundance in SHOBA. Impact Area II receives about 94% of the large caliber ordnance used in SHOBA under baseline conditions and the increases with Alternatives 1 and 2 are as described in Table D-1. Increased use of Impact Area II would not be expected to have substantial adverse effects on this species based on the likelihood that the existing occurrences would persist or expand as the area continues to recover from the effects of feral goats. Implementation of the Navy Access Policy applying to Impact Areas I and II and TARS 20, 21, and 22 will preclude future direct monitoring of this endangered plant species and its habitat in these locations.	Applicable conservation measures and Impact significance are as described for Impact Area I above.
TAR 21— Horse Beach Cove Training Area and Horse Beach Cove Amphibious Landing and Embarkation Area	SCI bush mallow: 17 of 80 occurrences on SCI (21.2% of SCI total occurrences), 223 of 1591 individuals on SCI (14.0 % of SCI total individuals). All of these occurrences are also within Impact Area I, which overlaps TAR 21.	TAR 21: Occurrences of SCI bush mallow are inland of the coastal road that parallels the beach and are associated with the floodplain or canyon sides of Horse Beach Canyon. Frequent foot traffic by small groups, ordnance use, and demolitions could directly affect this species where activity is most frequent. These effects would be localized to the specific activity areas. There is a moderate potential to introduce and spread invasive species related to the frequency of operations and disturbances proposed for TAR 21. Ship to shore live firing, tracers, use of flares, etc. have the potential to ignite fires that could spread into areas occupied by this species, which survives periodic fire by resprouting. It has not been observed to reproduce from seed on SCI (WFMP DoN 2005). Repeated fires at a very short return interval could adversely affect SCI bush mallow by killing plants before underground reserves have been replenished. Horse Beach Canyon in Impact Area I (including the overlapping portion of TAR 21) has a substantial proportion (67.5%) of the total documented occurrences of the SCI bush-mallow. Increased fire frequency resulting from the intensification of uses may lead to localized changes in vegetation (type conversion). The Wildland Fire Management Plan does not provide for ground-based fire suppression within SHOBA. However, fires are unlikely to spread far beyond the TAR boundary in an up-canyon direction because of the low elevational gradient of the lower canyon coupled with the direction of prevailing NW or NE winds under high and very high FDRS (DoN 2006) which would be opposed to spreading of fire in an up-canyon direction. Increased use in Alternatives 1 and 2 would increase the potential for adverse effects on this species. Amphibious Landing and Embarkation: Assuming no maneuvering or parking of vehicles inland of the egress road, direct impacts of vehicular traffic on vegetation would be localized between the beach and the egress road where the SCI bush	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-3* G-M-4 G-M-5 G-M-6* G-M-7 G-M-9 AVMC-M-1 AVMC-M-2* AVMC-M-3* AVMC-M-4 AVMC-M-5 AVMC-M-7 AVMC-M-10 TAR-M-1* *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant.

Table D-5 (continued). Occurrence of San Clemente Island Bush Mallow Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		mallow is not known to occur, so vehicular traffic associated with amphibious exercises would have less than significant impact on the species. Associated activity is accounted for above. Implementation of the Navy Access Policy applying to Impact Areas I and II and TARS 20, 21, and 22 will preclude future direct monitoring of this endangered plant species and its habitat in these locations. Baseline use = 79 ops/yr. ((This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.) Alternative 1: 91 ops/yr. including 81 NSW, 10 USMC Amphibious and 1 USMC Battalion Landing. Alternative 2: 102 ops/yr. including 90 NSW, 10 USMC Amphibious and 2 USMC Battalion Landing.	Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 22—China Cove Training Area	A pre-1998 historic occurrence of SCI bush mallow was not observed during 2005 surveys of this TAR.	Proposed activities at TAR 22 are unlikely to affect the previously documented occurrence of SCI bush mallow, which may no longer exist, given that it was not relocated during 2005 surveys of the TAR. This species is increasing in abundance in SHOBA despite historic and ongoing bombardment, ordnance use, and wildland fire. Evidence is that occasional fire is beneficial to bush mallow and impacts of No Action are less than significant. Increasing the number of operations in Alternatives 1 and 2 would increase the potential for effects on this species. Implementation of the Navy Access Policy applying to Impact Areas I and II and TARS 20, 21, and 22 will preclude future direct monitoring of this endangered plant species and its habitat in these locations. Baseline use = 96 ops/yr including 33 NSW ops/yr. and 63 Non-NSW Naval ops/yr. (This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.) Alternative 1: 200 ops/yr. including 33 NSW, 6 USMC Amphibious, 1 USMC Battalion Landing and 160 other naval operations. Alternative 2: 220 ops/yr. including 40 NSW, 16 USMC Amphibious, 2 USMC Battalion Landing and 162 other naval operations. (Other naval operations include naval artillery and delivery of air-to-ground ordnance into overlapping Impact Area II and IIA , which are overed under Impact Area II).	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-3* G-M-4 G-M-5 G-M-6* G-M-7 G-M-9 TAR-M-1* *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Infantry Operations Area	SCI bush mallow: 0 of 80 SCI 1998-2005 occurrences identified (0.0%); 1 of 28 pre-1998 historic SCI occurrences (3.6% SCI total occurrences) totaling 0.4 of 15.6 pre-1998	Less than 5% of known historic occurrences and individuals of SCI bush mallow are located in the Infantry Operations Area, where they would be exposed to dispersed foot traffic associated with Battalion Landings up to 2 times per year. Surveys of the 8,815-ac area have been recently completed and no additional occurrences of SCI bush mallow were located within the boundaries of the IOA. SCI bush mallow is a small to medium sized shrub and is unlikely to be affected by occasional foot traffic.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3

Table D-5 (continued). Occurrence of San Clemente Island Bush Mallow Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
	SCI acres (2.6%).	Any effects of foot traffic on a local occurrence of this species would be dispersed (because the Marines would be spread out), minor (damage to leaves or possible broken branches), infrequent (up to twice per year, generally less) and temporary. Because of the dispersion of the Marines and the small effect that the foot travel would have on plants, it is not expected that the direct effects of occasional foot travel on this species would be substantial. However, the potential for introduction or spread of invasive species as a result of dispersed battalion landing foot traffic is not discountable and adverse consequences from such an event on endangered plant species are reasonably foreseeable. Baseline use: Battalion-sized landings have occurred on SCI in the past, but are not considered part of the baseline. Foot traffic by individuals and groups is permitted within the IOA and elsewhere on the island. Proposed Action: Two USMC Battalion-sized landings per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road.	G-M-4 AVMC-M-1 AVMC-M-2 AVMC-M-4 AVMC-M-7 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Note:

1. See text for an explanation of the 1998-2007 rare plant data and pre-1998 “historical” data used in the analysis. Under “amount of resource”, resources (e.g., occurrences and numbers of individuals) occurring in overlapping operations areas are reported for each of the overlapping areas (e.g., Impact Area I and TAR 21), enabling the effects of the differing operations in the overlapping areas to be assessed.
2. Impact significance conclusion is based on discussion in “Description of Impacts” column and is assessed assuming application of mitigation measures identified in this document.
3. Impact significance assessment assumes mitigation for Alternatives 1 and 2.

Table D-6. Occurrence of Island Night Lizard (INL) Within or Near Individual Operations Areas on SCI, Description of Potential Impacts of Existing and Proposed Operations, and Impact Significance. Evaluation of Impact Significance for the No Action Alternative is Based on Comparison with the Baseline.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
IMPACT AREA I	INL Medium density habitat: 511.6 (8.7% of SCI total) Low density habitat: 397.8 (26% of SCI total) Lowest density habitat: 1.0 (<1% of SCI total) Estimated population in 511.6 ac of MDS Lycium is 400,583 individuals, based on average density of 783 individuals/acre for MDS Lycium habitat (DoN 2005, based on data from Mautz 2000). 397.9 ac of low density habitat would be expected to support about 229,190 individuals; 1.0 ac of lowest density would support 462 individuals.	Exposure to direct ordnance impacts, noise, and habitat degradation. Existing patterns of habitat disturbance from ordnance impacts and fire would be expected to continue, given the long history of similar use. Many individuals survive and populations are observed to persist in areas exposed to repeated fires and artillery bombardment, probably because of the high proportion of time spent by INL under cover (e.g., in rock crevices). Some take may occur from direct hits but would not be measurable at the population level. Table D-1 provides a summary of ordnance use for No Action, Alternative 1 and Alternative 2. Implementation of the Navy Access Policy applying to Impact Areas I and II and TARS 20, 21, and 22 will preclude future direct monitoring of this species and its habitat in these locations.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-2* G-M-3* G-M-4 G-M-5 G-M-6* G-M-7 G-M-8 G-M-9 INL-M-1* *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-2, G-M-3, G-M-6, INL-M-1) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-6 (continued). Occurrence of Island Night Lizard (INL) Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
IMPACT AREA II	INL High density habitat: 28.0 ac (0.4% of SCI total) Medium density habitat: 572.0 ac (9.8% of SCI total) Low density habitat: 0.0 ac Lowest density habitat: 0.0 ac Estimated population in 28.0 ac of high density habitat is 29,008 individuals, based on average density of 1,036 individuals/ac for MDS Prickly Pear habitat (DoN 2005, based on data from Mautz 2000). 572.0 ac of medium density habitat would be expected to support about 447,876 individuals	Existing patterns of habitat disturbance from ordnance impacts and fire would be expected to continue, given the long history of similar use. No observable effect on the population would be expected. Impacts on the species are less than significant, given the demonstrated continuance of the population despite historic and ongoing use and the low proportion of the SCI total habitat exposed in Impact Area II. Table D-1 provides a summary of ordnance use for No Action, Alternative 1 and Alternative 2. Implementation of the Navy Access Policy applying to Impact Areas I and II and TARS 20, 21, and 22 will preclude future direct monitoring of this species and its habitat in these locations.	Applicable conservation measures and Impact significance are as described for Impact Area I above.
NALF AVMA	INL Medium density habitat: 26.1 ac (4% of SCI total) Estimated population in 26.1 ac of MDS Lycium is 20,436 individuals, based on average density of 783 individuals/acre (DoN 2005, based on data from Mautz 2000).	Tracked vehicles, including M-1 tanks, AAVs, and EFVs would degrade coastal strand and MDS Lycium habitat by causing a reduction in shrub (especially boxthorn) cover with a concomitant reduction of thermal cover and suitability for INL. Some mortality of individuals is likely but probably would not be observable. Degradation of 26.1 ac of habitat would lead to reduced reproduction of breeding adults and reduced survivorship of non-breeding individuals in that habitat. This would be a long term effect but less than significant because of the small effect on the overall population (< 0.5% of the medium density habitat on SCI). Designation of the AVMA is part of Alternatives 1 and 2. Alternative 1. The AVMA could be used by tracked vehicles during approximately 43 (42 USMC Amphibious plus 1 USMC Battalion Landing) operations per year. Alternative 2. The AVMA could be used by tracked vehicles during approximately 63 (61 USMC Amphibious plus 2 USMC Battalion Landing) operations per year.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3 G-M-4 AVMC-M-2 AVMC-M-3 AVMC-M-5 AVMC-M-6 AVMC-M-7 AVMC-M-8 INL-M-1 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-6 (continued). Occurrence of Island Night Lizard (INL) Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
Old Rifle Range AVMA	INL Medium density habitat: 137.2 ac (2.3% of SCI total) Lowest density habitat: 0.5 ac (<1% of SCI total) Estimated population in 137.2 ac of MDS Lycium is 107,428 individuals, based on average density of 783 individuals/acre (DoN 2005, based on data from Mautz 2000). 0.5 ac of lowest density habitat would be expected to support about 231 additional individuals.	Tracked vehicles would degrade MDS Lycium habitat and grassland by causing a reduction in shrub (boxthorn) cover with a concomitant reduction of thermal cover and suitability for INL. Some mortality of individuals is likely but probably not observable. Take would include degradation of 143 ac of habitat expected to lead to reduced reproduction of breeding adults and reduced survivorship of non-breeding individuals in that habitat. This would be a long term effect but less than significant impact because of the small effect on the overall population (< 2.5% of the medium density and lowest density habitat on SCI). Designation of the AVMA is part of Alternatives 1 and 2. Alternative 1. The AVMA could be used by tracked vehicles during approximately 43 (42 USMC Amphibious plus 1 USMC Battalion Landing) operations per year. Alternative 2. The AVMA could be used by tracked vehicles during approximately 63 (61 USMC Amphibious plus 2 USMC Battalion Landing) operations per year.	Applicable Mitigation Measures as listed for NALF AVMA (above). No Action: No Impact Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
VC-3 AVMA	INL Low density habitat: 2.6 ac (0.2% of SCI total) Lowest density habitat: 275.5 ac (2.3% of SCI total) Estimated population in 275.5 ac of grassland habitat is 127,281 individuals, based on average density of 462 individuals/acre; 2.6 ac of MDS Cholla-Prickly Pear habitat would be expected to support about 1,498 additional individuals based on an average estimated density of 576 individuals/acre (DoN 2005, based on data from Mautz 2000).	Tracked vehicles would degrade MDS Cholla-Prickly Pear and grassland habitat by causing a reduction in vegetation cover with a concomitant reduction of thermal cover and suitability for INL. Some mortality of individuals is likely but probably not observable. Take would include degradation of 278 ac of habitat leading to reduced reproduction of breeding adults and reduced survivorship of non-breeding individuals in that habitat. This would be a long term effect but less than significant impact because of the small effect on the overall population (< 2.5% of the medium and lowest density habitat on SCI). Designation of the AVMA is part of Alternatives 1 and 2. Alternative 1. The AVMA could be used by tracked vehicles during approximately 43 (42 USMC Amphibious plus 1 USMC Battalion Landing) operations per year. Alternative 2. The AVMA could be used by tracked vehicles during approximately 63 (61 USMC Amphibious plus 2 USMC Battalion Landing) operations per year.	Applicable Mitigation Measures as listed for NALF AVMA (above). No Action: No Impact Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Old Rifle Range (ORR) AMP	INL Medium density habitat: 4.7 ac (<0.08% of SCI total). Estimated population in 4.7 ac of MDS Lycium is 3,680 individuals, based on average density of 783 individuals/acre (DoN 2005, based on data from Mautz 2000).	Vehicular activity would probably result in degradation of habitat, including reduction of thermal cover, possibly leading to a measurable reduction in population size in the affected area due to habitat degradation. Mortality of individual INLs may also result from vehicular activity. Take would include degradation of 4.7 ac of medium density INL habitat and reduction of carrying capacity for INL. Designation of the AMP is part of Alternatives 1 and 2. Alternative 1: Artillery maneuvering during 3-day exercises up to 6 times per year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering during 3-day exercises up to 8 times per year plus 2 USMC Battalion Landings.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3 G-M-4 AVMC-M-2 AVMC-M-3

Table D-6 (continued). Occurrence of Island Night Lizard (INL) Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
			AVMC-M-5 AVMC-M-6 AVMC-M-7 AVMC-M-8 INL-M-1 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Self Help AMP	INL Lowest density habitat: 3.4 ac (<0.01% of Island total). Estimated population in 3.4 ac of grassland is 1,571 individuals, based on average density of 462 individuals/acre for grassland habitat (DoN 2005, based on data from Mautz 2000).	Vehicular activity would probably result in degradation of habitat, including reduction of thermal cover, possibly leading to a measurable reduction in population size in the affected area due to habitat degradation. Mortality of individual INLs may also result from vehicular activity. Take includes degradation of 3.4 ac of lowest density INL habitat and reduction of carrying capacity for INL. Grassland, because it is dominated by weedy annual species, would be expected to recover rapidly after cessation of disturbance, compared to habitats dominated by native shrubs such as boxthorn. Designation of the AMP is part of Alternatives 1 and 2. Alternative 1: Artillery maneuvering during 3-day exercises up to 6 times per year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering during 3-day exercises up to 8 times per year plus 2 USMC Battalion Landings.	Applicable Mitigation Measures as listed for Old Rifle Range (ORR) AMP (above). No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Old Airfield AMP	INL Lowest density habitat: 2.3 ac (<0.02% of SCI total). Estimated population in 2.3 ac of grassland habitat is 1,063 individuals, based on average density of 462 individuals/acre (DoN 2005, based on data from Mautz 2000).	Vehicular activity would probably result in degradation of habitat, including reduction of thermal cover, possibly leading to a measurable reduction in population size in the affected area due to habitat degradation. Mortality of individual INLs may also result from vehicular activity. Take includes degradation of 2.3 ac of lowest density INL habitat and reduction of carrying capacity for INL. Grassland, because it is dominated by weedy annual species, would be expected to recover rapidly after cessation of disturbance, compared to habitats dominated by native shrubs such as boxthorn. Designation of the AMP is part of Alternatives 1 and 2. Alternative 1: Artillery maneuvering during 3-day exercises up to 6 times per year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering during 3-day exercises up to 8 times per year plus 2 USMC Battalion Landings.	Applicable Mitigation Measures as listed for Old Rifle Range (ORR) AMP (above). No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-6 (continued). Occurrence of Island Night Lizard (INL) Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
AFP-1	INL Low density habitat: 34.1 ac (2.2% of Island total). Estimated population in 34.1 ac of MDS Prickly Pear-Cholla is 19,642 individuals, based on an average density of 576 individuals/acre for MDS Prickly Pear-Cholla habitat (DoN 2005, based on data from Mautz 2000).	Vehicular activity would result in degradation of habitat, including reduction of thermal cover, possibly leading to a measurable reduction in population size in the affected area due to habitat degradation. Mortality of individual INLs may also result from vehicular activity. Take would include degradation of about 34 ac of low density INL habitat leading to reduced reproduction of breeding adults and reduced survivorship of non-breeding individuals in that habitat and a probable reduction in carrying capacity of the habitat. This is a long term effect but less than significant impact because of the small effect on the overall population (~2.2% of the low density habitat on SCI). INL would be expected to survive on the site but at lower population level. 5 operations per year from this general area. .Designation of this AFP is included in Alternatives 1 and 2. Alternative 1. Artillery maneuvering during 3-day USMC artillery exercises up to 6 times per year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering during 3-day USMC artillery exercises up to 8 times per year plus 2 USMC Battalion Landings.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3, G-M-4 G-M-8, G-M-9 AVMC-M-2 AVMC-M-3 AVMC-M-5 AVMC-M-7 AVMC-M-8 INL-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2. Impacts would be less than significant with mitigation.
AFP-6	INL Lowest density habitat: 123.3 ac (1.0% of Island total) Estimated population in 3.6 ac of MDS Prickly Pear-Cholla is 56,978 individuals, based on average density of 462 individuals/acre for grassland habitat (DoN 2005, based on data from Mautz 2000).	Vehicular activity would probably result in degradation of the grassland habitat, including reduction of thermal cover, possibly leading to a measurable reduction in population size in the affected area due to habitat degradation. Mortality of individual INLs may also result from vehicular activity. Take would include degradation of 123.3 ac of lowest density INL habitat leading to reduced reproduction of breeding adults and reduced survivorship of non-breeding individuals in that habitat and a probable reduction in carrying capacity of the habitat. This would be a long term effect but less than significant impact because of the small effect on the overall population (~1% of the lowest density habitat on SCI). INL would be expected to survive on the site but at lower population level. This site was not included in the No Action Alternative. Designation of this AFP is included in Alternatives 1 and 2. Alternative 1. Artillery maneuvering during 3-day USMC artillery exercises up to 6 times per year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering during 3-day USMC artillery exercises up to 8 times per year plus 2 USMC Battalion Landings.	Applicable Mitigation Measures as listed for AFP-1 (above). No Action: No impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 4—Whale	INL	Continued operations, including ordnance use, fire, and foot traffic, outside of developed	Implementation of the SCI Wildland Fire

Table D-6 (continued). Occurrence of Island Night Lizard (INL) Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
Point/Castle Rock	Medium density habitat: 11.7 ac (0.20% of SCI total). An additional 119.1 acres of medium density habitat are in the action area. Estimated population in 11.7 ac of MDS Lycium is 9,161 individuals, based on average density of 783 individuals/acre for MDS Lycium habitat (DoN 2005, based on data from Mautz 2000), with an additional 93,255 individuals in the action area.	facilities in this established TAR would be expected to lead to some reduced reproduction of breeding adults and reduced survivorship of non-breeding individuals as well as some direct mortality in heavily used portions of the habitat. Effect on population levels may not be detectable. The anticipated effects of operations on INL at this TAR would be long-term but less than significant because of the small effect on the overall population (~0.1% of the medium density INL habitat on SCI). This TAR was previously established. Baseline use = 222 ops/yr. Alternative 1: 240 ops/yr. Alternative 2: 300 ops/yr.	Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3 G-M-4 INL-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 10—Demolition Range West	INL Medium density habitat: 25.3 ac (0.43% of SCI total) An additional 9.0, 156.2 and 7.2 ac of lowest, medium, and high density habitat, respectively, are within the action area. Estimated population in 25.3 ac of MDS Lycium is 19,810 individuals, based on average density of 783 individuals/acre for MDS Lycium habitat (DoN 2005, based on data from Mautz 2000). 9.0, 156.2 and 7.2 ac of lowest, medium, and high density habitat would respectively be expected to support 4,158; 122,305; and 7,459 individuals.	Approximately 0.25 acres of habitat would be affected by construction, demolitions, or concentrated foot traffic. Take would include loss or degradation of 1.5 acres of habitat affected by construction, demolitions, or concentrated foot traffic, which would be expected to lead to reduced reproduction of breeding adults and reduced survivorship of non-breeding individuals in that habitat. Effect on population levels may not be detectable. The loss or degradation of habitat at this TAR would be a long term effect but less than significant (NEPA) because of the small effect on the overall population (< 0.5% of the medium density INL habitat on SCI). Baseline use = 3 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 20ops/yr. Alternative 2: 20 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3 G-M-4 INL-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-6 (continued). Occurrence of Island Night Lizard (INL) Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 17— Eel Point Tactical Training Range	INL Medium density habitat 7.2 ac (0.1% of SCI total); action area contains an additional 53.6 ac of medium density habitat and 35.8 ac of high density habitat. Estimated population in 7.2 ac of MDS Lycium is 5638 individuals, based on average density of 783 individuals/acre for MDS Lycium habitat (DoN 2005, based on data from Mautz 2000). Additional 53.6 ac of medium density habitat and 35.8 ac of high density habitat would respectively be expected to support 41,969 and 37,088 individuals.	Assuming that approximately 0.5 ac of habitat outside of existing disturbed areas would be affected by training operations, especially concentrated foot traffic, take would include loss or degradation of 0.5 ac of habitat expected to lead to reduced reproduction of breeding adults and reduced survivorship of non-breeding individuals in that habitat. Effect on population levels may not be detectable. The loss or degradation of habitat at this TAR would be a long term effect but less than significant (NEPA) because of the small effect on the overall population (~ 0.1% of the medium density INL habitat on SCI). Baseline use = 15 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 31 ops/yr. Alternative 2: 40 ops/yr.	Applicable Mitigation Measures as listed for TAR--10 (above). No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-6 (continued). Occurrence of Island Night Lizard (INL) Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 21—Horse Beach Cove Training Area	INL Medium density habitat: 80.3 ac (1.4% of SCI total medium density habitat). Action area contains an additional 172.6 ac (~3% of SCI total). Estimated population in 80.3 ac of MDS Lycium is 62,875 individuals, based on average density of 783 individuals/acre for MDS Lycium habitat (DoN 2005, based on data from Mautz 2000). Additional 172.6 ac of medium density habitat in action area would be expected to support 135,146 individuals.	Assuming that approximately 1 ac of habitat outside of existing disturbed areas would be directly affected by training operations, especially concentrated foot traffic, take would include loss or degradation of 1 ac of habitat expected to lead to reduced reproduction of breeding adults and reduced survivorship of non-breeding individuals in that habitat. Additionally fire would be expected to affect habitat and thermal cover. INL have been demonstrated to survive fire, even repeated fires. Effect on population levels may not be detectable unless sampling effort is intensive. The loss or degradation of habitat at this TAR would be a long term effect but less than significant (NEPA) because of the small effect on the overall population (~ 1.4% of the medium density INL habitat on SCI). Baseline use = 79 ops/yr. ((This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.). Alternative 1: 91 ops/yr. including 81 NSW, 10 USMC Amphibious and 1 USMC Battalion Landing. Alternative 2: 102 ops/yr. including 90 NSW, 10 USMC Amphibious and 2 USMC Battalion Landing.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-2* G-M-3* G-M-4 G-M-6* G-M-7 G-M-8 G-M-9 AVMC-M-2* AVMC-M-3* AVMC-M-4 AVMC-M-5 AVMC-M-6* AVMC-M-7 AVMC-M-10 INL-M-1* *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-6 (continued). Occurrence of Island Night Lizard (INL) Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 22—China Cove Training Area	INL Medium density habitat: 229.6 ac (3.9% of SCI total medium density habitat). Action area contains an additional 218 ac (3.7% of SCI total). Estimated population in 229.6 ac of MDS Lycium is 179,777 individuals, based on average density of 783 individuals/acre for MDS Lycium habitat (DoN 2005, based on data from Mautz 2000). Additional 218 ac of medium density habitat in action area would be expected to support an additional 170,694 individuals.	Existing patterns of habitat disturbance from activities of small groups on foot, demolitions, small arms use, and fire would be expected to continue, given the long history of similar use and impact of heavy ordnance in overlapping Impact Area II. No observable effect on the population would be expected from continued uses and impacts on the species are less than significant, given the demonstrated continuance of the population despite historic and ongoing use and the low proportion of the SCI total habitat exposed in TAR 22. Baseline use = 96 ops/yr including 33 NSW ops/yr. and 63 Non-NSW Naval ops/yr. (This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.) Alternative 1: 200 ops/yr. including 33 NSW, 6 USMC Amphibious, 1 USMC Battalion Landing and 160 other naval operations. Alternative 2: 220 ops/yr. including 40 NSW, 16 USMC Amphibious, 2 USMC Battalion Landing and 162 other naval operations. (Other naval operations include naval artillery and delivery of air-to-ground ordnance into overlapping Impact Area II and IIA , which are covered under Impact Area II).	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-2 G-M-3* G-M-4, G-M-7, G-M-8, G-M-9 INL-M-1* *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Infantry Operations Area	INL High density habitat: 179.6 ac (2.4% of SCI total high density habitat) Medium density habitat: 311.1 ac (5.4% of SCI total medium density habitat) Low density habitat: 435.6 ac (29.6% of SCI total low density habitat) Lowest density habitat: 6,351.6 ac (53.7% of SCI total lowest density habitat) Estimated population in 179.6 ac of MDS prickly pear is 186,066 individuals, based on average density of 1036 individuals/acre for MDS prickly pear habitat (DoN 2005, based on data from	Although it is possible that individual lizards under cover could be injured by foot traffic this would be an infrequent event and there would be no observable effect on the population. Establishment and spread of invasive species in the IOA from foot traffic may occur but effects on INL would depend on the characteristics of the species that establish, their growth habitats and growth forms, and their effect on the habitat including other plant species. No Action: Battalion-sized landings have occurred on SCI in the past, but are not considered part of the baseline. Foot traffic by individuals and groups is permitted within the IOA and elsewhere on the Island under the No Action Alternative. Alternative 1: 1 USMC Battalion-sized landing per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road. Alternative 2: 2 USMC Battalion-sized landings per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3 G-M-4 G-M-8 G-M-9 INL-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less

Table D-6 (continued). Occurrence of Island Night Lizard (INL) Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
	Mautz 2000). Estimated populations for 314.5 areas of medium density, 447.8 areas of low density, and 6,351.6 areas of lowest density would, respectively, be expected to support 246,254; 257,933; and 2,934,439 individuals.		than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Notes:

1. Population density categorizations (high density, medium density, low density, and lowest density) are based on population density figures in DoN (2005) based on data of Mautz (2000) and relate to vegetation classification and mapping by Sward and Cohen (1980). Under "amount of resource", resources (e.g., acres of habitat) occurring in overlapping operations areas are reported for each of the overlapping areas (e.g., Impact Area I and TAR 21), enabling the effects of the differing operations in the overlapping areas to be assessed.
2. Impact significance conclusion is based on discussion in "Description of Impacts" column and is assessed assuming application of mitigation measures identified in this document.
3. Impact significance assessment assumes mitigation for Alternatives 1 and 2.

Table D-7. Occurrence of San Clemente Loggerhead Shrike Within or Near Individual Operations Areas on SCI, Description of Potential Impacts of Existing and Proposed Operations, and Impact Significance. Evaluation of Impact Significance for the No Action Alternative is Based on Comparison with the Baseline.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
IMPACT AREA I	2007: Two of 66 nest sites on SCI (3.0% of SCI total) 2001-2007: Nine of 375 nesting records on SCI (2.4% of SCI total) Five additional nest sites used between 2001 and 2007 are located outside but within 500 ft of the Impact Area I boundary (on the western boundary). Wintering birds also present. Nest locations used during 2001-2007 are present in upper and lower Horse Beach Canyon. The three nest sites used between 2001 to 2005 within Impact Area I represent <5% of Island total during same period and have typical records of reproductive success for shrikes on SCI. Nest site HB2 (used in 2005) successfully fledged young. HB4 (used in 2003) was unsuccessful. HB1, near the northwestern corner of Impact Area I successfully fledged young in 3 of 4 seasons between 2001 and 2005.	Nest sites used since 2000 are located in Horse Beach Canyon along the western boundary of Impact Area I, away from targets and 1 km or more up canyon from the beach. The next sites used during 2007 are in upper Horse Beach Canyon at the northern boundary of Impact Area I. Potential for direct hits by ordnance is very low due to distance from targets and topographic shielding. Impact Area I receives about 6 % of the large ordnance incoming to SHOBA (the remainder goes to Impact Area II including Impact Area IIA). Existing large ordnance use and increases associated with Alternatives 1 and 2 are summarized under Vegetation in Table D-1. There is some exposure to impact noise, flares, and potential fires. Potential for injury or death resulting from direct hit or near miss is so unlikely as to be discountable. There is some potential for take of individuals or damage to essential habitat elements due to possible adverse effects from fire on nest trees or possible adverse response by individual shrikes to visual and noise effects associated with NSFS and CAS in the vicinity. Any reasonably foreseeable take under No Action and both alternatives would affect <<5% of the population, would average less than one individual per year, and would not likely be measurable. Implementation of the Navy Access Policy applying to Impact Areas I and II and TARS 20, 21, and 22 will preclude future direct monitoring of this endangered plant species and its habitat in these locations. Effects of existing and proposed operations are less than significant due to the unlikelihood of direct hit or near miss, infrequency of direct effect on habitat or individuals (e.g., by fire), the reproductive success of nearby pairs exposed to existing uses of the Impact Area, and the very small proportion of the population in proximity to the Impact Area.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-2* G-M-3* G-M-4 G-M-5 G-M-6* G-M-7 G-M-8 G-M-9 SCLS-M-1* *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-7 (continued). Occurrence of San Clemente Loggerhead Shrike Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
IMPACT AREA II	2007: One of 66 nest sites (1.5% of SCI total) 2001-2007: Ten of 375 nest sites (2.7% of SCI total) Two additional nest sites used between 2001 and 2007 are located outside but within 500 ft of the Impact Area II boundary. Wintering birds also present including males that remain around their breeding territories. Nest sites used during 2001-2007 are located in China Canyon, with one site used in 2005 at the NW edge of TAR 22 in Red Canyon. The Red Canyon site was not monitored because of its location adjacent to a target in the middle of the Impact Area (and < 200 m from the NW corner of Impact Area IIA). Other nesting territories in Impact Area II used in one or more years between 2001 and 2005 have had success in years when nesting occurred. These are China 11 (2/2), China 8 (3/3), China 3 (2/2). Nests at China 8 in 1999 and at China 3 in 1997 and 1998 were unsuccessful. Years 1997 and 1998 had generally poor nesting success throughout the San Clemente loggerhead strike population.	Nest sites used since 2001 in Impact Area II are located in Red Canyon, near the center of Impact Area II, and in China Canyon along the eastern boundary of Impact Area II. The nest site in Red Canyon was discovered in 2005 and is in very close proximity to two targets (approximately 175 m from the location of the nearer of the two targets). The nearest target to a China Canyon nest site is about 750 m to the southwest. Potential for direct hits or near misses by ordnance at the Red Canyon site is relatively high due to the proximity of targets but is low at the China Canyon sites due to distance from targets and a certain amount of topographic shielding. There would be some exposure to impact noise, flares, and potential fires. Potential for injury or death resulting from direct hit or near miss is discountable except at Red Canyon, given proximity of that site to targets. At Red Canyon, should that nest site be reoccupied in the future, the potential for take is higher, ranging from behavioral response leading to harm, to injury or death of an individual or loss of a clutch or nestlings. Existing large ordnance use and increases associated with Alternatives 1 and 2 are summarized under Vegetation in Table D-1. There is some additional potential for take of individuals or damage to essential habitat elements due to possible adverse effects from fire on nest trees or adverse response to visual and noise effects associated with NSFS and air-to-ground bombardment in the vicinity. Any reasonably foreseeable take under No Action and both alternatives would affect <<5% of the population, would probably average less than one individual per year, and would not likely be measurable in most years. Implementation of the Navy Access Policy applying to Impact Areas I and II and TARS 20, 21, and 22 will preclude future direct monitoring of this endangered plant species and its habitat in these locations. Effects of existing and proposed operations are less than significant due to the unlikelihood of direct hit or near miss, infrequency of direct effect on habitat or individuals (e.g., by fire), the reproductive success of nearby pairs, and the very small proportion of the population in proximity to the Impact Area.	Applicable conservation measures and Impact significance are as described for Impact Area I above.
VC-3 AVMA	2007: No nesting documented. 2001-2007: One of 375 nests documented during the period (0.3% of the SCI total). The one documented nest in this area was constructed in a building at VC-3 near Ridge Road at the southern edge of the AVMA during 2006. The first nesting attempt was depredated by a raven and the second is also believed to have been depredated.	Tracked vehicles would degrade habitat in the AVMA by causing a reduction in vegetation cover. Some of this habitat may be used by foraging shrikes from this one-time nest location. The likelihood of shrikes nesting here in the future is not known. The nest location at the edge of the AVMA would provide access to habitat outside the AVMA as well as within it. A nest at this location would be exposed to noise and activity of vehicles and personnel on Ridge Road and the AVMR. These disturbances would continue to affect this site in the future, which has also been used by wintering shrikes. Whatever the future use, this site represents a small fraction of the sites that have been used by shrikes for nesting in recent years. Designation of the AVMA is part of Alternatives 1 and 2. Alternative 1. The AVMA could be used by tracked vehicles during approximately 43 (42	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3 G-M-4 AVMC-M-2 AVMC-M-3

Table D-7 (continued). Occurrence of San Clemente Loggerhead Shrike Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		USMC Amphibious plus 1 USMC Battalion Landing) operations per year. Alternative 2. The AVMA could be used by tracked vehicles during approximately 63 (61 USMC Amphibious plus 2 USMC Battalion Landing) operations per year.	AVMC-M-5 AVMC-M-6 AVMC-M-7 AVMC-M-8 SCLS-M-1 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
AFP-1	Wintering only, nearest San Clemente loggerhead strike nest sites are about 4,000 m to the west in Horse Beach Canyon.	In the unlikely event that a shrike would be at the AFP during an operation in Alternative 1 or 2, it would be expected to be unaffected or to avoid the activity (Insignificant effect not reaching the level of "take"). There is a very low potential that artillery fired from this location could land in Horse Beach Canyon or China Canyon and directly affect San Clemente loggerhead strike or other listed species (potential so low as to be discountable). Nesting shrikes in Horse Beach and China Canyon are unlikely to be adversely affected by noise caused by live artillery and other weapons firing from this position and would be out of the line of sight of this AFP and impact areas due to their typical location in canyon bottoms (insignificant effect not reaching the level of take). Designation of this AFP is included in Alternatives 1 and 2. Artillery has been historically fired from this general area into SHOBA. Alternative 1. Artillery maneuvering during 3-day USMC artillery exercises up to 6 times per year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering during 3-day USMC artillery exercises up to 8 times per year plus 2 USMC Battalion Landings.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3 G-M-4 G-M-5 G-M-6, G-M-8, G-M-9 AVMC-M-2 AVMC-M-3 AVMC-M-4 AVMC-M-5 AVMC-M-9 SCLS-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
AFP-6	Wintering only, nearest San Clemente loggerhead strike nest sites are approximately 400 m to the north in Eagle	In the unlikely event that a shrike would be at the AFP during an operation in Alternative 1 or 2, it would be expected to be unaffected or to avoid the activity (Insignificant effect not reaching the level of "take"). There is a very low potential that artillery fired from this location	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1

Table D-7 (continued). Occurrence of San Clemente Loggerhead Shrike Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
	Canyon and 700 m to the west in Cave Canyon. Firing would be toward Impact Area II (south-southeast of the AFP).	toward Impact Area IIA could directly affect San Clemente loggerhead strike or other listed species (potential so low as to be discountable). Nesting shrikes in Cave and Eagle Canyons are within 400 to 800 m of the AFP, but are at lower elevation and topographically shielded from the AFP site. They would be exposed to noise from the artillery firing but would be out of the line of sight from the AFP and out of the line of fire, as well. The noise levels at these sites would be difficult to predict, given the topographic factors, but there would be no visual or other accompaniments to the firing and some habituation to artillery noise would be expected as a result of regular exposure to more distant naval artillery without any accompanying threat. Exposure to the artillery noise would happen up to 7 to 10 times per year, with Alternatives 1 and 2, respectively. Baseline use: Designation of this AFP is included in Alternatives 1 and 2. Alternative 1. Artillery maneuvering and firing during 3-day USMC artillery exercises up to 6 times per year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering and firing during 3-day USMC artillery exercises up to 8 times per year plus 2 USMC Battalion Landings.	and Alternative 2. G-M-1 G-M-2 G-M-3 G-M-4 G-M-5 G-M-6, G-M-8, G-M-9 AVMC-M-2 AVMC-M-3 AVMC-M-4 AVMC-M-5 AVMC-M-9 SCLS-M-1 SCLS-M-2 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 15	2007: No nesting documented. 2001-2007: One of 375 nests documented during the period (0.3% of the SCI total). The one documented nest in this area was constructed in a building at VC-3 near Ridge Road at the southern edge of the AVMA during 2006. The first nesting attempt was depredated by a raven and the second is also believed to have been depredated. This is the same nest discussed above under the VC-3 AVMA, which overlaps TAR -15 at this location.	Low effects on habitat associated with infrequent foot traffic by small groups near this one-time nesting location. There is some likelihood of disturbance of nesting shrikes at this location by noise of simulated weapons and human activity if a nearby location is chosen as an objective for NSW training. The likelihood of future nesting at this location is unknown. Likelihood of direct effects on a bird or nest is so low as to be discountable given the fact that all live fire on TAR 15 would be directed toward the east (away from the buildings on site and away from the SCLS nest site. Fire effects would be less than significant in the annual grassland foraging habitat. The increase in operations with Alternatives 1 and 2 would incrementally increase the potential for fire or disturbance around a nest but impacts would be less than significant with mitigation. Baseline use = 20 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 25 ops/yr. Alternative 2: 94 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3 G-M-4 G-M-5 G-M-6 TAR-M-1 SCLS-M-1 No Action: Impacts are less than significant.

Table D-7 (continued). Occurrence of San Clemente Loggerhead Shrike Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
			Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 21—Horse Beach Cove Training Area and Horse Beach Cove Amphibious Landing and Embarkation Area	Wintering only (documented); a breeding site used unsuccessfully in 2003 (HB4) is located about 500 m up the canyon from the TAR boundary; a breeding site used successfully in 2005 (HB2) is located over 800 m from the TAR boundary. These two nest sites represent < 1% of the nest sites used by San Clemente loggerhead strike on SCI between 2001 and 2005.	TAR 21-In the event that a wintering or foraging shrike would be at TAR 21 during an operation, it would be expected to be unaffected or to avoid the activity (Insignificant effect not reaching the level of "take"). Nesting locations used in 2003 and 2005 would be visually and topographically screened from TAR 21, minimizing disturbance of San Clemente loggerhead strike from activities within the TAR. A fire originating from activities within the TAR, including ship to shore weapons fire, could burn up canyon affecting shrike breeding habitat and, depending on the timing, could affect breeding shrikes. The general areas up canyon from TAR 21 have burned 1-3 times between 1979 and about 2000 (SCI INRMP, DoN 2002). Fires would be unlikely to spread far beyond the TAR boundary in an up-canyon direction because of the low elevational gradient of the lower canyon coupled with the direction of prevailing NW or NE winds under high and very high FDRS (DoN 2006), which would be opposed to spreading of fire in an up-canyon direction. The two San Clemente loggerhead strike territories in lower Horse Beach Canyon that have been occupied between 2001 and 2005 (HB2 and HB4-see additional information in column to left) represent <1% of the nesting sites occupied by San Clemente loggerhead strike during that period. Horse Beach Cove Amphibious Landing and Embarkation Area- A wintering or foraging shrike present at Horse Beach Cove during an amphibious landing or embarkation would be expected to be unaffected or to avoid the activity (Insignificant effect not reaching the level of "take"). Nesting locations used in 2003 and 2005 would be visually and topographically screened from the landing/embarkation site, minimizing disturbance of San Clemente loggerhead strike from activities at the landing site (Insignificant effect not reaching the level of "take"). The potential for fire to burn upcanyon from the landing site to areas where shrikes have nested in the past 5 years is very low as discussed above under TAR 21 and supported by analysis in the FMP BA (DoN 2006). Baseline use = 79 ops/yr. ((This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.) Alternative 1: 91 ops/yr. including 81 NSW, 10 USMC Amphibious and 1 USMC Battalion Landing. Alternative 2: 102 ops/yr. including 90 NSW, 10 USMC Amphibious and 2 USMC Battalion Landing.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-2* G-M-3* G-M-4 G-M-5 G-M-6*, G-M-7, G-M-8, G-M--9 SCLS-M-1* Horse Beach Cove Amphibious Landing and Embarkation Area Same as TAR 21 plus AVMC-M-2* AVMC-M-3* AVMC-M-4 AVMC-M-5 AVMC-M-6* AVMC-M-7 AVMC-M-10 *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less

Table D-7 (continued). Occurrence of San Clemente Loggerhead Shrike Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
			than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 22—China Cove Training Area	One nest on NW boundary of the TAR in Red Canyon was active in 2005 but success not known. TAR 22 and vicinity is a documented wintering location. The next nearest nest site (CH 11) is located in China Canyon about 500 m north of the TAR 22 boundary. It was used twice since 2001 and was successful in both years (2004 and 2005) The next nearest nest site (CH 8) was successful in 3 of 4 years with nesting attempts since 2001.	See Discussion above under Impact Area II which overlaps TAR 22. NSW activities in TAR 22 are not expected to be concentrated near the nest site in Red Canyon that was active in 2005 but not known to be active during 2006. This is the only nesting documented within or near TAR 22 in recent years (see discussion above under Impact Area II). In the event that a wintering shrike would be at TAR 22 during an operation, it would be expected to be unaffected or to avoid the activity (Insignificant effect not reaching the level of "take"). Effects of existing operations are less than significant due to the unlikelihood of direct hit or near miss, infrequency of direct effect on habitat or individuals (e.g., by fire), the reproductive success of nearby pairs, and the very small proportion of the population in proximity to the TAR. The near doubling of activity in the TAR associated with Alternatives 1 and 2 including increases in heavy ordnance use in overlapping Impact Areas II and IIA would make some level of take increasingly likely compared to under the No Action Alternative, but impacts would be less than significant because of the low percentage of the shrike population exposed to operations in this area. Baseline use = 96 ops/yr including 33 NSW ops/yr. and 63 Non-NSW Naval ops/yr. (This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.) Alternative 1: 200 ops/yr. including 33 NSW, 6 USMC Amphibious, 1 USMC Battalion Landing and 160 other naval operations. Alternative 2: 220 ops/yr. including 40 NSW, 16 USMC Amphibious, 2 USMC Battalion Landing and 162 other naval operations. (Other naval operations include naval artillery and delivery of air-to-ground ordnance into overlapping Impact Area II and IIA, which are covered under Impact Area II).	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-2* G-M-3* G-M-4 G-M-5 G-M-6*, G-M-7, G-M-8, G-M-9 SCLS-M-1* *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Infantry Operations Area	Nesting and wintering. 2007: 0 of 66 documented nest locations on SCI (0% of SCI total locations) were in the Infantry Operations Area. Between 2001 and 2007: 16 of 375 documented nest site locations were within the Infantry Operations Area (4.3% SCI total locations).	In the event that a wintering shrike would be in the vicinity of advancing Marines in the IOA during an operation, it would be expected to be unaffected or to avoid the activity (Insignificant effect not reaching the level of "take"). During the breeding season, approaching Marines could cause nesting adults to temporarily fly away from the nest, returning momentarily after the personnel have passed. This would be a brief exposure because the Marines would normally be spaced apart in formation perpendicular to the direction of travel. Many variables come into play in determining whether this would represent an adverse effect. Direct injury or harassment of adults is so unlikely as to be discountable. Some potential for injury or mortality to nestlings is possible, but unlikely given the brief duration of the proximity to the nest of a human walking by and the low likelihood of	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3 G-M-4

Table D-7 (continued). Occurrence of San Clemente Loggerhead Shrike Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		a very close approach of a human to a nest. Under current levels of shrike nesting activity, about one nest (about 1.5% of the nesting population) per breeding season could be exposed to close approaching foot traffic within the Infantry Operations Area. Assuming that a reaction reaching the level of take happened in about 1 of 5 encounters, then take would represent 1 nesting attempt affected every 5 years or so. This would be a short-term effect on less than 5% of the breeding pairs and would not be expected to affect renesting of the pair. Impacts would be less than significant due to infrequency of the effect, small portion of the population affected, and temporary nature of the effect. Baseline use: Battalion-sized landings have occurred on SCI in the past, but are not considered part of the baseline. Foot traffic by individuals and groups is permitted within the IOA and elsewhere on the Island under the No Action Alternative. Alternative 1: 1 USMC Battalion-sized landing per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road. Alternative 2: 2 USMC Battalion-sized landings per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road.	G-M-5 G-M-6 G-M-8 G-M-9 AVMC-M-1 AVMC-M-2 AVMC-M-4 AVMC-M-6 AVMC-M-7 SCLS-M-1 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Note:

1. Documented nest locations and totals 2001-2005 from the SCI GIS, based on annual monitoring studies. Under “amount of resource”, resources (e.g., nest sites used during different years) occurring in overlapping operations areas are reported for each of the overlapping areas (e.g., Impact Area I and TAR 21), enabling the effects of the differing operations in the overlapping areas to be assessed.
2. Impact significance conclusion is based on discussion in “Description of Impacts” column and is assessed assuming application of mitigation measures identified in this document.
3. Impact significance assessment assumes mitigation for Alternatives 1 and 2.

Table D-8. Impacts on San Clemente Sage Sparrow Within Individual Operations Areas on SCI, Description of Potential Impacts of Existing and Proposed Operations, and Impact Significance. Evaluation of Impact Significance for the No Action Alternative is Based on Comparison with the Baseline.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
IMPACT AREA II	Low density habitat: 176.9 ac along lower terraces in the western part of the Impact Area. This is about 6.8% of the low density habitat mapped on SCI. Based on 1999-2007 average SCSS density for low density habitat (0.11 adults/ac), 177 ac would be expected to support about 19 adults (roughly 2% of the population); however, according to Turner et al. (2006), sightings have been very infrequent in this area, which is near the southern limit of the species range on SCI, and so the population is probably lower.	Any disturbance from ordnance impacts would be expected to continue as a result of continuing Naval Surface Fire Support, air strikes and close air support. This includes exposure to impact noise, flares, and potential fires. There is some potential for take of individuals or damage to essential habitat elements due to possible adverse effects from fire on MDS-Lycium habitat, which does not recover rapidly after fire, or from adverse behavioral response by individuals to visual and noise effects associated with NSFS and CAS in the vicinity. Some habituation to these exposures would be expected, reducing the chance of adverse behavioral response. Any reasonably foreseeable take under No Action, Alternative 1, or Alternative 2 would affect <<5% of the SCSS population and would probably average less than one individual per year. Impacts are expected to be less than significant (NEPA) because of the extended history of use of this site as an impact area for live ordnance, the small proportion of individuals and habitat potentially exposed to the effects. Existing levels of large ordnance associated with No Action, and projected increases associated in Alternatives 1 and 2 are presented in Table D-1.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-2* G-M-3* G-M-4 G-M-5 G-M-6*, G-M-8, G-M-9 SCSS-M-1* SCSS-M-2* *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-8 (continued). Impacts on San Clemente Sage Sparrow Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
Old Rifle Range AVMA	Low density habitat: 142.5 ac (5% of SCI total low density habitat) contiguous with low and medium density habitat along the western and northern edges of the AVMA. The ORR AVMA is contiguous with large blocks of low and medium density habitat along its western boundary. Based on 1999-2007 average for low density habitat (0.11 adults/acre), about 16 adults would be expected in the 142 ac of low density habitat on the ORR AVMA.	Tracked vehicle activity associated with Alternatives 1 and 2 is expected result in take through a reduction in shrub cover and other long-term changes in the habitat reducing or eliminating its suitability to SCSS. In addition to gradual loss of habitat value, low levels of additional take (up to 2 individuals or nests per year) in the form of possible loss of eggs or nestlings, nest failure, unintentional harassment, injury, or death of adults are anticipated from the activities of tracked vehicles in this area. Because of sloping terrain on the western side of the AVMA associated with drainage heads and between-terrace slopes there is the potential for off site effects on SCSS habitat caused by increased runoff from the AVMA. Designation of the AVMA is part of Alternatives 1 and 2. Alternative 1. The AVMA could be used by tracked vehicles during approximately 43 (42 USMC Amphibious plus 1 USMC Battalion Landing) operations per year.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3, G-M-4 G-M-5, G-M-6 AVMC-M-2 AVMC-M-3 AVMC-M-4; AVMC-M-5
		Alternative 2. The AVMA could be used by tracked vehicles during approximately 63 (61 USMC Amphibious plus 2 USMC Battalion Landing) operations per year.	AVMC-M-7 AVMC-M-7 AVMC-M-9 AVMC-M-10 SCSS-M-1 SCSS-M-2 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Old Rifle Range (ORR) AMP	Low density habitat: 15.05 ac (<0.6% of SCI total low density habitat). Contiguous with low density habitat in adjacent portions of the overlapping AVMA and along the western edge of the AMP.	Degradation of vegetation and soils from vehicular activity associated with Alternatives 1 and 2 leading to loss of shrub cover, especially boxthorn, expected to make the habitat on the site unsuitable for this species. Habitat on site is estimated to be capable of supporting about 1-2 adults. Take would include degradation of 15.05 ac of SCSS habitat and reduction in carrying capacity for SCSS. Designation of the AMP is part of Alternatives 1 and 2. Alternative 1. Artillery maneuvering during 3-day exercises up to 6 times per year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering during 3-day exercises up to 8 times per year plus 2 USMC Battalion Landings.	Applicable mitigation measures as identified above under Old Rifle Range AVMA. No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-8 (continued). Impacts on San Clemente Sage Sparrow Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 4--Whale Point/Castle Rock	Medium density habitat: 27.1 ac (1.6% of SCI total medium density habitat). TAR 4 is surrounded by medium density habitat with 110 additional acres of medium density habitat and 29.9 ac of low density habitat within 1,000 feet of the TAR. Based on 1999-2007 average for medium density habitat (0.21 adults/ac), about 6 adults would be expected in the 27.1 ac medium density habitat and about 26 additional adults expected in the medium and low density habitat within 1,000 feet of the TAR. The mean SCSS population size on the Island is 808 adults (1999-2007). TAR 4 plus the area within 1,000 feet includes 8.3% of the medium density habitat and 1.1% of the low density habitat on the island.	In the TAR 4 area, most of the area occupied by sage sparrows (>75%) is infrequently used for military training (Turner et al. 2005, page 50). Construction activities, accidental fires, demolitions, and other disturbances have been documented during 2003 and 2004, which have affected sage sparrow habitat and which, based on timing and location, may have a causal association with the disappearance of a marked adult and a nest failure (Turner et al. 2005). However, a comparison of population dynamics from a study plot at TAR 4 with other plots established on the island conducted by Beaudry et al. (2004) indicated that the study plot encompassing TAR 4 generally fell within the range of other plots with regard to most parameters measured, including percent of nest success (high), number of fledglings per nest (high), and percent of birds resighted on plot from 2002 (high) despite ongoing construction and military use since its establishment. Based on continued reproductive success of the sage sparrow population at TAR 4, impacts of baseline use at TAR 4 are less than significant under No Action. Impacts associated with Alternative 1 would be less than significant with mitigation, including implementation of the Wildland Fire Management Plan. Alternative 2 would have a substantial increase in operations at TAR 4 compared to No Action and Alternative 1; however, a large proportion of these operations would be at developed facilities in the TAR (e.g., the MOUT, the village site, and the rifle ranges) and would involve minimal exposure of sage sparrows or sage sparrow habitat to the activities. Baseline use = 212 ops/yr. This TAR has been previously established. Alternative 1: 230 ops/yr. Alternative 2: 300 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3 G-M-4 G-M-5 G-M-6 TAR-M-1 SCSS-M-1 SCSS-M-2 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 10—Demolition Range West	High density habitat 43.6 ac (4.7% of SCI total). Medium density habitat: 11.3 ac (0.7% of SCI total). TAR 10 is surrounded by medium and high density SCSS habitat with 101.3, 119.3, and 25.0 additional acres of high, medium and low density habitat, respectively, within 1,000 feet of the TAR. TAR 10 plus the area within 1,000 feet of the TAR contain 15.7%, 7.9% and <1% of SCI totals of high density, medium density, and low density habitat, respectively.	Noise from weapons and demolition, human activity, and helicopters could disturb SCSS especially when bonding and establishing nests (late January through March), early in the breeding season. Fire and invasive species spread could affect habitat. Development of two small range buildings on this site would occupy about 0.25 ac, assumed to be in previously disturbed habitat. The potential for fire carrying from this TAR into adjacent contiguous areas of high and medium density SCSS habitat has been identified as a key issue. The SCI Draft Wildland Fire Management Plan (DoN 2006) has a series of increasing precautions and fire suppression measures related to increasing fire danger ratings, including a fully equipped and staffed fire truck in the vicinity of the TAR within line of sight visibility of the TAR and action area and ability to be on scene and pumping water within 10 minutes of an ignition report whenever any type of incendiary ordnance is used (See Section 2.X). The Fire Plan notes the slow growth and recovery of boxthorn and places a priority on preventing short-interval recurrences of fire that might result in replacement of shrub-dominated native vegetation by grasses or weeds (type conversion). Impacts on habitat are less than significant as described in Table D-1. Monitoring of SCSS in the vicinity of TAR 4 during a period of training operations coupled with construction of the MOUT and related facilities has shown that the SCSS population there is healthy and comparable to other SCSS populations on the Island (as described above under TAR 4). Most of the	Applicable mitigation measures are as identified for TAR 4. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-8 (continued). Impacts on San Clemente Sage Sparrow Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		training activity and all of the demolition within TAR 10 would be in previously disturbed areas, so that effects on habitat would be less than significant. Based on the results of monitoring sage sparrow response to NSW training at TAR 4, it is assumed that low levels of take (up to 2 individuals per year) in the form of unintentional harassment of birds nesting in the area would occur but this would not likely be measurable because it is expected that population levels and reproductive parameters would remain with the range of other sage sparrows on SCI. Baseline use = 3 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 25 ops/yr. Alternative 2: 40 ops/yr.	
TAR 14—VC-3 Onshore Parachute Drop Zone “Twinky”	No SCSS habitat mapped within the TAR. TAR 14 lies approximately 1,500 feet or more to the east of SCSS low density habitat.	The nearest SCSS habitat lies about 1,500 feet from the western boundary of TAR 14 and effects on the SCSS population or habitat from activities in TAR 14 would be insignificant (effects on habitat) or so unlikely as to be discountable (injury, death, or harassment of an SCSS). All live-fire on TAR 14 is directed toward the east (away from the SCSS habitat). Modeling in the Fire Plan BA shows considerable spread of fire into SCSS habitat off site during NE winds and very high to extreme FDRS (Fire Danger Rating System) conditions (DoN 2006). A variety of precautions have been defined to be in effect under these conditions, including a standby fully-equipped wildland fire truck staffed with 3 wildland fire certified personnel whenever incendiary ordnance (e.g., flares) is to be used (SCI Wildland Fire Management Plan DoN 2005). Modeling in the Fire Management Plan BA indicates take of SCSS ranging from <1 to 4 individuals under different fire scenarios associated with fire originating on TAR 14. Impacts are less than significant because of the distance from the site to the habitat, the small fraction of the population and habitat that would be affected, the ability of the population to recover rapidly, and the likelihood that with implementation of the Fire Management Plan (FMP), fires would become smaller in extent, less frequent, and less likely to result in habitat type conversion. The increase in operations with Alternatives 1 and 2 would incrementally increase the potential for fire but impacts would be less than significant with mitigation. Baseline use = 20 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 30 ops/yr. Alternative 2: 68 ops/yr.	Applicable mitigation measures are as identified for TAR 4. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-8 (continued). Impacts on San Clemente Sage Sparrow Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 15—VC-3 Airfield Training Area	Low density habitat: 5.0 ac in the SW corner of the TAR (<0.2% of SCI total low density habitat). An additional 92.3 ac of low density habitat (3.5% of SCI total) extends from the SW corner of the TAR within 1,000 feet of the TAR.	Low effects on habitat by infrequent foot traffic by small groups. Likelihood of direct effects on a bird or nest is so low as to be discountable given the fact that all live-fire on TAR 15 is directed toward the east (away from the SCSS habitat); the out of the way location of the SCSS habitat in the extreme southwestern corner of the TAR; and the very small area of the habitat. Fire effects are possible under very high and extreme FDRS and NE winds only. Take in the event of a fire would be generally as described under TAR 14 and impacts would be less than significant as described under TAR 14. The increase in operations with Alternatives 1 and 2 would incrementally increase the potential for fire but impacts would be less than significant with mitigation. Baseline use = 20 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 25 ops/yr. Alternative 2: 94 ops/yr.	Applicable mitigation measures are as identified for TAR 4. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-8 (continued). Impacts on San Clemente Sage Sparrow Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 17—Eel Point Tactical Training Range	High density habitat: 11.9 ac within TAR 17 (1.3% of SCI total high density habitat). TAR 17 is surrounded by high and medium density SCSS habitat with 43.6 and 40.3 additional acres of high and medium density habitat, respectively, within 1,000 feet of the TAR. TAR 17 plus the area within 1,000 feet of the TAR contain 6.0% and 2.4% of SCI totals of high density and medium density habitat, respectively.	Noise from weapons and demolition, human activity, and helicopters could disturb SCSS especially when bonding and establishing nests (late January through March), early in the breeding season. Fire and invasive species spread could affect habitat. Small groups on foot traveling across country between TAR 17 and another location (e.g., TAR 14) have the potential to damage low boxthorn shrubs in areas of dense shrubs, vines, and cactus, despite stealthy foot travel using Tactical Environmental Movement. Contact or very close approach to a nest shrub could cause abandonment, although this would be statistically unlikely given the small number of people in an operation (12-15), use of Tactical Environmental Movement, the low density and dispersion of nests (ranging from 1 nest per 8, 14, or 27 ac, in high, medium, and low density habitat, respectively, based on densities of males between 1999-2005 and assuming 1 nest per male), and small number of operations conducted annually during the nesting season (< 5 expected mid-March through June for No Action, ~ 10 for Alternative 1, ~12 for Alternative 2). Proposed measures in the SCI Fire Plan to reduce frequency and extent of wildland fire discussed under TAR 10 would apply to TAR 17, reducing the chance of repeated fires that could lead to habitat type conversion. Monitoring of SCSS in the vicinity of TAR 4 during a period of training operations coupled with construction of the MOUT and related facilities has shown that the SCSS population there is healthy and comparable to other SCSS populations on the Island (as described above under TAR 4). Although much of the training activity and all of the demolition within TAR 17 would be in previously disturbed areas, it is assumed that take in the form of 0.5 ac of habitat loss or degradation is likely and a low level of additional take (up to 2 individuals per year) in the form of possible loss of eggs or nestlings, nest failure, unintentional harassment, injury, or death of adult individuals is anticipated. Baseline use = 15 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 31 ops/yr. Alternative 2: 40 ops/yr.	Applicable mitigation measures are as identified for TAR 4. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 22—China Cove Training Area	Low density habitat: 18.2 ac (~0.7% of SCI total), all of which is accounted for in Impact Area II. The area within 1,000 feet of the TAR contains 28.9 additional acres of low density habitat (1.1% of SCI total). Based on average densities for low density habitat between 1999 and 2006, 18.2 ac would be expected to support two adult SCSS and the area within 1,000 feet of	Based on the amount of habitat present, the exposed population of SCSS would be very low in TAR 22 (~ 2 individuals or less) with 3 individuals or less in nearby habitat. Noise from weapons and demolition, human activity, and overflight by helicopters, fixed wing attack aircraft, and small UAVs could disturb SCSS especially when bonding and establishing nests (from late January through March), early in the breeding season. The sparseness of the vegetation in TAR 22 minimizes the potential for damage to low boxthorn shrubs from platoon-sized movements on foot through SCSS habitat in TAR 22. Contact or very close approach to a nest shrub would be very unlikely given the improbability of there being a nest in the TAR, the small number of people in an operation (12-15), sparseness of the MDS-Lycium at this locality, and use of stealthy Tactical Environmental Movement. Fire and	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-2* G-M-3* G-M-4 G-M-5

Table D-8 (continued). Impacts on San Clemente Sage Sparrow Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
	the TAR would be expected to support about 3 adults. However, actual densities at this location near the southern limit of the species on SCI are probably lower. According to Turner et al. (2006), SCSS are sighted infrequently in the area south of Kinkipar Canyon (near the western boundary of Impact Area II) including Impact Area II and TAR 22.	invasive species spread could affect habitat. However, spread of wildland fire through the MDS-Lycium habitat in the TAR and adjacent impact area would be expected to occur slowly because of the sparseness of the vegetation and infrequency of conditions that would cause fire to spread up the coast in the direction of additional habitat. Insertion of SEALS would be primarily by boat or by swimming (vs. overland) minimizing the potential for introduction/spread of invasive species. Monitoring of SCSS in the vicinity of TAR 4 during a period of training operations coupled with construction of the MOUT and related facilities has shown that the SCSS population there is healthy and comparable to other SCSS populations on the Island (as described above under TAR 4). Because the training activity, including demolition within TAR 22, would be in previously disturbed areas, take of SCSS in the form of habitat loss or degradation is not anticipated with No Action, Alternative 1, or Alternative 2. Given the low size of the exposed population (~ 2 individuals or less in the TAR with an additional 3 individuals or less within1,000 feet of the TAR), additional take in the form of possible loss of eggs or nestlings, nest failure, unintentional harassment, injury, or death of adult individuals is expected to be very low (<1/year) and probably not observable for No Action and also for Alternative 1 and Alternative 2 due to the very low probability of impact. Impacts are less than significant. Baseline use = 96 ops/yr including 33 NSW ops/yr. and 63 Non-NSW Naval ops/yr. (This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.) Alternative 1: 200 ops/yr. including 33 NSW, 6 USMC Amphibious, 1 USMC Battalion Landing and 160 other naval operations. Alternative 2: 220 ops/yr. including 40 NSW, 16 USMC Amphibious, 2 USMC Battalion Landing and 162 other naval operations. (Other naval operations include naval artillery and delivery of air-to-ground ordnance into overlapping Impact Area II and IIA, which are covered under Impact Area II).	G-M-6* G-M-8 G-M-9 TAR-M-1* SCSS-M-1* SCSS-M-2 *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-8 (continued). Impacts on San Clemente Sage Sparrow Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
Infantry Operations Area	Low density habitat: 153.5 ac, about 6% of the SCI total low density habitat. Most (130.4 ac) of the SCSS habitat within the IOA is addressed above under the overlapping NALF AVMA, Old Rifle Range AVMA, the associated AMPs, and TAR 15.	Foot traffic in the IOA would occur during the USMC Battalion Landings which could occur once to twice per year in Alternatives 1 and 2, respectively. Marines walking through the area would normally be spread out more or less perpendicular to the direction of travel with about 5-m spacing between individuals. Where not overlapped by an AVMA or AMP, direct impacts on the shrub-dominated habitat in the IOA would be short term and minor given the infrequency of the operation. The peripheral location of the SCSS habitat to the IOA would probably reduce the chances that it would be walked through in any given operation. Individual SCSS, if present in the vicinity of advancing personnel during the operation, would be expected to be unaffected or to avoid the activity (insignificant effect not reaching the level of "take"). During the breeding season, approaching Marines could cause nesting adults to temporarily fly away from the nest, returning momentarily after the line of personnel has passed. Direct injury or harassment of adults is so unlikely as to be discountable. Some potential for injury or mortality to nestlings is possible, but unlikely given the brief duration that a human walking by would be in proximity of the nest and the low likelihood of a very close approach of a human to a nest. Under current levels of sage sparrow nesting activity, about one nest (less than 0.1% of the nesting population) per breeding season could be exposed to close approaching foot traffic within the Infantry Operations Area. [This is based on the low density and dispersion of nests (ranging from 1 nest per 8, 14, or 27 ac, in high, medium, and low density habitat, respectively, assuming observed densities of males between 1999-2005 and assuming 1 nest per male)]. Impact on SCSS from use of the IOA under Alternatives 1 and 2 would be less than significant because of the minimal nature of the potential exposure to foot traffic, the temporary and likely insignificant nature of any response, and the small portion of the population and habitat exposed. Baseline use: Battalion-sized landings have occurred on SCI in the past, but are not considered part of the baseline . Foot traffic by individuals and groups is permitted within the IOA and elsewhere on the Island under the No Action Alternative. Alternative 1: 1 USMC Battalion-sized landing per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road. Alternative 2: 2 USMC Battalion-sized landings per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-2 G-M-3 G-M-4 G-M-8 G-M-9 AVMC-M-2 AVMC-M-5 AVMC-M-7 SCSS-M-1 SCSS-M-2 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Note:

1. Population density figures by habitat density category are averages of density estimates in annual reports for 1999 through 2007. Under “amount of resource”, resources (e.g., acres of medium density habitat) occurring in overlapping operations areas are reported for each of the overlapping areas (e.g., Old Rifle Range AVMA, AMP B, Infantry Operations Area), enabling the effects of the differing operations in the overlapping areas to be assessed.
2. Impact significance conclusion is based on discussion in “Description of Impacts” column and is assessed assuming application of mitigation measures identified in this document.
3. Impact significance assessment assumes mitigation for Alternatives 1 and 2.

Table D-9. Occurrence of Western Snowy Plover Within or Near Individual Operations Areas on SCI, Description of Potential Impacts of Existing and Proposed Operations, and Impact Significance. Evaluation of Impact Significance for the No Action Alternative is Based on Comparison with the Baseline.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
IMPACT AREA I	21.1 ac (mostly where it overlaps TARs 20 and 21). SCI INRMP (DoN 2002) reported breeding attempts at Horse Beach Cove in 1997 (nest depredated) and 1998 ("probably hatched"). These are the most recent breeding attempts reported on SCI. Compared to elsewhere on SCI, Pyramid Cove consistently has had the highest numbers of wintering birds (15-25 individuals) on SCI while being used for NSFS, CAS and other training activities that are part of the baseline.	The beaches within Impact Area I are used by the western snowy plover primarily for winter foraging and roosting; plovers are generally absent during the breeding season months. Plovers may temporarily leave the affected area in response to noise or visual effects from ordnance use including flares during exercises such as FIREX or EFEX. See Table D-1 for a breakdown of heavy ordnance associated with No Action, Alternative 1 and Alternative 2. Likelihood of injury or mortality from ordnance hit in plover habitat is discountable. Effects of amphibious landings are addressed under Horse Beach Cove Amphibious Landing and Embarkation Area. Impact Area I receives < 6% of incoming large-caliber ordnance. Implementation of the Navy Access Policy applying to Impact Areas I and II and TARS 20, 21, and 22 will preclude future direct monitoring of this endangered plant species and its habitat in these locations.	G-M-1* G-M-2* G-M-3* G-M-4 G-M-5 G-M-7 G-M-8 *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant.
IMPACT AREA II	9.1 ac (mostly where it overlaps TAR 22). Used by wintering birds only.	The beaches within Impact Area II are used by the western snowy plover primarily for winter foraging and roosting; plovers are generally absent during the breeding season months. Bombardment is generally inland from the beach. Plovers may temporarily leave the affected area during NSFS exercises in response to noise or visual effects of ordnance use, including flares. The proposed increases in heavy ordnance associated with Alternatives I and 2 (see Table D-1) would not increase the likelihood of injury or mortality from an ordnance hit in plover habitat to a level above discountable or result in adverse behavioral response above that for ongoing activities. Implementation of the Navy Access Policy applying to Impact Areas I and II and TARS 20, 21, and 22 will preclude future direct monitoring of this endangered plant species and its habitat in these locations.	Applicable conservation measures and Impact significance are as described for Impact Area I above.

Table D-9 (continued). Occurrence of Western Snowy Plover Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
NALF AVMA	See TAR 5 below.	See discussion of amphibious landings and embarkation under TAR 5 which is overlapped by the NALF AVMA.	See TAR 5 and West Cove Landing and Embarkation Area (below).
TAR 3--BUD/S Beach Underwater Demolition Range	4.8 ac mapped within the TAR with an additional 7.9 ac within action area. Beach is used by small numbers of wintering plovers. No breeding has been documented at this site.	Plovers would be expected to be unaffected by the NSW activity or, if approached closely by a boat or personnel coming ashore, would be expected to move to another part of the beach and continue their activities (insignificant effect not reaching the level of "take"). Impacts are less than significant in No Action. Alternatives 1 and 2 would increase the number of operations and, therefore, the potential for impacts to plovers. Baseline use = 82 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2) Alternative 1: 82 ops/yr. Alternative 2: 95 NSW and 4 USMC Amphibious ops/yr.	G-M-1 G-M-2 G-M-3 G-M-4 G-M-5 G-M-6 WSP-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 5--West Cove Amphibious Assault Training Area and West Cove Landing and Embarkation area for NALF AVMA	0.8 ac mapped plus 3.4 ac where TAR 5 is overlapped by NALF AVMA. One nesting attempt with 1 chick documented in 1989, it is not known whether it fledged (SCI INRMP, DoN 2002). No other nesting attempts documented despite periodic monitoring in subsequent years. Used by small numbers (typically 5-10) of plovers during winter.	<u>TAR 5.</u> Most potential snowy plover nesting habitat at this site is subject to periodic inundation during high tides and frequented by predators such as domestic cat, island fox, and ravens making it largely unsuitable for nesting. Plovers would be expected to be unaffected by the increased NSW activity in Alternatives 1 and 2, or, if approached closely by a boat or personnel coming ashore, would be expected to move to another part of the beach and continue their activities (insignificant effect not reaching the level of "take"). <u>West Cove Landing and Embarkation Area.</u> Wintering snowy plovers would be expected to move to other parts of the beach or to another site during frequent landings and unloadings of LCACs and LCUs on the beach, as well as landings and transit of AAVs (and ultimately EFVs) across the beach. This is considered an insignificant effect and is not expected to reach the level of take. Baseline use = 10 ops/yr incl. 10 USMC Amphibious. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 25 ops/yr (incl. 17 USMC Amphibious). Alternative 2: 55 ops/yr (incl. 44 USMC Amphibious).	G-M-1 G-M-2 G-M-3 G-M-4 G-M-5 G-M-6 AVMC-M-9 WSP-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-9 (continued). Occurrence of Western Snowy Plover Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 20—Pyramid Cove Training Area	9.1 ac, all of which are accounted for under Impact Area I. Pyramid Cove Beach has generally had the largest number of wintering plovers on SCI (ranging from 10 to 20 during peak months) but was not monitored in 2004 or subsequently because of safety concerns related to unexploded ordnance (Lynn et al. 2005).	The beach at Pyramid Cove within and adjacent to Impact Area I is used by WSP primarily for winter foraging and roosting; plovers are generally absent during the breeding season months. Plovers may temporarily move from the affected area in response to noise or visual effects from daytime or nighttime operations during NSW exercises such as GUNEX or EFEX, in which landings by CRRC and ship to shore firing are involved. Impacts would be less than significant; likelihood of injury or mortality from ship to shore weapons fire in plover habitat is low, but possible, if it is not preceded by some type of stimulus to cause them to move from the area. Baseline use = 44 ops/yr. (This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.). Alternative 1: 50 ops/yr. Alternative 2: 60 ops/yr.	G-M-1* G-M-2* G-M-3* G-M-4 G-M-5 G-M-7 G-M-8 *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 21—Horse Beach Cove Training Area and Horse Beach Cove Amphibious Landing and Embarkation Area	12.0 ac, all of which are previously accounted for under Impact Area I. The beach at Horse Beach Cove is used by small numbers of WSP (typically 0-5) primarily for winter foraging and roosting; plovers are generally absent during the breeding season months. However, SCI INRMP (DoN 2002) reported breeding attempts at Horse Beach Cove in 1997 (nest depredated) and 1998 ("probably hatched"). These are the most recent breeding attempts reported on SCI.	TAR 21: Roosting or foraging plovers may temporarily move away from the human activity, noise or visual effects of daytime or nighttime operations during live-fire exercises such as GUNEX or EFEX, which may include landings by CRRC, weapons firing from support craft to shore, demolitions, and overflights by helicopters, fixed-wing attack aircraft, and small UAVs. Observations suggest that the plovers would rapidly resume normal behavior after moving away from the activity. The scope of some of the operations and multiple sources of disturbance may result in take in the form of unintentional harassment of a small number of birds. Likelihood of injury or mortality to an individual plover from ship to shore weapons fire or other project-related activity in plover habitat is very low, but possible. Impacts (NEPA) for No Action, Alternative 1, and Alternative 2 would be less than significant due to the low likelihood of harm to individuals and the small number of individuals potentially exposed to the activity. Horse Beach Cove Amphibious Landing and Embarkation Area. Roosting or foraging plovers may temporarily move away from the human and vehicular activity, noise or visual effects of daytime or nighttime amphibious landings. Observations suggest that the plovers would rapidly resume normal behavior after moving away from the activity. The scope of some of the operations and multiple sources of disturbance may result in take in the form of unintentional harassment of a small number of birds. Likelihood of injury or mortality to an individual plover from project-related activity in plover habitat is very low, but possible. It is estimated that take in the form of	G-M-1* G-M-2* G-M-3* G-M-4 G-M-5 G-M-7 G-M-8 *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than

Table D-9 (continued). Occurrence of Western Snowy Plover Within or Near Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		unintentional harassment would not exceed 4 individuals per year. Take in the form of injury or mortality to individuals is so improbable as to be discountable. Impacts (NEPA) for No Action, Alternative 1, and Alternative 2 would be less than significant because of the low likelihood of harm to individuals and the small number of individuals potentially exposed to the activity. Baseline use = 79 ops/yr. ((This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.). Alternative 1: 91 ops/yr. including 81 NSW, 10 USMC Amphibious and 1 USMC Battalion Landing. Alternative 2: 102 ops/yr. including 90 NSW, 10 USMC Amphibious and 2 USMC Battalion Landing.	significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 22—China Cove Training Area	9.2 ac, all of which is accounted for under Impact Area II. This is the narrowest and most exposed of the SHOBA beaches. There have been no records of plovers breeding or attempting to breed on this beach. The beach at China Cove within Impact Area II is used by small numbers of WSP primarily for winter foraging and roosting; plovers are generally absent during the breeding season months. During 2004, a median number of 8 birds was observed at this location when birds were present (range 1-19).	Roosting or foraging plovers may temporarily move away from the human activity, noise or visual effects of daytime or nighttime operations during live-fire exercises such as GUNEX or EFEX, which may include landings by CRRC, weapons firing from support craft to shore, demolitions, and overflights by helicopters, fixed-wing attack aircraft, and small UAVs. Observations suggest that the plovers would rapidly resume normal behavior after moving away from the activity. The scope of some of the operations and multiple sources of disturbance may result in take in the form of unintentional harassment of a small number of birds. There would be no effects on breeding WSP. Likelihood of injury or mortality to an individual plover from ship to shore weapons fire or other project-related activity in plover habitat is very low, but possible. Impacts (NEPA) would be less than significant because of the low likelihood of harm to individuals and the small number of individuals potentially exposed to the activity. Baseline use = 96 ops/yr including 33 NSW ops/yr. and 63 Non-NSW Naval ops/yr. (This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.) Alternative 1: 200 ops/yr. including 33 NSW, 6 USMC Amphibious, 1 USMC Battalion Landing and 160 other naval operations. Alternative 2: 220 ops/yr. including 40 NSW, 16 USMC Amphibious, 2 USMC Battalion Landing and 162 other naval operations. (Other naval operations include naval artillery and delivery of air-to-ground ordnance into overlapping Impact Area II and IIA, which are covered under Impact Area II).	G-M-1* G-M-2* G-M-3* G-M-4 G-M-5 G-M-7 G-M-8 *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Note:

1. Habitat acreage calculated from the SCI GIS. Acreages are approximate and should be used only for comparative purposes for several reasons including seasonal and year to year changes in the narrow strips of beach habitat.
2. Impact significance conclusion is based on discussion in "Description of Impacts" column and is assessed assuming application of mitigation measures identified in this document.
3. Impact significance assessment assumes mitigation for Alternatives I and 2.

Table D-10. State-listed and California Native Plant Society (CNPS)-List 1B Plant Species (Rare and Endangered in California and Elsewhere) Within Individual Operations Areas on SCI, Description Of Potential Impacts Of Existing and Proposed Operations, and Impact Significance. Evaluation of Impact Significance for the No Action Alternative is Based on Comparison With the Baseline.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
IMPACT AREA I	State Listed and Sensitive Plant Species SCI bedstraw (*Galium catalinense* ssp. *acrispum*): 2 of 224 (0.9% of SCI total occurrences) with 48 individuals (1.8% of 2,647 SCI total individuals). SCI silvery hosackia (*Lotus argophyllus* subsp. *adsurgens*): 25 of 207 occurrences on SCI (12.1% of SCI total occurrences); 330 of 5,505 individuals on SCI (6% of total SCI individuals). Aphanisma *(Aphanisma blitoides)* : 46 of 175 occurrences on SCI (26.3% of SCI total occurrences). SCI milkvetch (*Astragalus nevinii*) : 21 of 205 occurrences on SCI (10.2% of SCI total occurrences). South Coast saltscale (*Atriplex pacifica*): 9 of 67 occurrences on SCI (13.4% of SCI total occurrences). SCI evening primrose (suncup) (*Camissonia guadalupensis clementina*): 6 of 89 occurrences on SCI (6.7% of SCI total occurrences). Island apple-blossom *(Crossosoma californicum)*: 4 of 60 occurrences on SCI (6.7% of SCI total occurrences). Island green dudleya (*Dudleya virens* ssp. *virens*) : 7 of 324 occurrences on SCI (2.2% of SCI total occurrences). SCI buckwheat (*Eriogonum giganteum var. formosum*): 1 of 270 occurrences on SCI (0.4% of SCI total occurrences). SCI hazardia (*Hazardia cana*): 2 of 153 occurrences on SCI (1.3% of SCI total occurrences).	Existing patterns of disturbance from ordnance impacts and fire would be expected to continue, given the long history of similar use. Much of the distribution of SCI silvery hosackia (*Lotus argophyllus adsurgens*) is within SHOBA, and 12% of the populations documented since 1998 are within Impact Area I, where this state-listed endangered species is relatively abundant on south facing slopes and ridgetops. These habitats are largely away from target areas and many of the occurrences are very sparsely vegetated and unlikely to carry fire. This species regenerates from seed after fire. Under no action, Impact Area I receives about 6 % of the large caliber ordnance used in SHOBA. Because of its distribution is in up-canyon locations away from target areas, and the long history of ordnance use in Impact Area I, continued use of Impact Area I would have less than significant impacts on this species. Other sensitive species in Impact Area I have smaller proportions of their Island distribution in Impact Area I and would also be expected to experience less than significant impacts from continued use of the Impact Area. Increases in ordnance use associated with Alternatives 1 and 2 are as described in Table D-1. The patterns of disturbance from the increased use associated with these alternatives would be expected to be similar to existing patterns. Compared to baseline conditions, substantial changes in distribution and abundance of state-listed and sensitive plant species, including the SCI silvery hosackia, would not be expected. Implementation of the Navy Access Policy applying to Impact Areas I and II will preclude future monitoring of these state-listed and sensitive plants species and their habitat.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-3* G-M-4 G-M-5 G-M-6* G-M-7 G-M-9 *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

	Guadalupe Island lupine (*Lupinus guadalupensis*): 5 of 356 occurrences on SCI (1.4% of SCI total occurrences). SCI phacelia (*Phacelia floribunda*): 3 of 52 occurrences on SCI (5.8% of SCI total occurrences).		

Table D-10 (continued). State-Listed and CNPS-Listed Sensitive Plant Species Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
IMPACT AREA II	State Listed and Sensitive Plant Species SCI bedstraw (*Galium catalinense* ssp. *acrispum*): 2 of 224 (0.9% of SCI total occurrences) with 3 individuals (0.1% of 2,647 SCI total individuals). SCI silvery hosackia (*Lotus argophyllus* subsp. *adsurgens*): 2 of 207 occurrences on SCI (1.0% of SCI total occurrences) with 70 individuals (1.3% of 5,505 SCI total individuals). Aphanisma *(Aphanisma blitoides)* : 1 of 175 occurrences on SCI (0.6% of SCI total occurrences). SCI evening primrose (suncup) (*Camissonia guadalupensis clementina*): 6 of 89 occurrences on SCI (6.7% of SCI total occurrences). Trask's cryptantha (Cryptantha traskiae): 1 of 25 occurrences on SCI (4.0% of SCI total occurrences). Island green dudleya (*Dudleya virens* ssp. *virens*): 5 of 324 occurrences on SCI (1.5% of SCI total occurrences). SCI buckwheat (*Eriogonum giganteum var. formosum*): 5 of 270 occurrences on SCI (1.85% of SCI total occurrences). SCI hazardia (*Hazardia cana*): 1 of 153 occurrences on SCI (0.6% of SCI total occurrences). Guadalupe Island lupine (*Lupinus guadalupensis*): 7 of 356 occurrences on SCI (2.0% of SCI total occurrences). SCI tritelia: 1 of 88 occurrences on SCI (1.1% of SCI total occurrences).	Existing patterns of disturbance from ordnance impacts and fire would be expected to continue, given the long history of similar use. Continued use of Impact area II would have less than significant impacts on these species based on the historic and ongoing pattern of the disturbance, the ability of these species to survive or escape (through habitat association) fire or other disturbance, and the low proportions of their Island occurrences in Impact Area II. Increases in ordnance use associated with Alternatives 1 and 2 are as described in Table D-1. Impacts of the alternatives on these species would be less than significant despite the increased ordnance use because the patterns of disturbance are expected to be similar to existing and historic patterns. Implementation of the Navy Access Policy applying to Impact Areas I and II will preclude future monitoring of these state-listed and sensitive plants species and their habitat.	Applicable conservation measures and Impact significance are as described for Impact Area I above.
NALF AVMA	State Listed and Sensitive Plant Species SCI silvery hosackia *Lotus argophyllus* subsp. *adsurgens*): 2 of 207 occurrences on SCI (1.0% of SCI total occurrences) with 2 individuals (0.04% of 5,505 SCI total	Physical disturbance to vegetation and soils caused by tracked vehicle activity coupled with indirect impacts associated with introduction or spread of invasive species may lead to a reduction in these local populations of sensitive species. Newly discovered occurrences of southern Island tree mallow, SCI silvery hosackia (state-listed as endangered, SCI Indian paintbrush (federally listed as endangered Table D-2), and SCI milkvetch are clustered near	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2.

Table D-10 (continued). State-Listed and CNPS-Listed Sensitive Plant Species Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
	individuals). SCI milkvetch (*Astragalus nevinii*) : 5 of 205 occurrences on SCI (2.4% of SCI total occurrences). SCI evening primrose (suncup) (*Camissonia guadalupensis clementina*): 4 of 89 occurrences on SCI (4.5% of SCI total occurrences). Southern Island Tree Mallow (*Lavatera assurgentifolia* subsp. *glabra*): 5 of 32 occurrences on SCI (15.6% of the total SCI occurrences) with 5 individuals (1.8% of 276 SCI total individuals). The southern island tree mallow has also been noted in the SCI INRMP (DoN 2002) to occur on sandy soils south of the airfield immediately adjacent to the AVMA and AMP. This plant, which is CNPS 1B status, is noted in the INRMP (page D-17) as being in danger of extirpation on SCI because it is known from only 32 occurrences comprising less than 300 individuals total.	the egress from TAR 5, where their localized habitat may be susceptible to impacts from vehicle traffic. Protection of this localized area can be addressed through development of the erosion control plan (AVMC-M-3), briefing of maneuver area boundaries prior to conducting operations in these areas (AVMC-M-4), and continuing to use the existing route for ingress and egress from the beach at West Cove (AVMC-M-9), as appropriate. The occurrences of SCI evening primrose and SCI milkvetch at the northwestern and northeastern boundaries of the overlapping TAR 5 and along the southern boundary of the AVMA would probably not be affected during most operations because their peripheral locations would not receive frequent tracked vehicle activity. There would not be a substantial impact given the existing level of disturbance, the infrequency of activity at the sites, and the low proportion of the occurrences on SCI represented on this site. The southern island tree mallow population is inside the boundary of this AVMA and upwind from most of the activity and is therefore unlikely to be directly or indirectly affected by tracked vehicle activity within the AVMA. Designation of this AVMA is part of Alternatives 1 and 2. Alternative 1. The AVMA could be used by tracked vehicles during approximately 43 (42 USMC Amphibious plus 1 USMC Battalion Landing) operations per year. Alternative 2. The AVMA could be used by tracked vehicles during approximately 63 (61 USMC Amphibious plus 2 USMC Battalion Landing) operations per year.	G-M-1, G-M-3, G-M-4 AVMC-M-1 AVMC-M-2 AVMC-M-3 AVMC-M-4 AVMC-M-5 AVMC-M-6 AVMC-M-7, AVMC-M-9 No Action: No Impact. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Old Rifle Range AVMA	State Listed and Sensitive Plant Species Aphanisma *(Aphanisma blitoides)*: 1 of 175 occurrences on SCI (0.6% of SCI total occurrences). SCI milkvetch (*Astragalus nevinii*) : 5 of 205 occurrences on SCI (2.4% of SCI total occurrences). Island appleblossom (*Crossosoma californicum*): 1 of 60 occurrences on SCI (1.7% of total SCI occurrences).	Physical disturbance to vegetation and soils caused by tracked vehicle activity coupled with indirect impacts associated with introduction or spread of invasive species may lead to a reduction in this local population. It might be able to persist on site given its annual habitat and association with sparsely vegetated habitats. Low proportions of the occurrences of aphanisma, SCI milkvetch, and island appleblossom on SCI are represented on this site (0.6%, 2.4%, and 1.7 %, respectively). Designation of this AVMA is part of Alternatives 1 and 2. Alternative 1. The AVMA could be used by tracked vehicles during approximately 43 (42 USMC Amphibious plus 1 USMC Battalion Landing) operations per year. Alternative 2. The AVMA could be used by tracked vehicles during approximately 63 (61 USMC Amphibious plus 2 USMC Battalion Landing) operations per year.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 AVMC-M-1 AVMC-M-2 AVMC-M-3 AVMC-M-4 AVMC-M-5 AVMC-M-6 AVMC-M-7 No Action: No Impact

Table D-10 (continued). State-Listed and CNPS-Listed Sensitive Plant Species Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
			Alternatives 1 and 2: As described above for NALF AVMA, impacts would be less than significant with mitigation.
VC-3 AVMA	State Listed and Sensitive Plant Species Guadalupe Island lupine (*Lupinus guadalupensis*): 5 of 356 occurrences on SCI (1.4% of SCI total occurrences).	Physical disturbance to vegetation and soils caused by tracked vehicle activity coupled with indirect impacts associated with introduction or spread of invasive species may lead to a reduction in the local population of this species. A low proportion (< 3%) of the occurrences on SCI represented on this site. It might be able to persist on site given its annual habitat and association with sparsely vegetated habitats. Designation of this AVMA is part of Alternatives 1 and 2. Alternative 1. The AVMA could be used by tracked vehicles during approximately 43 (42 USMC Amphibious plus 1 USMC Battalion Landing) operations per year. Alternative 2. The AVMA could be used by tracked vehicles during approximately 63 (61 USMC Amphibious plus 2 USMC Battalion Landing) operations per year.	Applicable mitigation measures as identified above for Old Rifle Range AVMA. No Action: No Impact No Action: No Impact Alternatives 1 and 2: As described above for NALF AVMA, impacts would be less than significant with mitigation.
AVMC in SHOBA	Thorne's royal larkspur (*Delphinium variegatum* subsp. *Thornei*): 3 of 78 SCI occurrences (3.8 percent of SCI total occurrences) with 51 of 10,026 individuals (0.5% of SCI total individuals). Guadalupe Island lupine (*Lupinus guadalupensis*): 1 of 356 occurrences on SCI (0.3% of SCI total occurrences).	Construction of the AVMC in SHOBA would require engineering and would be addressed in a separate environmental document and permitted separately. The occurrences of Thorne's royal larkspur and Guadalupe Island lupine in the 26.3-acre conceptual alignment represent a low proportion of the SCI totals for these plants. Operation of the AVMC in SHOBA in Alternatives 1 and 2 would have localized impacts including erosion, deposition of dust on vegetation, and spread of invasive plant species. The impacts would be localized along the sides of the AVMC, where beginning populations of invasive species would be detectable and treatable. Frequency of use would be up to approximately 43 times per year in Alternative 1 and up to 63 times per year in Alternative 2. (Construction of the route would be addressed in a separate environmental document and permitted separately).	Applicable Mitigation Measures as listed for Old Rifle Range AVMA (above) No Action: No Impact Alternative 1: Impacts from use of the route during operations would be less than significant with mitigation. Alternative 2: Impacts from use of the route during operations would be less than significant with mitigation.
AFP-1 SHOBA	SCI silvery hosackia (*Lotus argophyllus* subsp *adsurgens*): 4 of 207 SCI occurrences (1.9% of SCI total occurrences) with 289 individuals (5.2% of 5,505 SCI total individuals).	Maneuvering of heavy wheeled and tracked vehicles, including tanks, and digging in of recoil spades on howitzers may adversely affect individuals in this population through the physical effects of vehicle activity and possibly by spread of invasive species facilitated by the activity. Portions of this 34-acre site had been disturbed previously by grading and off-road tracked vehicle and artillery activity. The newly discovered silvery hosackia occurrences appear to be outside of the previously disturbed portions of the site and at least some appear to be in operationally inaccessible portions of the site due to topographic constraints. Depending on the specifics of the site, protection of some or all of the silvery hosackia occurrences could potentially be addressed through development of the erosion control plan (AVMC-M-3) and/or briefing of maneuver area boundaries prior to conducting operations in these areas (AVMC-M-4).Less than significant impacts for No Action due to small size and previous disturbance of site, the likely inaccessibility of some or all of the occurrences, and the small	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 G-M-9 AVMC-M-1 AVMC-M-2

Table D-10 (continued). State-Listed and CNPS-Listed Sensitive Plant Species Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		proportion of the SCI silvery hosackia population represented on site (5.2 percent). No Action: 5 operations per year from this general area, which had been disturbed by past activities. Future disturbance under no action would be confined to the previously used portions of AFP-1. Designation of this AFP is included in Alternatives 1 and 2. Alternative 1. Artillery maneuvering during 3-day USMC artillery exercises up to 6 times per year plus 1 USMC Battalion Landing. Alternative 2. Artillery maneuvering during 3-day USMC artillery exercises up to 8 times per year plus 2 USMC Battalion Landings.	AVMC-M-3 AVMC-M-4 AVMC-M-5 AVMC-M-6 AVMC-M-7 AVMC-M-8 No Action: Impacts are less than significant. Alternative 1. Impacts would be less than significant with mitigation. Alternative 2. Impacts would be less than significant with mitigation.
TAR 1-Demolition Range Northeast Point	State Listed and Sensitive Plant Species Trask's cryptantha: 1 of 10 occurrences reported by Junak and Wilken (1998) is located outside this TAR and was estimated to contain 10,000 individuals of this annual plant species, comprising 50% of the individuals located by Junak and Wilken (1998).	This population was considered in the EA authorizing development and use of this TAR, which was originally proposed to be about 65 ac, much larger than its current 1.8 ac extent. The plants reported in 1998 and addressed in the EA are outside the boundary of this TAR. This species, an annual plant that exists as dormant seed during conditions unfavorable for growth, was not found during 2005 surveys of the TAR. No Action: 23 ops/yr. This TAR has been previously established. Alternative 1: 28 ops/yr. Alternative 2: 30 ops/yr.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 4--Whale Point/Castle Rock	State Listed and Sensitive Plant Species Guadalupe Island lupine (*Lupinus guadalupensis*): 1 of 356 occurrences on SCI (0.3% of SCI total occurrences).	A single occurrences of this annual species is documented on this site. The seedbank of this species would be expected to survive fire and the species has been observed to reappear abundantly after fire where a seedbank is present. This species would probably tolerate disturbance from foot traffic and germinate and establish in areas where there has been light disturbance to perennial shrub cover and would be expected to persist on site. Impacts are less than significant given the expected persistence of the species on site and the small	Applicable mitigation measures as identified above for TAR 1. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with

Table D-10 (continued). State-Listed and CNPS-Listed Sensitive Plant Species Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
		portions of their SCI populations represented on site. Baseline use = 212 ops/yr. This TAR has been previously established. Alternative 1: 230 ops/yr. Alternative 2: 300 ops/yr.	mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 5--West Cove Amphibious Assault Training Area	State Listed and Sensitive Plant Species SCI milkvetch (*Astragalus nevinii*): 1 of 205 occurrences on SCI (0.5% of SCI total occurrences). SCI evening primrose (suncup) (*Camissonia guadalupensis clementina*): 1 of 89 occurrences on SCI (1.1% of SCI total occurrences).	NSW activities are unlikely to affect these species due to their infrequent, low intensity nature. Species are located at the northwestern and northeastern boundaries of the TAR where frequent activity of NSW forces or amphibious vehicles are not expected. See also discussion above under NALF AVMA, which overlaps this site. Existing use is for amphibious landings and extractions and access to NALF AVMA, which overlaps West Cove. Impacts are less than significant due to out of the way location of the sensitive species and the small proportion of the SCI population represented on site. Baseline use = 10 ops/yr incl. 10 USMC Amphibious. Designation of this TAR is part of Alternatives 1 and 2. Alternative 1: 22 ops/yr (incl. 17 USMC Amphibious). Alternative 2: 52 ops/yr (incl. 44 USMC Amphibious).	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 TAR-M-1 AVMC-M-9 For amphibious landings measures listed above for NALF AVMA are also applicable. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 10—Demolition Range West	State Listed and Sensitive Plant Species Aphanisma (*Aphanisma blitoides*): 2 of 175 occurrences on SCI (1.1% of SCI total occurrences). SCI milkvetch (*Astragalus nevinii*): 15 of 205 occurrences on SCI (7.3% of SCI total occurrences). SCI evening primrose (suncup) *Camissonia guadalupensis clementina*: 1 of 89 occurrences on SCI (1.1% of SCI total occurrences). Southern island tree mallow (*Lavatera assurgentifolia* ssp. *glabra*): 1 of 32	Sensitive species occurrences are concentrated in a sandy area along the northeastern part of the access road and in relatively undisturbed habitat east and south of the previously disturbed demolitions area. At these locations, direct impacts would be primarily from foot traffic by small groups and are expected to be less than significant. Development of range facilities associated with Alternatives 1 and 2 is assumed to be in existing disturbed habitat lacking these species. Implementation of the Wildland Fire Management Plan is assumed to contain fires and prevent spread of fires at short intervals and possible type conversion of habitat. Establishment and spread of invasive species as a result of training operations could adversely affect these sensitive species within the TAR and in adjacent undisturbed habitat. These species regenerate from fire by seed and possibly by resprouting. Implementation of the Wildland Fire Management Plan is assumed to contain fires and prevent spread of fires at short intervals and possible type conversion of habitat. Impacts are less than significant due to infrequency of operations and small number of individuals involved coupled with	Applicable mitigation measures as identified above for TAR 1. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-10 (continued). State-Listed and CNPS-Listed Sensitive Plant Species Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
	occurrences on SCI (3.1% of SCI total occurrences). Guadalupe Island lupine (*Lupinus guadalupensis*): 13 of 356 occurrences on SCI (3.6% of SCI total occurrences).	demolitions in existing disturbed area. Baseline use = 3 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 25 ops/yr. Alternative 2: 40 ops/yr.	
TAR 13—Randall Radar Site Training Area	State Listed and Sensitive Plant Species SCI bedstraw (*Galium catalinense* ssp. *acrispum*): 1 of 224 occurrences on SCI (0.4% of SCI total occurrences) with 1 individual (0.04% of 2,647 total SCI individuals).	Low effects on these species would be caused by infrequent foot traffic by small groups. Some potential for spreading of invasive species into habitat associated with the foot traffic. This species is able to regenerate following fire. Baseline use = 10 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 16 ops/yr. Alternative 2: 22 ops/yr.	Applicable mitigation measures as identified above for TAR 1. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 14—VC-3 Onshore Parachute Drop Zone “Twinky”	State Listed and Sensitive Plant Species Guadalupe Island lupine *Lupinus guadalupensis*): 1 of 356 occurrences on SCI (0.3% of SCI total occurrences).	Infrequent use by small groups on foot are unlikely to adversely affect this annual species, which is also unlikely to be adversely affected by fire because fire would generally not be expected to burn through its grassland habitat until after the plant has produced its seed. Some potential for spreading of invasive species into habitat associated with the foot traffic. Baseline use = 20 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 30 ops/yr. Alternative 2: 68 ops/yr.	Applicable mitigation measures as identified above for TAR 1. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-10 (continued). State-Listed and CNPS-Listed Sensitive Plant Species Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 15—VC-3 Airfield Training Area	State Listed and Sensitive Plant Species Guadalupe Island lupine *Lupinus guadalupensis*): 8 of 356 occurrences on SCI (2.2% of SCI total occurrences).	Infrequent use by small groups on foot are unlikely to adversely affect this annual species, which is also unlikely to be adversely affected by fire because fire would generally not be expected to burn through its grassland habitat until after the plant has produced its seed. Some potential for spreading of invasive species into habitat associated with the foot traffic. Baseline use = 43 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 80 ops/yr. Alternative 2: 94 ops/yr.	Applicable mitigation measures as identified above for TAR 1. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 16—South VC-3 (Missile Impact Range)	State Listed and Sensitive Plant Species SCI brodiaea: 2 of 142 occurrences on SCI (1.4% of SCI total occurrences).	These plants are located on the periphery of the TAR where direct effects on the plants or the soils from trampling or vehicle traffic are unlikely. These exist as dormant underground corms (bulbs) during most of the summer after they set seed and do not sprout leaves until after seasonal rains start. Because of the dormancy they are resistant to impact much of the year. Unlikely to be adversely affected by fire for the same reason. Many related species increase after fire from dormant underground corms. Some potential for spreading of invasive species into habitat associated with actions at the TAR. Baseline use = 25 ops/yr. This TAR has been previously established. Alternative 1: 41 ops/yr. Alternative 2: 52 ops/yr.	Applicable mitigation measures as identified above for TAR 1. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
TAR 17— Eel Point Tactical Training Range	State Listed and Sensitive Plant Species Aphanisma (*Aphanisma blitoides*): 1 of 175 occurrences on SCI (0.6% of SCI total occurrences). SCI milkvetch: 1 of 205 occurrences on SCI (0.5% of SCI total occurrences). South coast allscale (*Atriplex pacifica*): 3 of 67 SCI occurrences (4.5% of SCI total occurrences). Guadalupe Island lupine (*Lupinus guadalupensis*): 5 of 356 occurrences on SCI (1.4% of SCI total occurrences).	Less than significant impacts expected due to the low physical disturbance outside the demolition areas and the small proportion of SCI's populations present at TAR 17. Spread of invasive species could adversely affect these occurrences. Fire is unlikely to adversely affect these annual or short-lived perennial species. Baseline use = 15 ops/yr. (Designation of this TAR is part of Alternatives 1 and 2). Alternative 1: 31 ops/yr. Alternative 2: 40 ops/yr.	Applicable mitigation measures as identified above for TAR 1. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-10 (continued). State-Listed and CNPS-Listed Sensitive Plant Species Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 21—Horse Beach Cove Training Area and Horse Beach Cove Amphibious Landing and Embarkation Area	State Listed and Sensitive Plant Species Aphanisma (*Aphanisma blitoides*): 9 of 175 occurrences on SCI (5.1% of SCI total occurrences). SCI milkvetch (*Astragalus nevinii*): 8 of 205 occurrences on SCI (3.9% of SCI total occurrences). SCI evening primrose (suncup) (*Camissonia guadalupensis clementina*): 6 of 89 occurrences on SCI (6.7% of SCI total occurrences) Island green dudleya (*Dudleya virens virens*): 2 of 280 occurrences on SCI (0.71% of SCI total occurrences). Guadalupe Island lupine (*Lupinus guadalupensis*): 2 of 356 occurrences on SCI (0.6% of SCI total occurrences). Most of these occurrences are located in Horse Beach Canyon, including the associated hillslopes and canyon walls. Additional occurrences are located upstream of the TAR 21 boundary.	TAR 21: Frequent use by small groups on foot with live firing is likely to cause localized disturbance to individual plants when they are located in or near frequently used areas and routes. There is a moderate potential to introduce and spread invasive species related to the frequency of operations proposed for TAR 21. Increased fire frequency resulting from the intensification of uses is likely to lead to localized changes in vegetation in the most frequently used areas, possibly affecting sensitive species. The Wildland Fire Management Plan does not provide for ground based fire suppression within SHOBA. All of these species are able to survive or regenerate after fire. Most of the sensitive species occurrences in the TAR are located east of the landing beach or north of it where they would be exposed to effects from individuals on foot and live-fire but not vehicular traffic. With the exception of Island green dudleya (a succulent perennial) these species are annual or perennial herbs and would be sensitive to foot traffic only when actively growing, existing during the dry months as seed or as seed and dormant stems or roots. Impacts are less than significant because most if not all of the occurrences on the TAR would be expected to persist given the nature of the training activities and the resilience of the plants and because of the relatively small proportion of their numbers located within the TAR. Horse Beach Cove Amphibious Landing and Embarkation Area: None of the sensitive species is known from the area between the beach and the coast road that would be used during amphibious landings and embarkations, therefore none of these species is expected to be directly affected by amphibious operations. Impacts are less than significant. Baseline use = 79 ops/yr. (This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.) Alternative 1: 91 ops/yr. including 81 NSW, 10 USMC Amphibious and 1 USMC Battalion Landing. Alternative 2: 102 ops/yr. including 90 NSW, 10 USMC Amphibious and 2 USMC Battalion Landing.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-3* G-M-4 G-M-5 G-M-6* G-M-7 G-M-9 AVMC-M-1 AVMC-M-2* AVMC-M-3* AVMC-M-4 AVMC-M-5 AVMC-M-7 AVMC-M-10 *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-10 (continued). State-Listed and CNPS-Listed Sensitive Plant Species Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
TAR 22—China Cove Training Area	State Listed and Sensitive Plant Species SCI bedstraw (*Galium catalinense* ssp. *acrispum*): 1 of 224 occurrences on SCI (0.4% of SCI total occurrences) with 2 individuals (0.08% of 2,647 SCI total individuals). SCI evening primrose (suncup) (*Camissonia guadalupensis clementina*): 5 of 89 occurrences on SCI (5.6% of SCI total occurrences). Island green dudleya (*Dudleya virens* ssp. *virens*):: 1 of 324 occurrences on SCI (0.3% of SCI total occurrences). SCI buckwheat (*Eriogonum giganteum var. formosum*): 3 of 270 occurrences on SCI (1.1% of SCI total occurrences). SCI hazardia (*Hazardia cana*): 1 of 153 occurrences on SCI (0.6% of SCI total occurrences). Guadalupe Island lupine (*Lupinus guadalupensis*): 7 of 356 occurrences on SCI (2.0% of SCI total occurrences). SCI tritelia: 1 of 88 occurrences on SCI (1.1% of SCI total occurrences).	Existing patterns of disturbance from ordnance impacts and fire would be expected to continue and the sensitive plant populations would be expected to persist, given their presence despite a long history of similar use. Use of TAR 22 by NSW as proposed would have less than significant impacts on these species based on the historic and ongoing pattern of disturbance in this area and the low proportions of their Island occurrences in TAR 22. Baseline use = 96 ops/yr including 33 NSW ops/yr. and 63 Non-NSW Naval ops/yr. (This TAR is located in SHOBA where ongoing live-fire and bombardment are included in the No Action Alternative. Designation of this TAR is part of Alternatives 1 and 2.) Alternative 1: 200 ops/yr. including 33 NSW, 6 USMC Amphibious, 1 USMC Battalion Landing and 160 other naval operations. Alternative 2: 220 ops/yr. including 40 NSW, 16 USMC Amphibious, 2 USMC Battalion Landing and 162 other naval operations.	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1* G-M-3* G-M-4 G-M-5 G-M-6* G-M-7 G-M-9 *CRNSW policy prohibiting access for natural resource surveys or management means that some applicable mitigation measures (e.g., G-M-1, G-M-3, G-M-6) would be conducted around the periphery of impact areas but not within them. No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.
Infantry Operations Area	State Listed and Sensitive Plant Species SCI bedstraw (*Galium catalinense* ssp. *acrispum*): 3 of 224 occurrences on SCI (1.3% of SCI total occurrences) with 5 individuals (0.2% of 2,647 SCI total individuals). SCI silvery hosackia (*Lotus argophyllus* subsp. *adsurgens*): 92 of 207 occurrences on SCI (44% of SCI total occurrences) with 1,662 individuals (30.2% of 5,505 SCI total	During the dry season on SCI when many of the sensitive species are dormant, direct effects of foot travel would be minimal and dispersed. Direct effects of trampling are possible, especially when soils are wet and seasonal plants such as geophytes and annuals are actively growing. Geophytes, such as Thorne's royal larkspur, SCI brodiaea, and SCI tritelia, go dormant after producing seed and survive unfavorable periods as underground bulbs, corms, rhizomes, or similar underground structures. Annuals, such as Guadalupe Island lupine, complete their life cycles from seed to seed within a few months and exist as seed during the dry season. Generally, the majority of the affected plants would be expected to survive the foot traffic even during the growing season and would complete their life cycle. During the dry months there would be little effect of foot traffic on seasonal species. Because	Implementation of the SCI Wildland Fire Management Plan is part of the No Action Alternative, Alternative 1 and Alternative 2. G-M-1 G-M-3 G-M-4 G-M-8 AVMC-M-1 AVMC-M-2

Table D-10 (continued). State-Listed and CNPS-Listed Sensitive Plant Species Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
	individuals). Aphanisma (*Aphanisma blitoides*): 2 of 175 occurrences on SCI (1.1% of SCI total occurrences). SCI milkvetch (*Astragalus nevinii*): 98 of 205 occurrences on SCI (47.8% of SCI total occurrences). South coast allscale (Atriplex pacifica): 2 of 67 SCI occurrences (3.0 % of SCI total occurrences). SCI brodiaea: 59 of 142 occurrences on SCI (41.6% of SCI total occurrences). San Clemente SCI evening primrose (suncup) (*Camissonia guadalupensis clementina*): 3 of 89 occurrences on SCI (3.4% of SCI total occurrences). Island apple-blossom (*Crossosoma californicum*): 6 of 60 occurrences on SCI (10.0% of SCI total occurrences). Thorne's royal larkspur (*Delphinium variegatum subsp. thornei*): 40 of 78 occurrences on SCI (51.3% of SCI total occurrences). Island green dudleya (*Dudleya virens* ssp. *virens*): 27 of 324 occurrences on SCI (8.3% of SCI total occurrences). SCI buckwheat (*Eriogonum giganteum var. formosum*): 75 of 270 occurrences on SCI (27.8% of SCI total occurrences). SCI hazardia (*Hazardia cana*): 28 of 153 occurrences on SCI (18.3% of SCI total occurrences). Southern island tree mallow (*Lavatera assurgentifolia* ssp. *glabra*): 19 of 32 occurrences on SCI (59.4% of SCI total occurrences). Guadalupe Island lupine Guadalupe Island lupine (*Lupinus guadalupensis*): 197 of 356 occurrences on SCI (55.3% of SCI total occurrences).	infantry would be spread across the landscape with approximately 5 m spacing between individual Marines, impacts on any individual population would be very dispersed. Shrubs and trees would be minimally affected by foot traffic. There is a potential for foot traffic to introduce or spread invasive plant species. Because the Marines would be spread over a large area when advancing, the large size and remoteness of parts of the Infantry Operations Area will make beginning infestations of invasive species difficult to detect when they are localized and most treatable. The outcome of an invasive plant species introduction is not always predictable, however it is very well documented, especially on islands, that plant invasions can result in dramatic ecological changes affecting the survival of plant and wildlife species. As described above, introduction or spread of invasive plant species as a result of use of the IOA by large numbers of personnel associated with the Battalion Landing is a reasonably foreseeable indirect impact with the potential for serious adverse consequences on sensitive plant species. Baseline use = 0 ops/yr, Battalion-sized landings have occurred on SCI in the past, but not during the baseline year. Foot traffic by individuals and groups is permitted within the IOA and elsewhere on the Island under the No Action Alternative. Alternative 1: 1 USMC Battalion-sized landing per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road. Alternative 2: 2 USMC Battalion-sized landings per year with troops on foot using the IOA and mechanized vehicles using the AVMC or Ridge Road.:	AVMC-M-4 AVMC-M-7 No Action: Impacts are less than significant. Alternative 1: Impacts would be less than significant with mitigation. Alternative 2: Impacts would be less than significant with mitigation.

Table D-10 (continued). State-Listed and CNPS-Listed Sensitive Plant Species Within Individual Operations Areas on SCI.

Operations Area	Amount of Resource[1]	Description of Impacts	Applicable Mitigation Measures and Impact Significance[2,3]
	Santa Cruz ironwood: 4 of 153 occurrences on SCI (2.6% of SCI total occurrences). Blair's stephanomeria: 20 of 296 occurrences on SCI (6.8% of SCI total occurrences).		

Note:

1. Sensitive plant occurrence and abundance is based on information in the SCI GIS developed from information in Junak and Wilken (1998), the SCI INRMP (DoN 2002), Junak (2006), and Tierra Data, Inc (2007). The data reported by Junak also includes occurrences documented by the Soil Ecology and Restoration Group (SERG), who operate the on-island nursery and conduct restoration projects on behalf of the Navy. The surveys by Junak and Wilken (1998), Junak (2006) were botanically driven and not focused on operations areas and covered large portions of the Island including TARs. The Tierra Data Inc surveys were conducted in 2005-2007 and were focused on operations areas including the AVMAs, AMPs, AFPs, and IOA. Three CNPS List 1B species [*Eriophyllum* (=*Constancea*) *nevinii*, *Galvezia speciosa*, and *Linanthus* (=*Leptosiphon*) *pygmaeus* ssp. *pygmaeus)*] were found to be so widespread and abundant that they were not included in the island-wide datasets of Junak and Wilken (1998) and Junak (2006) . Table 3.11-8 provides additional information about distribution, status, and population size as well as scientific and common names for these species. These species are listed alphabetically by genus, starting with the two state-listed endangered species *Galium* and *Lotus*. Under "amount of resource" resources (e.g., occurrences) occurring in overlapping operations areas are reported for each of the overlapping areas, enabling the effects of the differing operations in the overlapping areas to be assessed.
2. Impact significance conclusion is based on discussion in "Description of Impacts" column and is assessed assuming application of mitigation measures identified in this document.
3. Impact significance assessment assumes mitigation for Alternatives I and 2.

Appendix E

DRAFT

ESSENTIAL FISH HABITAT ASSESSMENT

Prepared for:
Department of the Navy
Commander, U.S. Pacific Fleet

APRIL 2008

EXECUTIVE SUMMARY

This assessment of the impact of United States Navy training in the Southern California (SOCAL) Range Complex on Essential Fish Habitat (EFH) covers regulatory issues, Fishery Management Plans and Managed Species, the project area, proposed actions, impacts, and mitigation measures. The SOCAL Range Complex encompasses 120,000 square nautical miles (nm^2) of ocean between Dana Point and San Diego, California, and extends more than 600 miles (mi) southwest into the Pacific Ocean. It includes land areas, water areas, and airspace used to conduct operations, training, research, development, testing, and evaluation of military hardware, personnel, tactics, munitions, explosives, and electronic combat systems.

The Magnuson-Stevens Fisheries Conservation and Management Act (16 United States Code [U.S.C.] § 1801 *et seq.*), mandates identification and protection of EFH. A second habitat type is also protected: Habitat Areas of Particular Concern (HAPC). These subsets of EFH are rare, sensitive, ecologically important, or located in an area that is already stressed. Federal agencies are required to consult with the NOAA Fisheries Service and to prepare an EFH Assessment describing potential adverse affects of their activities on EFH.

The SOCAL Range Complex contains EFH for 109 species covered under Fishery Management Plans. These 109 Managed Species include 83 species of groundfish that live on or near the bottom (e.g., rockfish and flatfish), six pelagic species that live in the water column (e.g., anchovies, mackerel, and squid), and 13 highly migratory species including tuna, billfish, and sharks. Three federal Fisheries Management Plans, for Groundfish, Coastal Pelagic Species, and Highly Migratory Species, include areas within the SOCAL Range Complex.

All marine waters in the SOCAL Range Complex offshore to depths of 3,500 meters (m) (1,914 fathoms (fm)) are designated as EFH for Groundfish Managed Species (seamounts out to 200 nautical miles (nm) offshore are also included). EFH for Coastal Pelagic Species includes all marine and estuarine waters above the thermocline from the shoreline to 200 nm offshore. Highly Migratory Species EFH includes all marine waters from the shoreline to 200 nm offshore. Estuaries, sea grass beds, canopy kelp, rocky reefs, and other “areas of interest” (e.g., seamounts, offshore banks, canyons) are designated Groundfish HAPCs. No HAPCs have been adopted for Coastal Pelagic or Highly Migratory Species in the SOCAL Range Complex.

Navy operations in the SOCAL Range Complex involve a wide variety of activities including: tactical reconnaissance and surveillance; attacking surface and subsurface targets; intercepting and engaging aircraft and missiles; suppressing air defenses; conducting electronic attack; interdicting enemy forces and targets; conducting fire support; mine and mine countermeasures exercises; performing search and rescue; and, research, development, testing and evaluation. These exercises utilize fixed-winged aircraft, helicopters, unmanned aerial vehicles, boats and ships, submarines, unmanned surface and underwater vehicles, divers, and amphibious vehicles. Radar, sonar, and lasers are used in the course of these training activities.

The following factors were considered in the analysis of potential impacts: the duration, frequency, intensity, and spatial extent of the impact; the sensitivity/vulnerability of the habitat; habitat functions that might be altered by the impact; and the timing of the impact relative to when Managed Species may use or need the habitat. Adverse effects are defined in EFH guidelines as being more than minimal, not temporary, causing significant change in ecological function, and not allowing the environment to recover without measurable impact.

Impacts to EFH and Managed Species could be associated with vessel movement, aircraft over-flight, expended materials, hazardous chemicals, detonation of explosive ordnance, weapons training, sensor testing, and sonar use. Navy operations could have direct and indirect impacts on individual species, modify their habitat, or alter water quality. The EFH assessment focuses on activities and impacts common to most offshore operations, but also discusses specific types of operations such as Expeditionary Assault, TORPEX, and SINKEX that may have the unique aspects relevant to the EFH Assessment.

Vessel movement and aircraft over-flights would cause brief, reversible disruptions in fish distribution. Fuel spills are unlikely, with any occurrence mitigated through standard spill control responses and wildlife rescue procedures. Discharge from ships would comply with international conventions and have minimal impact.

Potential impacts from expended material (e.g., flares, chaff, dye, torpedo accessories, sunken targets and vessels) could result from exposure to toxic chemicals, through contact with or ingestion of debris, and from entanglement. The small quantity of material expended, the rapid dilution of dissolved constituents, the relatively non-toxic nature of the debris, and its eventual encrustation and incorporation into the sediments would minimize adverse affects on resident marine communities. Bioaccumulation of toxic metals and organic compounds to higher-order food chain species is not expected. Expended material would not significantly disturb the sea floor or compromise habitat components that support feeding, resting, sheltering, reproduction, or migration of Managed Species.

Underwater detonations and weapons training could disrupt habitats, release hazardous chemical by-products, kill or injure marine life, affect hearing organs, modify behavior, mask biologically-relevant sounds, induce stress, and have indirect effects on prey species and other components of the food web. Underwater detonation will not take place within 1,000 m (3,281 ft) of live, hard-bottom habitats, artificial reefs, or shipwrecks. Initial concentrations of explosion by-products are not hazardous to marine life and would not accumulate because training exercises are widely dispersed over time and space. A small number of fish would be killed by shockwaves from explosions or would be injured and could subsequently die or suffer greater rates of predation. Beyond the range of direct, lethal or sub-lethal impacts to fish, minor, short-term behavioral reactions would not be ecologically significant or substantially impact their ability to survive, grow, and reproduce. No lasting adverse effect of underwater detonations or weapons training on prey availability or on the food web is expected.

Most bombs and missiles used in SOCAL Range Complex exercises would not have explosive warheads. The shock force from dummy bombs and missiles hitting the sea surface could result in a limited number of fish kills or injuries, and minor acoustic displacement, but would not substantially affect local species or habitats. Although few fish would be directly struck by naval gun fire, explosive 5-inch gunnery rounds could kill or injure a small proportion of the nearby assemblage. Behavioral reactions of fish would extend over a larger area. However, adverse regional consequences are not anticipated.

Training torpedoes used in the SOCAL EIS/OEIS Range Complex would not have exploding warheads. The physical force marine organisms would be exposed to would be limited to torpedo launch and movement. Due to the small size of torpedo transit areas, the probability of fish strikes would be low. Similar, minimal effects would be expected from training exercises employing Expendable Mobile Acoustic Torpedo Targets and Acoustic Device Countermeasures.

Some fish species may be able to detect mid frequency sonar at the lower end of its range. Short-term behavioral responses such as startle and avoidance may occur, but are not likely to adversely affect indigenous fish communities. Auditory damage from sonar signals is not expected and there is no indication that non-impulsive acoustic sources result in significant fish mortality at the population level.

This assessment concludes that based on the limited extent, duration, and magnitude of potential impacts from SOCAL Range Complex training and testing, and with the mitigation proposed; there would not be adverse effects on EFH or Managed Species. Range operations would not significantly contribute to cumulative impacts on present or future uses of the area.

Table of Contents

List of Figures

List of Tables

Acronyms and Abbreviations

A-A	Air-to-Air
AAMEX	Air-to-Air Missile Exercise
AASBn	Assault Amphibian School Battalion
AAV	Amphibious Assault Vehicle
AAW	Anti-Air Warfare
ACM	Air Combat Maneuvering
ADC	Acoustic Device Countermeasures
ADEX	Air Defense Exercise
ALMDS	Airborne Laser Mine Detection System
AMCM	Airborne Mine Countermeasures
AMNS	Airborne Mine Neutralization System
AMW	Amphibious Warfare
AS	At-Sea
ASROC	Rocket-Assisted Anti-Submarine Torpedo
ASUW	Anti-Surface Warfare
ASW	Anti-Submarine Warfare
ATC	Air Traffic Control
BA	Biological Assessment
BFM	Basic Fighter Maneuvers
BO	Biological Opinion
°C	Degrees Celsius
C3F	Commander, Third Fleet
CAS	Commercial Air Services
CCC	Command Control and Communications
CEQ	Council on Environmental Quality
CFFC	Commander, United States Navy Fleet
CFR	Code of Federal Regulations
CIWS	Close-In Weapon System
CJTFEX	Combined Joint Task Force Exercise
cm	Centimeter
CMLMA	California Marine Life Management Act
CNO	Chief of Naval Operations
COMPACFLT	Commander, Pacific Fleet
COMPTUEX	Composite Training Unit Exercise
CPAAA	Camp Pendleton Amphibious Assault Area
CPAVA	Camp Pendleton Amphibious Vehicle
CPF	Commander, Pacific Fleet
CPS	Coastal Pelagic Species
CRRC	Combat Rubber Raiding Craft
CSAR	Combat Search and Rescue
CSG	Carrier Strike Group
DoD	Department of Defense
DON	Department of the Navy
DoN	Department of the Navy
e.g.	For Example
EA	Environmental Assessment
EC	Electronic Combat
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EHF	Extremely High Frequency
EIS	Environmental Impact Statement
EMW	Expeditionary Maneuver Warfare
ENETA	Encinitas Naval Electronic Test Area
EO	Executive Order
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESG	Expeditionary Strike Group
ESGEX	Expeditionary Strike Group Exercise
EW	Electronic Warfare
EX	Exercise
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
FL	Flight Level
FLEETEX	Fleet Exercise
FLETA	Fleet Training Area
fm	Fathom
FMC	Fisheries Management Council
FMP	Fishery Management Plan
FPT	Fleet Project Team
FRP	Fleet Response Plan
FRTP	Fleet Readiness Training Plan
ft	Foot/Feet
FTS	Fleet Training Strategy
GHz	Gigahertz
GPS	Global Positioning System
GUNEX	Gun Exercise
HAPC	Habitat Areas of Particular Concern
HCOTA	Helicopter Offshore Training Area
HF	High Frequency
HMS	Highly Migratory Species
Hz	Hertz
IEER	Improved Extended Echo Ranging
Sonobuoy	
I MEF	First Marine Expeditionary Force
i.e.	That Is
IPHC	International Pacific Halibut Commission
IOC	Initial Operational Capability
IR	Infra Red
ISE	Independent Steaming Exercise
ISR	Intelligence, Surveillance and Reconnaissance
JFCOM	Joint Forces Command
JNTC	Joint National Training Capability
JSF	Joint Strike Fighter
JTFEX	Joint Task Force Exercise
KB(X)	Kernel Blitz Experimental
kg	Kilogram
KHz	Kilohertz
km	Kilometer
km^2	Square Kilometers
kt	Knot
lb	Pound
LCAC	Landing Craft Air Cushion
LCS	Littoral Combat Ship
LMRS	Long-Term Mine Reconnaissance System
m	Meter
m^2	Square Meter
MARFORPAC	Marine Forces Pacific
MCM	Mine Countermeasures
MCT	Marine Corps Training
MCTL	Marine Corps Task List
MEU	Marine Expeditionary Unit
mi	Mile
min	Minute
MINEX	Mine Warfare Exercise
MISR	Missile Range
MISSILEX	Missile Exercise
MIW	Mine Warfare

mm	Millimeter
MMPA	Marine Mammal Protection Act
MOA	Military Operating Area
Mph	Mile Per Hour
MPRSA	Marine Protection Research & Sanctuaries Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
msl	Mean Sea Level
N	North
N.E.W.	Net Explosive Weight
NAOPA	Northern Air Operating Area
NAS	Naval Air Station
NBC	Naval Base Coronado
NEPA	National Environmental Policy Act
nm	Nautical Mile
nm	Nautical Miles
nm^2	Square Nautical Miles
NMFS	National Marine Fisheries Service
NMSA	National Marine Sanctuaries Act
NOAA	National Oceanic & Atmospheric Administration
NSFS	Naval Surface Fire Support
NSW	Naval Special Warfare
NTTL	Navy Tactical Task List
OAMCM	Organic Airborne Mine Countermeasures
OCS	Outer Continental Shelf
OEA	Overseas Environmental Assessment
OEIS	Overseas Environmental Impact Statement
^oF	Degrees Fahrenheit
OMCM	Organic Mine Countermeasures
OPAREA	Operating Area
OPFOR	Opposition Force
Ops	Operations
PFMC	Pacific Fisheries Management Council
PACFIRE	Pre-Action Calibration Firing Planning
PTS	Permanent Threshold Shift
R&D	Research and Development
RAMICS	Rapid Airborne Mine Clearance System
RCMP	Range Complex Management Plan
RDT&E	Research, Development, Test and Evaluation
RF	Radio Frequency
RHIB	Rigid Hull Inflatable Boat
RTE	Routine Training Exercise
RTS	Remote Training Site
S-A	Surface-to-Air
SBTA	San Diego Bay Training Area
SCB	Southern California Bight
SCI	San Clemente Island
SFA	Sustainable Fisheries Act
SHOBA	Shore Bombardment Area
SINKEX	Sinking Exercise
SMCM	Surface Mine Countermeasures
SMZ	Special Management Zone
SOA	Sustained Operations Ashore
SOCAL	Southern California
SPCOA	San Pedro Channel Operating Area
S-S	Surface-to-Surface
STW	Strike Warfare
SUA	Special Use Airspace
SUW	Surface Warfare
T&E	Testing & Evaluation
TAP	Tactical Training Theater Assessment and Planning
TLAM	Tomahawk Land Attack Missile
TNT	Trinitrotoluene
TORPEX	Torpedo Exercise
TRACKEX	Tracking Exercise
TTS	Temporary Threshold Shift
UNDET	Underwater Detonation
U.S.	United States of America
U.S.C.	U.S. Code
UHF	Ultra High Frequency
UNDET	Underwater Detonation
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USS	United States Ship
USW	Undersea Warfare
UUV	Unmanned undersea vehicle
VAST/IMPASS	Virtual At-Sea Training/Integrated
VHF	Very High Frequency
W	West
WSCOA	Western San Clemente Island

Planning

1 INTRODUCTION

This assessment of the impact of United States (U.S.) Navy activities in the Southern California (SOCAL) Range Complex on "Essential Fish Habitat" (EFH) covers the regulatory background, project area, environmental setting, Fishery Management Plans and Managed Species, designated EFH in the SOCAL Range Complex, proposed actions, project impacts, mitigation measures, and cumulative impacts. The Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to which this EFH Assessment is appended details Navy operations in the SOCAL Range Complex, describes the existing environment for marine biology and fish, and discusses potential environmental effects associated with ongoing and proposed naval activities. The Marine Resources Assessment prepared for the Southern California Operating Area (DON 2005a) also contains comprehensive descriptions of the ocean environment including: climate; marine geology; physical, chemical, and biological oceanography; marine biology; marine habitats; and protected species in the project area.

This assessment uses the term "fish" to include both cartilaginous species - sharks, skates, and rays - and bony species. Cartilaginous fish, as the name implies, have a skeleton of cartilage, which is partially calcified, but is not true bone. Bony fish also have cartilage, but their skeletons consist of calcified bone.

1.2 REGULATORY SETTING

1.2.1 The Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) of 1976 (16 United States Code [U.S.C.] § 1801 *et seq.*) established jurisdiction over marine fishery resources in the 200-nautical mile (nm) (370-kilometer (km)) U.S. Exclusive Economic Zone (EEZ). The MSFCMA was reauthorized and amended by the Sustainable Fisheries Act (SFA) of 1996 (Public Law 104-297) which provided a new habitat conservation tool: the Essential Fish Habitat mandate. The SFA requires that regional Fishery Management Councils (FMCs) prepare Fishery Management Plans (FMPs) identifying EFH for federally "Managed Species". Managed Species are species covered under FMPs.

Congress defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. § 1802(10)). The term "fish" is defined in the SFA as "finfish, mollusks, crustaceans, and all other forms of marine animals and plant life other than marine mammals and birds". The National Marine Fisheries Service (NMFS) in 2002 further clarified EFH with the following definitions (50 Code of Federal Regulations [C.F.R.] §§ 600.05–600.930):

- "Waters" include all aquatic areas and their associated biological, chemical, and physical properties that are used by fish and may include aquatic areas historically used by fish where appropriate.
- "Substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities.
- "Necessary" means the habitat required to support a sustainable fishery and the Managed Species' contribution to a healthy ecosystem; and "Spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle" (NMFS 2002a).

The SFA requires that EFH be identified and mapped for each federally Managed Species (NMFS 2007a). The NMFS and regional FMCs determine the species distributions by life stage and characterize associated habitats, including Habitat Areas of Particular Concern (HAPC). HAPCs are discrete areas within EFH that either play especially important ecological roles in the life cycles of Managed Species or are especially vulnerable to degradation from human-induced activities (50 CFR 600.815[a][8]). The SFA requires federal agencies to consult with the NMFS on activities that may adversely affect EFH. For actions that affect a threatened or endangered species, or its critical habitat, and its EFH, federal agencies must integrate Endangered Species Act (ESA) and EFH consultations.

An Essential Fish Habitat Assessment is a critical review of the proposed project and its potential impacts to EFH (NMFS 2004a,b). As set forth in the rules (50 C.F.R. § 600.920(e)(3)), EFH Assessments must include: (1) a description of the proposed action; (2) an analysis of the effects, including cumulative effects, of the action on EFH, and Managed Species; (3) the federal agency's views regarding the effects of the action on EFH; and (4) proposed mitigation, if applicable. Once the NMFS learns of a federal or state activity that may have adverse effects on designated EFH, the NMFS is required to develop EFH consultation recommendations for the activity. These recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH (NMFS 2002a).

1.3 PROJECT AREA

1.3.1 SOCAL Range Complex

The SOCAL Range Complex consists of three primary components: ocean operating areas, special use airspace, and San Clemente Island. The SOCAL Range Complex is geographically situated between Dana Point and San Diego, and extends more than 600 nm southwest into the Pacific Ocean (Figures 1-1 and 1-2). The SOCAL Range Complex encompass 120,000 nm^2 of sea space, 113,000 nm^2 of special use airspace (SUA), and over 42 nm^2 of land area (San Clemente Island). The ocean areas of the SOCAL Range Complex include surface and subsurface operating areas extending generally southwest from the coastline of southern California between Dana Point and San Diego for a distance of approximately 600 nm into international waters west of the coast of Baja California, Mexico. The SOCAL Range Complex includes military airspace designated as Warning Area 291, or W-291. W-291 comprises 113,057 nm^2 of SUA that generally overlays the SOCAL ocean operating areas (OPAREAS) and San Clemente Island, extending seaward to the southwest beginning approximately 12 nm off the coast for a distance of approximately 600 nm. W-291 is the largest component of SUA in the Navy range inventory. San Clemente Island includes a Shore Bombardment Area (SHOBA), landing beaches, several live-fire areas and ranges for small arms, maneuvers, and other types of training.

Figure 1-1: SOCAL EIS/ORange Complex

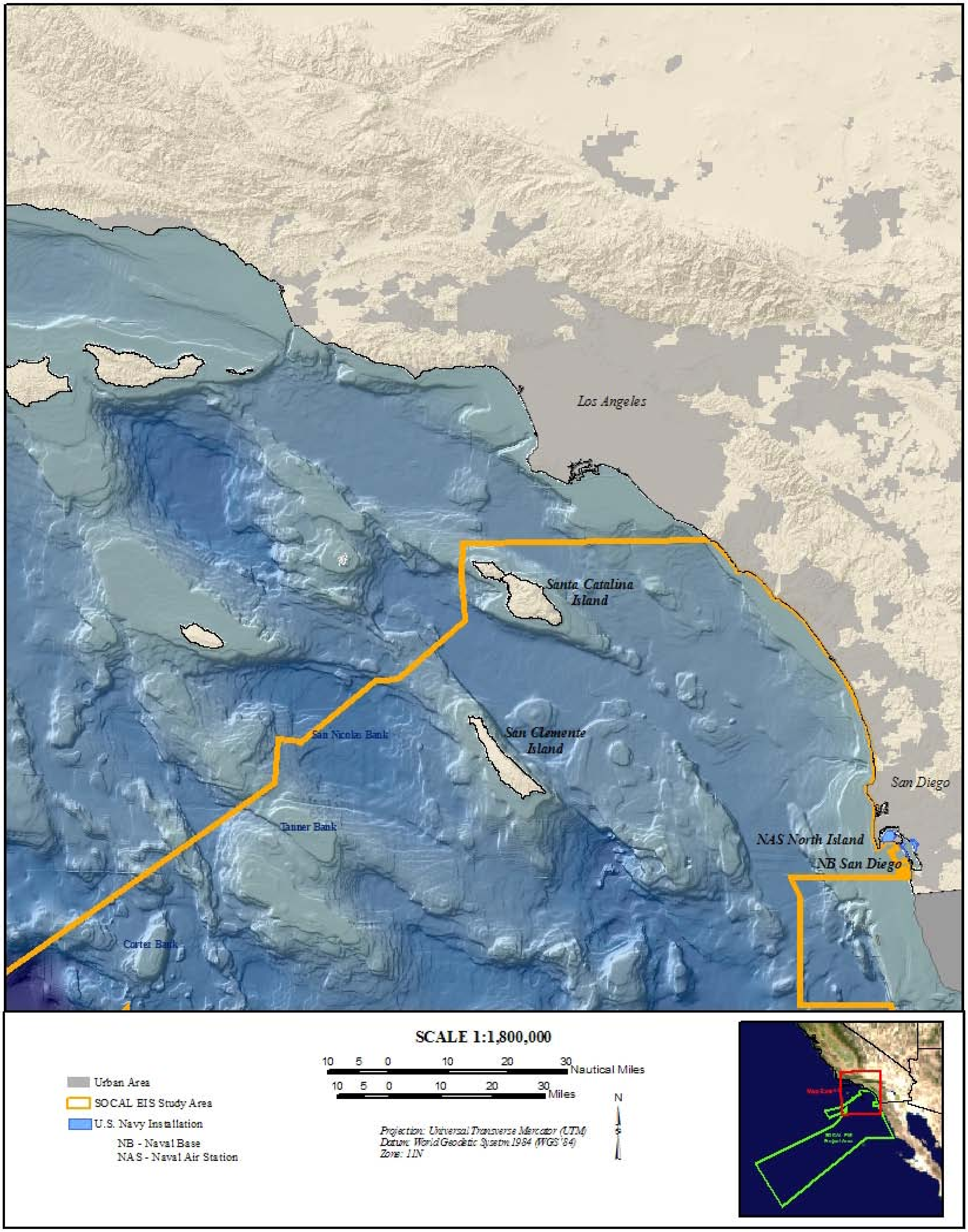


Figure 1-2.: Northern Portion of the SOCAL Range Complex Bathymetry and Topography

1.4 ENVIRONMENTAL SETTING

An indentation of California's coastline south of Point Conception creates a broad ocean embayment known as the Southern California Bight (SCB). The SCB encompasses the area from Point Conception south to Mexico, including the offshore Channel Islands, and is influenced by two major oceanic currents: the southward-flowing, cold-water California Current and the northward-flowing, warm-water California Countercurrent (DON 2005a, Perry 2007). These currents mix in the SCB and strongly influence patterns of ocean water circulation, sea temperatures, and distributional trends of marine flora and fauna assemblages along the southern California coast and Channel Islands (Folley *et al.* 1993).

The SOCAL Range Complex is situated in a region of diverse ichthyofauna. High species richness is a product of the region's complex oceanographic topography and the convergence of multiple, influential water masses (Cross and Allen 1993, DON 2005a). The SCB is home to over 480 species of marine fish and more than 5,000 species of marine invertebrates (Cross and Allen 1993, Schiff *et al.* 2000, Allen *et al.* 2006). The diversity of species, fish and invertebrates, is greatest in southern California and declines as one moves north through the region (Horn and Allen 1978, Horn et al. 2006). The study area is located within a transitional zone between subarctic and subtropical water masses. Specifically, Point Conception, California (34.5ºN) is the distinguished ichthyofaunal boundary between subtropical species (i.e., species with preferences of temperatures above 10º to 20ºC) of the San Diego Province and temperate fish species (*i.e.*, species with temperature preferences below 15ºC) of the Oregon Province (Horn and Allen 1978, Froese and Pauly 2004, Horn *et al.* 2006).

The California Current system is rich in microscopic organisms (i.e., diatoms, tintinnids, and dinoflagellates) which form the base of the food chain in the area (DON 2005a). Small coastal pelagic fish and squid depend on this planktonic food supply and in turn are fed upon by larger species. Groundfish (e.g., flatfish, roundfish, skates/sharks/chimeras, rockfish, etc.) are important recreational and commercial species (Love 2006). The shelf and slope demersal rockfish are the most specious genus of fish off the western coast of North America (Love *et al.* 2000). These fish are typically the dominant species documented in many ichthyological surveys, in terms of abundance and diversity, especially between the 20 to 200 m isobaths (Mearns *et al.* 1980). Highly Migratory Species (HMS) (*e.g.*, tuna, billfish, sharks, dolphinfish, and swordfish) and Coastal Pelagic Species (CPS) (e.g., anchovies, mackerels, sardines, and squids) support extensive fisheries in the area (Allen and Cross 2006).

The diverse habitats of the SCB greatly influence the distribution of fish and invertebrates in the area (Horn *et al.* 2006). Cross and Allen (1993) defined these habitats in three broad categories: the pelagic zone, soft substrate habitats (i.e., bays, estuaries, open coast), and hard substrate and kelp bed habitats (*i.e.*, rocky habitats, reefs). The pelagic zone, relating to open water, is the largest habitat in the area with 40% of the fish species inhabiting this area. This zone is subdivided into three distinct regions: epipelagic (up to 50 m deep), mesopelagic (50 to 500 m deep), and bathypelagic regions (greater than 500 m deep) (Cross and Allen 1993). The epipelagic region is inhabited by small, planktivorous schooling fish (*e.g.*, northern anchovy), predatory schooling fish (*e.g.*, Pacific mackerel), and large solitary predators (*e.g.*, blue shark). Abundance of all epipelagic species changes seasonally with fish moving offshore to spawn. The northern anchovy is the most abundant epipelagic species in the study area. The mesopelagic region is characterized by steep environmental gradients and fish that are small, slow growing, long-lived, and reproduce early and repeatedly (*e.g.*, bigeye lightfish). The bathypelagic zone is a rather uniform system containing large, sluggish, fast growing, short-lived fish, that reproduce late and typically only once (*e.g.*, bigscale and hatchetfish) (Cross and Allen 1993).

Typical fish utilizing soft substrates (sand, silt, and mud) include sharks, skates, rays, smelts, flatfish (flounders), gobies and northern anchovies (Pondella and Allen 2000). Regions with hard substrates and kelp beds (*Macrocystis*) are not as abundant as other benthic habitats in the SCB, but they nevertheless provide important habitats for many species. Shallow reefs (*i.e.*, <30 m depth) are the most common type of hard substrate (*i.e.*, coarse sand, calcareous organic debris, rocks) found in the study area (Cross and

Allen 1993, DON 2005a). These reefs also support kelp beds, which provide nursery areas for various fish species. Rocky intertidal regions are often turbulent, dynamic environments, where organisms must cope with stresses associated with tides (*e.g.*, changes in temperature, salinity, oxygen, and pH). Deep reef fish, found along deep banks and seamounts, are typically large, mobile species (*e.g*., rockfish and spiny dogfish). Kelp beds are regions with a high diversity of fish species. Smaller fish feed on high plankton densities in the area, while larger fish are attracted to these habitats to feed on smaller species. They are especially important habitats for young-of-the-year rockfish species, such as the kelp rockfish, whose densities correlate to the size of the kelp bed (McCain 2003).

Inshore areas (bays and estuaries) provide important nursery habitats and feeding grounds to a variety of species, some of commercial importance (e.g., California halibut) (Allen et al. 2002). San Diego Bay's seagrass beds are used by schooling species, such as anchovies and topsmelt (Cross and Allen 1993) with the highest abundance and biomass of fish occurring in the spring (i.e., April) and summer (i.e., July) (Allen et al. 2002). Juvenile northern anchovy, topsmelt, and slough anchovy comprise up to 79% of the fish in the Bay (Allen et al. 2002).

The influence of the California Current on the physical and biological environment of the SCB undergoes significant year-to-year fluctuations (Horn and Stephens 2006). Its impact is also affected by larger-scale climate variations, such as El Niño-La Niña and the Pacific Decadal Oscillation (PDO) (Hickey 1993). El Niño-La Niña (also called the El Niño Southern Oscillation (ENSO)) is the result of interannual changes in sea level pressures between the eastern and western hemispheres of the tropical Pacific; these events can initiate large shifts in the global climate, atmospheric circulation, and oceanographic processes (NOAA 2007a). ENSO conditions typically last 6 to 18 months although they can persist for longer periods of time. They are the main signs of global change over time scales of months to years (Benjamin and Carlton 1999, Schwing et al. 2002). Under normal conditions, rainfall is low in the eastern Pacific and is high over the warm waters of the western Pacific. El Niño conditions occur when unusually high atmospheric pressure develops over the western tropical Pacific and Indian Oceans and low sea level pressure develop in the southeastern Pacific. During El Niño conditions, the trade winds weaken in the central and west Pacific; thus, the normal east to west surface water transport and upwelling along South America decreases. This results in increased (sometimes extreme) rainfall across the southern U.S. and Peru and drought conditions in the western Pacific (NOAA 2007a). La Niña is the opposite phase of El Niño in the Southern Oscillation cycle. La Niña is characterized by strong trade winds that push the warm surface waters back across to the western Pacific increasing upwelling along the eastern Pacific coastline, causing unusually cold sea surface temperatures. The PDO is a longer-term climatic pattern than ENSO with similar warm and cool phases that may persist for 20 to 30 years (Miller 1996, Benjamin and Carton 1999).

During years experiencing an El Niño event, tropical species (i.e., species with temperature preferences above 20ºC) begin to migrate into the study area, while temperate species, which normally inhabit the area, move north and out of the region (Froese and Pauly 2004). For example, two tropical species, the Mexican barracuda and scalloped hammerhead shark, were recorded off southern California for the first time during the 1997/1998 El Niño event (Moser et al. 2000). Rockfish are particularly sensitive to El Niño, with these events resulting in recruitment failure and adults demonstrating reduced growth, ultimately a decline in biomass is exhibited and poor overall condition in the region becomes evident. Landings of market squid were dramatically decreased during the 1997/1998 El Niño event (Hayward 2000).

Past La Niña events have not had such a dramatic impact on ichthyofauna and marine invertebrate populations as El Niño events. Nevertheless, La Niña years can result in below normal recruitment for many invertebrate species (e.g., rock crabs), and larval rockfish abundance has been reportedly low during years experiencing La Niña events (Lundquist et al. 2000). Cooling trend years (i.e., 1999 La Niña event) can result in increased abundance and commercial landing of herring, anchovies, and squid populations (Hayward 2000; Lluch-Belda et al. 2003).

1.5 FISHERIES MANAGEMENT PLANS

Under the MSFCMA, the federal government has jurisdiction to manage fisheries in the U. S. EEZ which extends from the outer boundary of state waters (3 nm (5.6 km) from shore) to a distance of 200 nm (370 km) from shore. Offshore fisheries in the SOCAL Range Complex are managed by NMFS with assistance from the Pacific Fisheries Management Council (PFMC) (PFMC 2007a), and the Southwest Fisheries Science Center (National Oceanic and Fisheries Administration (NOAA)) (NOAA 2007b,c). Inshore fisheries (less than 3 nm (5.6 km) from shore) are managed by the California Department of Fish and Game (CDFG) (CDFG 2007a). However, in practice, state and federal fisheries agencies manage fisheries cooperatively and FMPs generally cover the area from coastal estuaries out to 200 nm (370 km) offshore.

Fishery Management Plans are extensive documents that are constantly revised and updated. The Pacific Coast Groundfish Fishery Management Plan, for example, originally produced in 1977, has been amended 19 times (PFMC 2006a). FMPs describe the nature, status, and history of the fishery, and, specify management recommendations, yields, quotas, regulations, and harvest guidelines. Associated Environmental Impact Statements (EISs) addresses the biological and socioeconomic consequences of management policies. Fishery Management Councils have web sites that present the various elements of their FMPs, current standards and regulations, committee hearings and decisions, research reports, source documents, and links to related sites (see, for example, PFMC 2007a). Recent coverage of the ecology of marine fish, fisheries and marine environmental issues in California is presented in reviews by Allen 2006, Allen, Pondella and Horn 2006, Allen and Cross 2006, Horn and Stephens 2006, Horn et al. 2006, and Love 2006.

Fishery Management Plans covering the SOCAL Range Complex include; Pacific Groundfish (GF) (83 species), Coastal Pelagic Species (CPS) complex (6 species), and Highly Migratory Species (HMS) (13 species) (Table 1-1, 1-2, 1-3). The Pacific halibut (*Hippoglossus stenolepis*), a flat groundfish, is regulated by the United States and Canada through a bilateral commission, the International Pacific Halibut Commission (IPHC) (IPHC 2007) and is therefore not in a federal FMP. The usual range of Pacific halibut is from Santa Barbara, CA to Nome, Alaska and it would not usually be found in the study area.

Table 1-1. Groundfish Management Plan Species

Groundfish Management Plan Species http://www.pcouncil.org/groundfish/gffmp.html
Flatfish
Arrowtooth flounder *(Atheresthes stomias)*
Butter sole *(Isopsetta isolepis)*
Curlfin sole (*Pleuronichthys decurrens*)
Dover sole (*Microstomus pacificus*)
English sole (*Parophrys vetulus*)
Flathead sole *(Hippoglossoides elassodon)*
Pacific sanddab (*Citharichthys sordidus*)
Petrale sole (*Eopsetta jordani*)
Rex sole (*Glyptocephalus zachirus*)
Rock sole (*Lepidopsetta bilineata*)
Sand sole (*Psettichthys melanostictus*)
Starry flounder (*Platichthys stellatus*)
Rockfish
Aurora rockfish (*Sebastes aurora*)
Bank rockfish (*Sebastes rufus*)
Black rockfish (*Sebastes melanops*)
Black-and-yellow rockfish (*S. chrysomelas*)
Blackgill rockfish (*Sebastes melanostomus*)
Blue rockfish (*Sebastes mystinus*)
Bocaccio (*Sebastes paucispinis*)
Bronzespotted rockfish (*Sebastes gilli*)
Brown rockfish (*Sebastes auriculatus*)
Calico rockfish (*Sebastes dallii*)
Canary rockfish (*Sebastes pinniger*)
Chameleon rockfish (*Sebastes phillipei*)
Chilipepper (*Sebastes goodei*)
China rockfish (*Sebastes nebulosus)*
Copper rockfish (*Sebastes caurinus*)
Cowcod (*Sebastes levis*)
Darkblotched rockfish (*Sebastes crameri*)
Dusky rockfish (*Sebastes ciliatus*)
Dwarf-red rockfish (*Sebastes rufinanus*)
Flag rockfish (S*ebastes rubrivinctus*)
Freckled rockfish (*Sebastes lentiginosus*)
Gopher rockfish (*Sebastes carnatus*)
Grass rockfish (*Sebastes rastrelliger*)

Greenblotched rockfish (*Sebastes rosenblatti*) Greenspotted rockfish (*Sebastes chlorostictus*) Squarespot rockfish (*Sebastes hopkinsi*) Starry rockfish (*Sebastes constellatus*) Stripetail rockfish (*Sebastes saxicola*) Swordspine rockfish (*Sebastes ensifer*) Tiger rockfish (*Sebastes nigrocinctus*) Treefish (*Sebastes serriceps*) Vermillion rockfish (*Sebastes miniatus*) Widow rockfish (*Sebastes entomelas*) Yelloweye rockfish (*Sebastes ruberrimus*) Yellowmouth rockfish (*Sebastes reedi*) Yellowtail rockfish (*Sebastes flavidus*) **Scorpionfish** Ca. scorpionfish (*Scorpaena guttatta*) **Thorneyheads** Longspine thornyhead (*Sebastolobus altivelis*) Shortspine thornyhead (*S. alascanus*) **Roundfish** Cabezon (*Scorpaenichthvs marmoratus*) Kelp greenling (*Hexagrammos decagrammus*) Lingcod (*Opiodon elongatus*) Pacific cod (*Gadus macrocephalus*) Pacific hake (*Merluccius productus*) Sablefish (*Anoplopoma fimbria*) **Skates, Sharks and Chimeras** Big skate (*Raja binoculata*) California skate (*Raja inornata*) Finescale codling (*Antimora microlepis)* Leopard shark (*Triakis semifasciata*) Longnose skate (*Raja rhina*) Pacific rattail (*Coryphaenoides acrolepis)* Soupfin shark (*Galeorhinus zyopterus*) Spiny dogfish (*Squalus acanthias*) Spotted ratfish (*Hydrolagus colliei*)
Source: NMFS 2005a, PFMC 2006a.

Table 1-2: Coastal Pelagic Management Plan Species

Coastal Pelagic Management Plan Species http://www.pcouncil.org/cps/cpsfmp.html
Jack mackerel (*Traxchurus symmetricus*) Krill (euphausiids) Pacific mackerel (*Scomber japonicus*) Pacific sardine(*Sardinops sagax*) Market squid (*Loligo opalescens*) Northern anchovy (*Engraulis mordax*)
Source: PFMC 2003, 2005.

Table 1-3: Highly Migratory Management Plan Species

Highly Migratory Management Plan Species http://www.pcouncil.org/hms/hmsfmp.html
Sharks Bigeye thresher shark (*Alopias superciliosus*) Blue shark (*Prionace glauca*) Common thresher shark (*Alopias vulpinus*) Pelagic thresher shark (*Alopias pelagicus*) Shortfin mako shark (*Isurus oxyrinchus*) **Tunas** Albacore tuna (*Thunnus alalunga*) Bigeye tuna (*Thunnus obesus*) Northern bluefin tuna (*Thunnus orientalis*) Skipjack tuna (*Katsuwonus pelamis*) Yellowfin tuna (*Thunnus albacares*) **Billfish** Striped marlin (*Tetrapturus audax*) **Swordfish** Broadbill swordfish (*Xiphias gladius*) **Dolphin-fish** Dorado (mahi mahi) (*Coryphaena hippurus*)
Source: PFMC 2006b

1.6 ESSENTIAL FISH HABITAT DESCRIPTIONS AND IDENTIFICATIONS

The NMFS and the PFMC designate Essential Fish Habitat and develop Fishery Management Plans for all fisheries occurring within the boundary of the EEZ in the SCB from Point Conception to the U.S./Mexico border. The MSFCMA, as amended by the SFA, contains provisions for the identifying and protecting habitat essential to federally Managed Species. The FMPs identify EFH, describe EFH impacts (fishing and non-fishing), and suggest measures to conserve and enhance EFH. The FMPs also designate HAPCs where one or more of the following criteria are demonstrated: (a) important ecological function; (b) sensitivity to human-induced environmental degradation; (c) development activities stressing the habitat type; or (d) rarity of habitat.

With respect to EFH, nearshore areas are considered to be shallower than 120 ft (36 m) with offshore areas beyond that depth. The continental shelf is considered to begin at the 656 ft (200 m) contour (Figure 1-3). EFH/HAPC designations and detailed life histories, habitat preferences, and distribution maps for each Managed Species are included in the Marine Resources Assessment for the Southern California Operating Area (DON 2005a).

Groundfish species are bottom dwelling finfish. More than 80 species of marine fish are included under the Pacific Coast Groundfish FMP that was adopted by the PFMC in 1982 (PFMC, 2006a). In general, the FMP provides for management of bottom dwelling finfish species (including all rockfish and whiting) that are found in U.S. waters off Washington, Oregon, and California. Of these, fewer than 20 of the commercially and recreationally most important have ever been comprehensively assessed. Groundfish management is complicated and demanding because fisheries for many of the species are interrelated, but the various stocks have responded differently to fishing pressure. For example, flat fish populations such as Dover, Petrale, and English soles have been subjected to significant commercial fisheries for decades yet have not shown the magnitude of declines that have occurred in other rockfish populations. The current status of many rockfish and lingcod off the West Coast is poor, and significant changes in the groundfish fishery have been necessary to address this situation. In response to the sharp decline in groundfish landings and the generally poor condition of West Coast groundfish stocks, the Secretary of Commerce formally announced a disaster determination for the fishery in January 2000 (NOAA 2000).

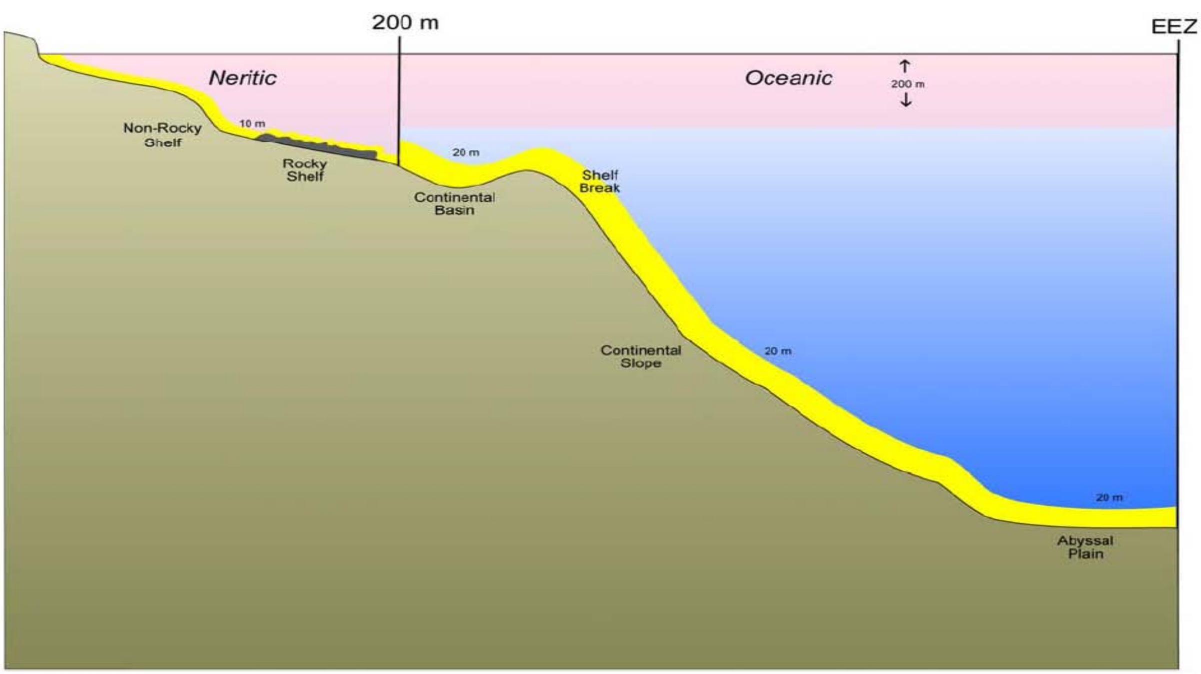


Figure 1-3. Continental Shelf Biological Zones (from SOCAL MRA)

The Pacific Groundfish FMP divides EFH into seven composite habitats including their waters, substrates, and biological communities: 1) estuaries - coastal bays and lagoons, 2) rocky shelf - on or within 10 m (33 ft) of rocky bottom (excluding canyons) from the high tide line to the continental shelf break, 3) nonrocky shelf - on or within 10 m (33 ft) of unconsolidated bottom (excluding the rocky shelf and canyons) from the high tide line to the continental shelf break, 4) canyon - submarine canyons, 5) continental slope/basin - on or within 20 m (66 ft) of the bottom of the continental slope and basin below the shelf break extending to the westward boundary of the EEZ, 6) neritic zone - the water column more than 10 m (33 ft) above the continental shelf, and 7) oceanic zone - the water column more than 20 m (66 ft) above the continental slope and abyssal plain, extending to the westward boundary of the EEZ (PFMC 2006a).

The groundfish species managed by the Pacific Groundfish FMP range throughout the EEZ and occupy diverse habitats at all stages in their life histories (Table 1-4). Some species are broadly dispersed during specific life stages, especially those with pelagic eggs and larvae. The distribution of other species and/or life stages may be relatively limited, as with adults of many nearshore rockfish which show strong affinities to a particular location or substrate type.

Table 1-4: Groundfish Species Essential Fish Habitat

Pacific Groundfish Species EFH and Lifestages Associated With the Seven EFH Designations. A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2006a). * =Associated with macrophytes, algae, or seagrass. (from DON 2005a).							
Group/Species	Estuarine	Rocky Shelf	Non-Rocky Shelf	Neritic	Canyon	Continent Slope/ Basin	Ocean
Flatfish							
Curlfin Sole			A, SA	E		A, SA	E
Dover Sole			A, SA, J	L, E		A, SA, J	L, E
English Sole	A*, SA, J*, L*, E	A*, SA, J*	A*,SA, J*	L*, E		A*	
Petrale Sole			A, J	L, E		A, SA	L, E
Rex Sole	A		A, SA	E		A, SA	L, E
Rock Sole		A*, SA*, J*, E*	A*, SA*, J*, E*	L		A*, SA*, J*, E*	
Sand Sole			A, SA, J	L, E			
Pacific Sanddab	J, L, E		A*, SA, J	L, E			L, E
Rockfish							
Aurora Rockfish			A, MA, LJ			A, MA, LJ	L
Bank Rockfish		A, J	A, J		A, J	A, J	
Black Rockfish	A*, SJ*	LJ*	LJ*	A*, SJ*			A*
Black-and-yellow		A*, MA,		L*			

Pacific Groundfish Species EFH and Lifestages Associated With the Seven EFH Designations.

A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2006a). * =Associated with macrophytes, algae, or seagrass. (from DON 2005a).

Rockfish		LJ*, SJ*, P					
Blackgill Rockfish		LJ		SJ, L		A, LJ	S, LJ
Blue Rockfish		A*, MA, LJ*	LJ*	SJ*,L			
Bocaccio	SJ*, L	A*, LJ*	A*, LJ*	SJ*, L	LJ*	A*, LJ*	
Bronzespotted Rockfish						A	
Brown Rockfish	A*, MA, J*, P	A*, MA, J*, P					
Calico Rockfish	A, J	A, J	A, J				
Canary Rockfish		A, P		SJ*, L		A, P	SJ*, L
Chilipepper		A, LJ, P	A, LJ, P	SJ*, L		A, LJ, P	
China Rockfish		A, J, P		L			
Copper Rockfish	A*, LJ*, SJ*, P	A*, LJ*		SJ*, P			
Cowcod		A, J	J	L			
Darkblotched Rockfish		A, MA, LJ, P	A, MA, LJ, P			A, MA, P	SJ, L
Flag Rockfish		A, P					
Gopher Rockfish		A*, MA, J*, P	A*, A, J*, P				
Grass Rockfish		A*, J*, P					
Greenblotched Rockfish		A, J, P	A, J, P		A, J, P	A, P	
Greenspotted Rockfish		A, J, P	A, J, P				
Greenstriped Rockfish		A, P	A, P				
Honeycomb Rockfish		A, J, P			J		
Kelp Rockfish	SJ*	A*, LJ*,P		SJ*			
Mexican Rockfish		A	A	L			L
Olive Rockfish		A*, J*, P			A*, P		
Pacific Ocean Perch		A, LJ	A, LJ	SJ	A	A, P	SJ, L
Pink Rockfish		A	A			A	
Redbanded Rockfish			A			A	
Redstripe Rockfish		A, P				A, P	
Rosethorn Rockfish		A, P	A, P			A, P	
Rosy Rockfish		A, J, P					
Rougheye Rockfish		A	A			A	
Sharpchin Rockfish		A, P	A, P			A, P	L

Pacific Groundfish Species EFH and Lifestages Associated With the Seven EFH Designations.

A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2006a). * =Associated with macrophytes, algae, or seagrass. (from DON 2005a).

Shortbelly Rockfish		A*, P	A*, P		A*, P	A*, P	
Silverygray Rockfish		A*	A*			A*	
Speckled Rockfish		A, J, P			A, P	A, P	
Splitnose Rockfish			A,J*, P			A, P	
Squarespot Rockfish		A, P			A, P		
Starry Rockfish		A, P				A, P	
Stripetail Rockfish			A, P			A, P	
Tiger Rockfish		A				A	
Treefish		A					
Vermilion Rockfish		A, J*	J*		A	A	
Widow Rockfish		A, MA, LJ,P	A, MA, LJ, P	SJ*, L	A, MA, LJ, P	A, MA, P	SJ*, L
Yelloweye Rockfish		A, P				A, P	
Yellowtail Rockfish		A, MA, LJ, P	A, MA, LJ, P	SJ*		A, MA, P	SJ*
Scorpionfish							
California Scorpionfish	E	A, SA, J	A, SA, J	E			
Thornyheads							
Longspine Thornyhead						A, SA, J	L, E
Shortspine Thornyhead			A			A, SA	L, E
Roundfish							
Cabezon	A, SA, LJ, SJ*, L, E	A, SA, LJ, E		SJ*, L			SJ*, L
Kelp Greenling	A*, SA, LJ*, SJ*, L, E	A*, SA, LJ*, E		SJ*, L			SJ*, L
Lingcod	A*, SA, LJ*, SJ*, L, E	A*, SA, LJ*, E	A*, LJ*	SJ*, L		A*	
Pacific Cod	A, SA, J, L, E		A, SA, J, E	A, SA, J, L		A, SA, E	A, SA, J, L
Pacific Hake (Whiting)	A, SA, J, L, E			A, SA, J, L, E			A, SA, L, E
Pacific Flatnose					A	A	
Pacific Grenadier			A, SA, J			A, SA, J	L

Pacific Groundfish Species EFH and Lifestages Associated With the Seven EFH Designations. A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2006a). * =Associated with macrophytes, algae, or seagrass. (from DON 2005a).							
Sablefish	SJ	A	A, LJ	SJ, L	A, LJ	A, SA	SJ, L, E
Skates/Sharks/Chimeras							
Big Skate			A, MA, J, E			A, MA	
California Skate	A, MA, J, E		A, MA, J, E			A, MA, J, E	
Longnose Skate			A, MA, J, E			A, MA, J, E	
Leopard Shark	A, MA, J, P	A, MA, J, P	A, MA, J, P	A, MA, J, P			
Soupfin Shark	A, MA, J, P	A, MA, J	A, MA, J, P	A, MA, J, P	A, MA, J		A, MA, J
Spiny Dogfish	A, LJ, SJ, P	A, MA, LJ	A, LJ, P	A, LJ, SJ	A	A, MA	A
Spotted Ratfish	A, MA, J	A, MA, J, E	A, MA, J, E			A, MA, J, E	
A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2006a). * =Associated with macrophytes, algae, or seagrass. (from DON 2005a).							

The Groundfish Management Plan designates EFH for Managed Species (i.e., those covered under FMPS) as: all waters and substrate within the following areas; 1) depths less than or equal to 3,500 m (1,914 fm) to mean higher high water level or the upriver extent of saltwater intrusion, 2) seamounts in depths greater than 3,500 m, and 3) areas designated as HAPCs not already identified by the above criteria (Figure 1-4).

The Pacific Fisheries Management Council has identified six HAPC types. One of these types, certain oil rigs in Southern California waters, was disapproved by NMFS. The current HAPC types are: estuaries, canopy kelp, seagrass, rocky reefs, and “areas of interest” (e.g., submarine features, such as banks, seamounts, and canyons) (Table 1-5, Figure 1-5).

Coastal pelagic species (CPS) include six pelagic species. While “pelagic” designates organisms that live in the water column as opposed to living near the sea floor, some species can be distributed anywhere from the surface to 1,000 m (3,280 ft) depending on species-specific preference. Most pelagic species are typically within 200 m of the surface (PMFC 2003, 2005, Allen and Cross 2006).

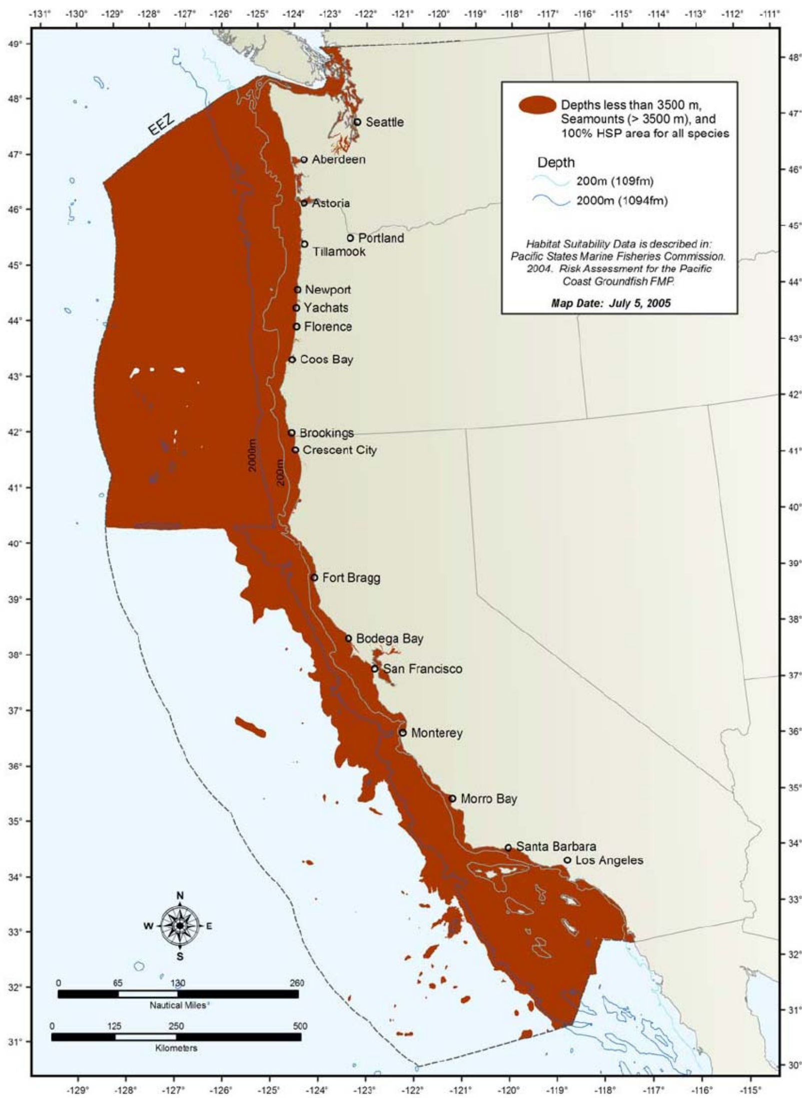


Figure 1-4: Groundfish EFH (from PFMC 2006a)

Table 1-5: EFH and HAPCs in the SOCAL Range Complex

Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPCs) for the SOCAL Range Complex.		
	EFH	HAPCs
Pacific Groundfish	Marine and esturarine waters less than or equal to 3,500 m (1,914 fm) to mean higher high water level or the upwater extent of seawater intrusion, seamounts in depths greater than 3,500 m, and areas designated as HAPCs not identified by the above criteria.	Estuaries, canopy kelp, sea grass, rocky reefs, and other areas of interest.
Coastal Pelagic Species	All marine and estuarine waters above the thermocline from the shoreline offshore to 200 nm offshore.	No HAPCs designated.
Highly Migratory Species	All marine waters from the shoreline offshore to 200 nm offshore.	No HAPCs designated.
Pacific Coast Salmon	North of project area.	North of project area.
Source: NMFS 2005a, PFMC 2005, 2006a,b		

EFH identified for CPS Managed Species is wide-ranging. It includes the geographical range where they are currently found, have been found in the past, and may be found in the future (PFMC 2005). In the SOCAL Range Complex, the CPS EFH includes all marine waters above the thermocline from the shoreline offshore to the limits of the EEZ with no HAPCs designated (PFMC 2005). The thermocline is an area in the water column where water temperature changes rapidly, usually from colder at the bottom to warmer on top. The CPS live near the surface primarily above the thermocline, and within a few hundred miles of the coast, so their designated EFH is less complex than for groundfish Managed Species (Table 1-6).

Only market squid are significantly associated with benthic environments; the females lay their eggs in sheaths on sandy bottom in 33-165 ft (10-50 m) depths (PFMC 2005). The CPS are found in shallow waters and within bays and even brackish waters, but are not considered dependent upon these habitats. They prefer temperatures in the 10-28 °C range with successful spawning and reproduction occurring from 14 to 16 °C. Larger, older individuals are generally found farther offshore and farther north than younger, smaller individuals. Northern areas tend to be utilized most often when temperatures and abundance is high. All life stages of all CPS species are found in the SOCAL Range Complex.

The term “Highly Migratory Species” (HMS) derives from Article 64 of the United Nations Convention on the Law of the Sea (United Nations 1982). Although the Convention does not provide an operational definition of the term, an annex to it lists species considered highly migratory by parties to the Convention. In general, these species have a wide geographic distribution, both inside and outside countries’ 200-mile zones, and undertake migrations of significant but variable distances across oceans for feeding or reproduction. They are pelagic species, which means they do not live near the sea floor, and mostly live in the open ocean, although they may spend part of their life cycle in near shore waters (DON 2005a, Allen and Cross 2006).

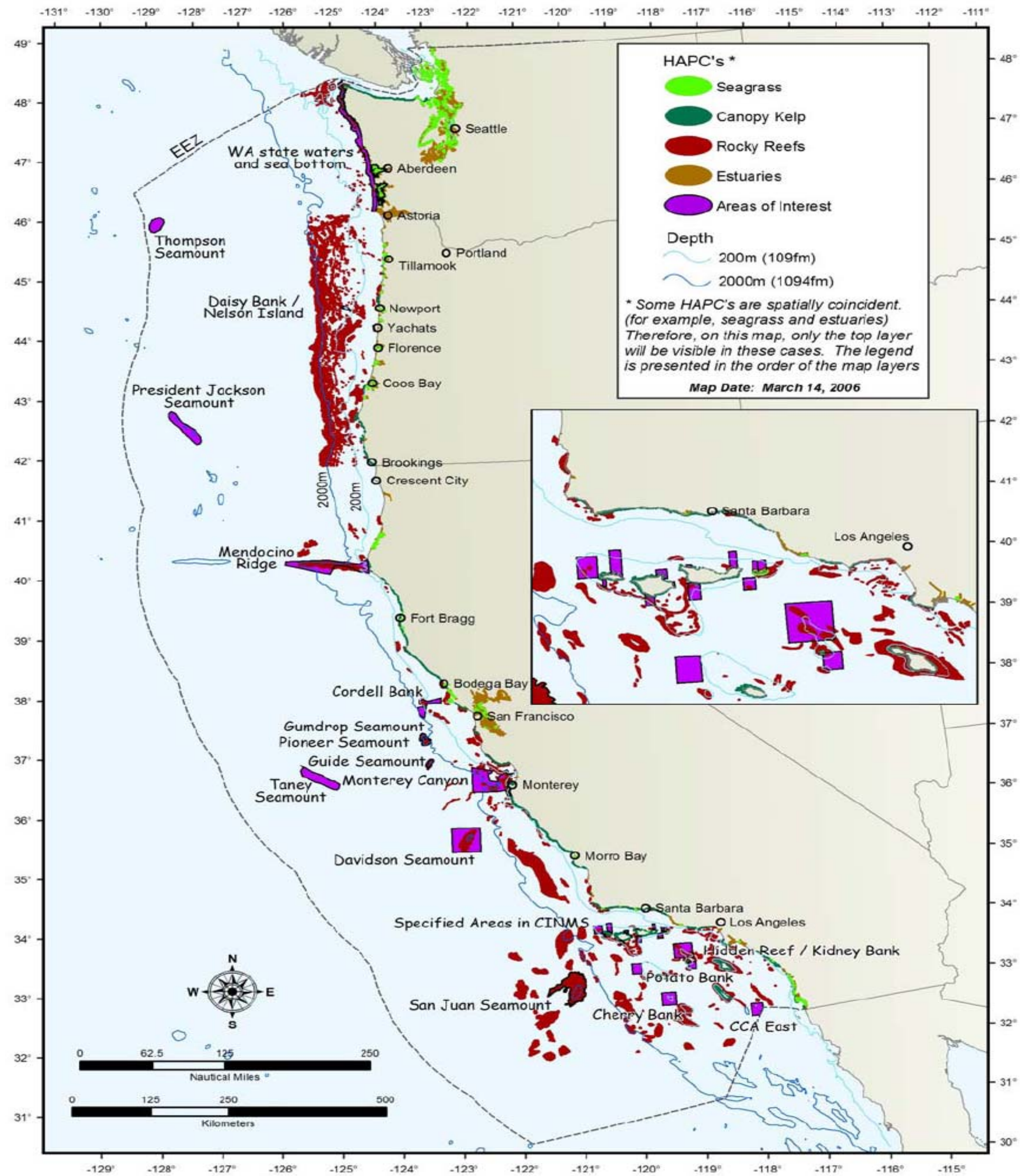


Figure 1-5: Pacific Groundfish HAPCs (from PFMC 2006a)

Table 1-6: Coastal Pelagic Species Essential Fish Habitat

Coastal Pelagic Species and Lifestages Associated with EFH designations.			
Group/Species	Coastal epipelagic	Coastal mesopelagic	Coastal benthic
Krill	E, L, J, A		
Northern anchovy	E, L, J, A		
Mackerels	E, L, J, A		
Sardine	E, L, J, A		
Market Squid	L, J, A		E
A = Adults, J = Juveniles, L = Larvae, E = Eggs. (PFMC 2005).			

HMS species are highly migratory across broad ocean scales, with occurrence in the SCB subject to extreme variability in horizontal and vertical distribution (DON 2005a). Of these pelagic and HMS species, the largest commercial fisheries in Southern California (Los Angeles and San Diego), are for swordfish, albacore tuna, yellowfin tuna, and pacific mackerel based on poundage landed and value reported for the Los Angeles and San Diego areas (see EIS/OEIS Section 3.14, Socioeconomics).

Highly Migratory Species EFH designation for species likely within the Range Complex includes the common thresher shark (all life stages), pelagic thresher shark (late juveniles/sub-adults, adult life stages), bigeye thresher shark (late juveniles/sub-adults, adult life stages), shortfin mako shark (all life stages), blue shark (all life stages), albacore tuna (juvenile and adult life stages), bigeye tuna (juvenile and adult life stages), northern bluefin tuna (juvenile and adult life stages), skipjack tuna (adult life stages), yellowfin tuna (juvenile and adult life stages), striped marlin (adult life stages), broadbill swordfish (juvenile and adult life stages), and dorado (mahi mahi) (juvenile and adult life stages) (DON 2005a).

EFH for Highly Migratory Species such as tuna, sharks, and billfish is even more extensive than for CPS (Table 1-7) (PFMC 2006b, 2007b). HMS travel widely in the ocean, both in terms of area and depth. They are usually not associated with the features typically considered fish habitat (like estuaries, seagrass beds, or rocky bottoms). Their habitat selection appears to be less related to physical features and more to temperature ranges, salinity levels, oxygen levels, and currents. For the U.S. West Coast Fisheries for Highly Migratory Species, EFH occurs throughout the SOCAL Range Complex (PFMC 2006b, 2007b). The PFMC has currently identified no HMS HAPCs . Further, EFH in the Pacific Coast Salmon Plan (PFMC 2003) extends northward from Point Conception and is, thus, out of the Range Complex.

Table 1-7: Highly Migratory Species Essential Fish Habitat

Highly Migratory Species and Lifestages Associated with EFH Designations.				
Group/Species	Coastal epi-pelagic	Coastal meso-pelagic	Oceanic epi-pelagic	Oceanic meso-pelagic
Sharks				
Blue Shark			N, EJ, LJ, SA, A	
Shortfin Mako			N, EJ, LJ, SJ, A	
Thresher Sharks	LJ, SA, A	LJ, SA, A	LJ, SA, A	LJ, SA, A
Tunas				
Albacore			J, A	
Bigeye Tuna			J, A	J, A
Northern Bluefin			J	
Skipjack			A	
Yellowfin			J	
Billfish				
Striped Marlin			A	
Swordfish				
Broadbill Swordfish			J, A	J, A
Dolphinfish				
Dorado			J, SA, A	
A = Adults, SA = Sub-Adults, LJ = Late Juveniles, N= Neonate, EJ = Early Juveniles, J = Juveniles, L = Larvae, E = Eggs. (PFMC 2006b, 2007b).				

1.7 MANAGED SPECIES

Groundfish Managed Species are found throughout the SOCAL Range Complex. As indicated above, EFH for groundfish includes all waters from the high tide line to 3,500 m (1,914 fathoms (fm)) in depth (PFMC 2006a).

The Pacific coast groundfish fishery is the largest, most important fishery managed by the Pacific Fishery Management Council in terms of landings and value (PFMC 2006a). The 83 species managed under the Pacific Groundfish Management Plan are usually found on or near the bottom; rockfish - 63 species including widow, yellowtail, canary, shortbelly, and vermilion rockfish; bocaccio, chilipepper, cowcod, yelloweye, thornyheads, and Pacific Ocean perch; roundfish - six species: lingcod, cabezon, kelp greenling, Pacific cod, Pacific whiting (hake), and sablefish; flatfish - 12 species including various soles, starry flounder, and sanddab; sharks and skates - six species: leopard shark, soupfin shark, spiny dogfish, big skate, California skate, and longnose skate; and three other species: ratfish, finescale codling, and Pacific rattail grenadier (Table 1-1) (PFMC 2006a).

Rockfish can be found from the intertidal zone out to deepest waters of the EEZ (Love 1998, Love et al. 2002, Leet et al. 2001, CDFG 2000). For management purposes, these species are often placed in three groups defined by depth range and distance offshore; nearshore rockfish, shelf rockfish, and slope rockfish (Table 1-8).

Table 1-8: Rockfish Distribution in the SOCAL Range Complex

Shallow Nearshore Rockfish	
black-and-yellow (S. chrysomelas)	grass (S. rastrelliger)
China (S. nebulosus)	kelp (S. atrovirens)
gopher (S. carnatus)	
Deeper Nearshore Rockfish	
black (Sebastes melanops)	copper (S. caurinus)
blue (S. mystinus)	olive (S. serranoides)
brown (S. auriculatus)	quillback (S. maliger)
calico (S. dalli)	treefish (S. serriceps)
Shelf Rockfish	
bocaccio (Sebastes paucispinis)	pinkrose (S. simulator)
bronzespotted (S. gilli)	pygmy (S. wilsoni)
canary (S. pinniger)	redstriped (S. proriger)
chameleon (*S. phillipsi*)	rosethorn (*S. helvomaculatus*)
chilipepper (*S. goodei*)	rosy (*S. rosaceus*)
cowcod (*S. levis*)	silvergrey (*S. brevispinis*)
dwarf-red (*S. rufinanus*)	speckled (*S. ovalis*)
flag (*S. rubrivinctus*)	squarespot (*S. hopkinsi*)
freckled (*S. lentiginosus*)	starry (*S. constellatus*)
greenblotched (*S. rosenblatti*)	stripetail (*S. saxicola*)
greenspotted (*S. chlorostictus*)	swordspine (*S. ensifer*)
greenstriped (*S. elongatus*)	tiger (*S. nigrocinctus*)
halfbanded (*S. semicinctus*)	vermilion (*S. miniatus*)
honeycomb (*S. umbrosus*)	yelloweye (*S. ruberrimus*)
Mexican (*S. macdonaldi*)	yellowtail (*S. flavidus*)
pink (*S. eos*)	
Slope Rockfish	
aurora (*S. aurora*)	rougheye (*S. aleutianus*)
bank (*S. rufus*)	sharpchin (*S. zacentrus*)
blackgill (*S. melanostomus*)	shortraker (*S. borealis*)
darkblotched (*S. crameri*)	splitnose (*S. diploproa*)
Pacific ocean perch (*S. alutus*)	yellowmouth (*S. reedi*)
redbanded (*S. babcocki*)	
Source: CDFG 2007b	

The nearshore rockfish spend most of their lives in relatively shallow water. This group is often subdivided into a shallow component and a deeper component. Shelf rockfish are found along the continental shelf (Figure 1-3). Slope rockfish occur in the deeper waters of the shelf and down the continental slope. The roundfish, flatfish, sharks, and skates covered under the Groundfish FMP are generally concentrated in shallow water while the ratfish, finescale codling, and Pacific rattail are deepsea fish (Eschmeyer et al. 1985, CDFG 2000, Leet et. al. 2001).

A variety of different fishing gear is used to target groundfish including troll, longline, hook and line, pots, gillnets, and other types of gear (Table 1-9 (from NMFS 2005b)). The West Coast groundfish fishery has four components: limited entry - which limits the number of vessels allowed to participate; open access - which allocates a portion of the harvest to fishers without limited entry permits; recreational; and tribal - fishers who have a federally recognized treaty rights (PFMC 2006a).

Table 1-9: Gear Types Used in the West Coast Groundfish Fishery

Fishery	Trawl and Other Net	Longline, Pot, Hook & Line	Other
Limited Entry Fishery (commercial)	Mid-water Trawl, Whiting trawl, Scottish Seine	Pot, Longline	
Open Access Fishery Directed Fishery (commercial)	Set Gillnet Sculpin Trawl	Pot, Longline, Vertical hook/line, Rod/Reel, Troll/dinglebar, Jig, Drifted (fly gear), Stick	
Open Access Fishery Incidental Fishery (commercial)	Exempted Trawl (pink shrimp, spot and ridgeback prawn, CA halibut, sea cucumber), Setnet, Driftnet, Purse Seine (Round Haul Net)	Pot (Dungeness crab, CA sheephead, spot prawn) Longline, Rod/reel Troll	Dive (spear) Dive (with hook and line) Poke Pole
Recreational	Dip Net, Throw Net (within 3 miles)	Hook and Line methods Pots (within 3 miles) from shore, private boat, commercial passenger vessel	Dive (spear)

The Coastal Pelagics FMP includes four finfish (northern anchovy, Pacific sardine, Pacific (chub) mackerel, jack mackerel), and two invertebrates, market squid and krill (Table 1-2). The CPS inhabit the pelagic realm, i.e., live in the water column, not near the sea floor. They are usually found from the surface to 1,000 m (3,281 ft) deep (PFMC 2005).

Northern anchovy (*Engraulis mordax*) are small, short-lived fish that typically school near the surface. They occur from British Columbia to Baja California. Northern anchovies are divided into northern, central, and southern sub-populations. The central sub-population used to be the focus of large commercial fisheries in the U.S. and Mexico. Most of this sub-population is located in the SCB between Point Conception, California and Point Descanso, Mexico. Northern anchovy are an important part of the food chain for other species, including other fish, birds, and marine mammals.

Pacific sardine (*Sardinops sagax*), also small schooling fish, have been the most abundant fish species managed under the Pacific Groundfish FMP. They range from the tip of Baja California to southeastern Alaska and throughout the Gulf of Mexico. Sardines live up to 13 years, but are usually captured in the fishery at less than 5 years old.

Pacific (chub) mackerel (*Scomber japonicus*) are found from Mexico to southeastern Alaska, but are most abundant south of Point Conception, California within 20 miles (mi) (32 km) from shore. The “northeastern Pacific” stock of Pacific mackerel is harvested by fishers in the U.S. and Mexico. Like sardines and anchovies, mackerel are schooling fish, often co-occurring with other pelagic species like jack mackerel and sardines. As with other CPS, they are preyed upon by a variety of fish, mammals, and sea birds.

Jack mackerel (*Trachurus symmetricus*) grow to about 60 centimeters (cm) (2 ft) and can live up to 35 years. They are found throughout the northeastern Pacific, often well outside the EEZ. Small jack mackerel are most abundant in the SCB, near the mainland coast, around islands, and over shallow rocky banks. Older, larger fish range from Cabo San Lucas, Baja California, to the Gulf of Alaska, offshore into deep water and along the coast to the north of Point Conception. Jack mackerel in southern California usually school over rocky banks, artificial reefs, and shallow rocky reefs (PFMC 2005).

Market squid (*Loligo opalescens)* range from the southern tip of Baja California to southeastern Alaska. They are most abundant between Punta Eugenio, Baja California, and Monterey Bay, California. Usually found near the surface, market squid can occur to depths of 800 m (2,625 ft) or more. Squid live less than a year and prefer full-salinity ocean waters. They are important forage foods for fish, birds and marine mammals (PFMC 2005).

In 2006, the PFMC adopted a complete ban on commercial fishing for all species of krill in West Coast federal waters (PFMC 2006c). Krill (euphausiids) are small shrimp-like crustaceans that are an important basis of the marine food chain. They are eaten by many Managed Species, as well as by whales and seabirds. The PFMC is presently considering identifying EFH and possibly HAPCs for two individual krill species, *Euphausia pacifica* and *Thysanoessa spinifera*, and for other species of krill as a separate category.

Coastal pelagic species are harvested directly and incidentally (as bycatch) in other fisheries. Usually targeted with "round-haul" gear including purse seines, drum seines, lampara nets, and dip nets, they are also taken as bycatch in midwater trawls, pelagic trawls, gillnets, trammel nets, trolls, pots, hook-and-line, and jigs. Market squid are fished nocturnally using bright lights to attract the squid to the surface. They are pumped directly from the sea into the hold of the boat, or taken with an encircling net (PFMC 2005).

Most of the CPS commercial fleet is located in California, mainly in Los Angeles, Santa Barbara-Ventura, and, Monterey. About 75 percent of the market squid and Pacific sardine catch are exported, mainly to China, Australia (where they are used to feed farmed tuna), and Japan (where they are used as bait for longline fisheries).

The U.S. West Coast Fisheries for HMS covers 13 free-ranging species; 5 tuna - Pacific albacore, yellowfin, bigeye, skipjack, and northern bluefin; 5 sharks - common thresher, pelagic thresher, bigeye thresher, shortfin mako, and blue shark; 2 billfish - striped marlin and Pacific swordfish; and dorado (also known as dolphinfish and mahi-mahi) (Table 1-3) (PFMC 2006b). HMS have a wide geographic distribution, both inside and outside the EEZ. They are open-ocean, pelagic species, that may spend part of their life cycle in nearshore waters. HMS are harvested by U.S. commercial and recreational fishers and by foreign fishing fleets, with only a fraction of the total harvest taken within U.S. waters (PFMC 2006b). HMS are also an important component of the recreational sport fishery, especially in southern California.

The PFMC has developed stock rebuilding plans for seven overfished, depleted species; Bocaccio, Canary Rockfish, Cowcod, Darkblotched Rockfish, Pacific Ocean Perch, Widow Rockfish, and Yelloweye Rockfish (PFMC 2006d). Conservation Areas, closed to fishing, have also been established to protect sensitive Pacific Coast Groundfish habitat (Figure 1-6, from PMFC 2006a). Though not much bottom trawling is done south of Pt. Conception, bottom trawling and other bottom fishing activities are prohibited in Cowcod Conservation Areas (Figure 1-7, PMFC 2006a).

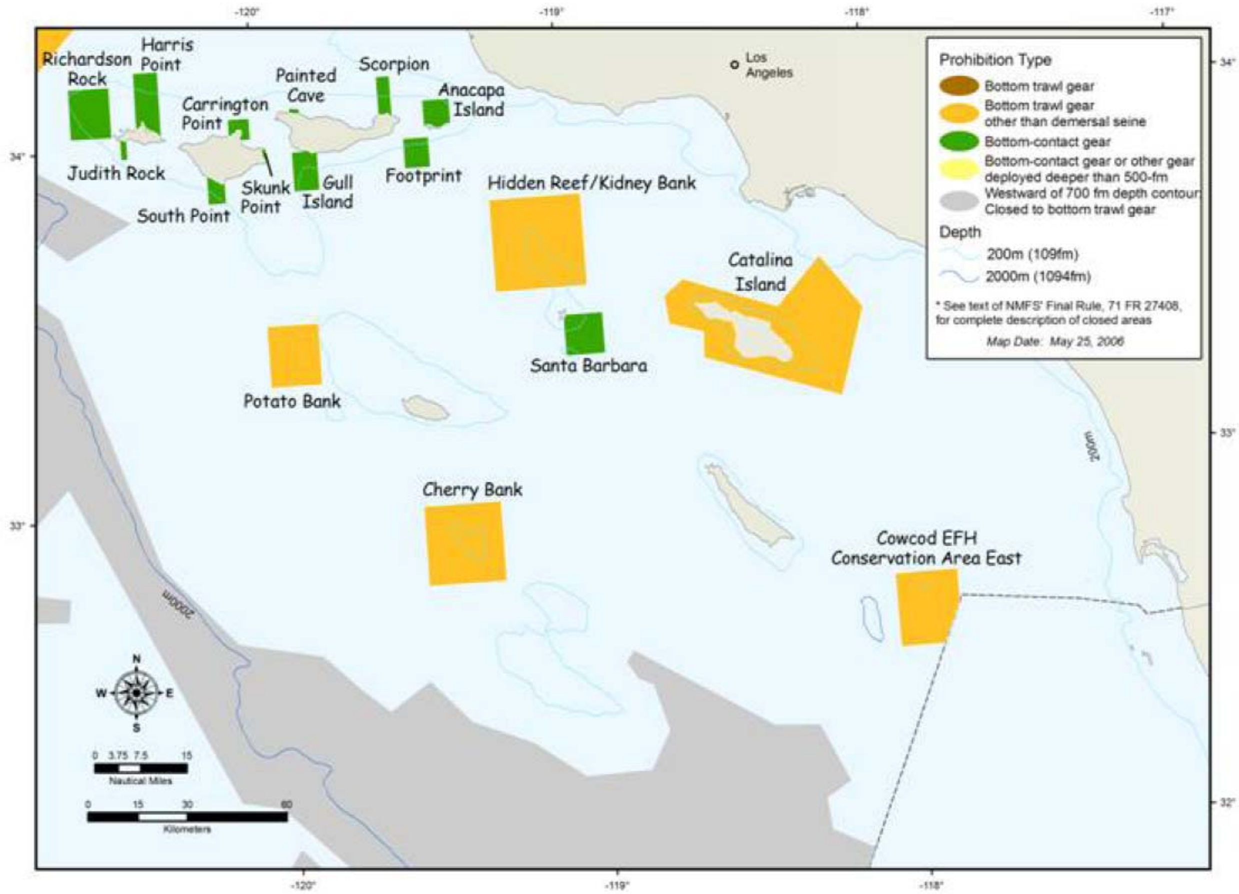


Figure 1-6: Essential Fish Habitat Conservation Areas

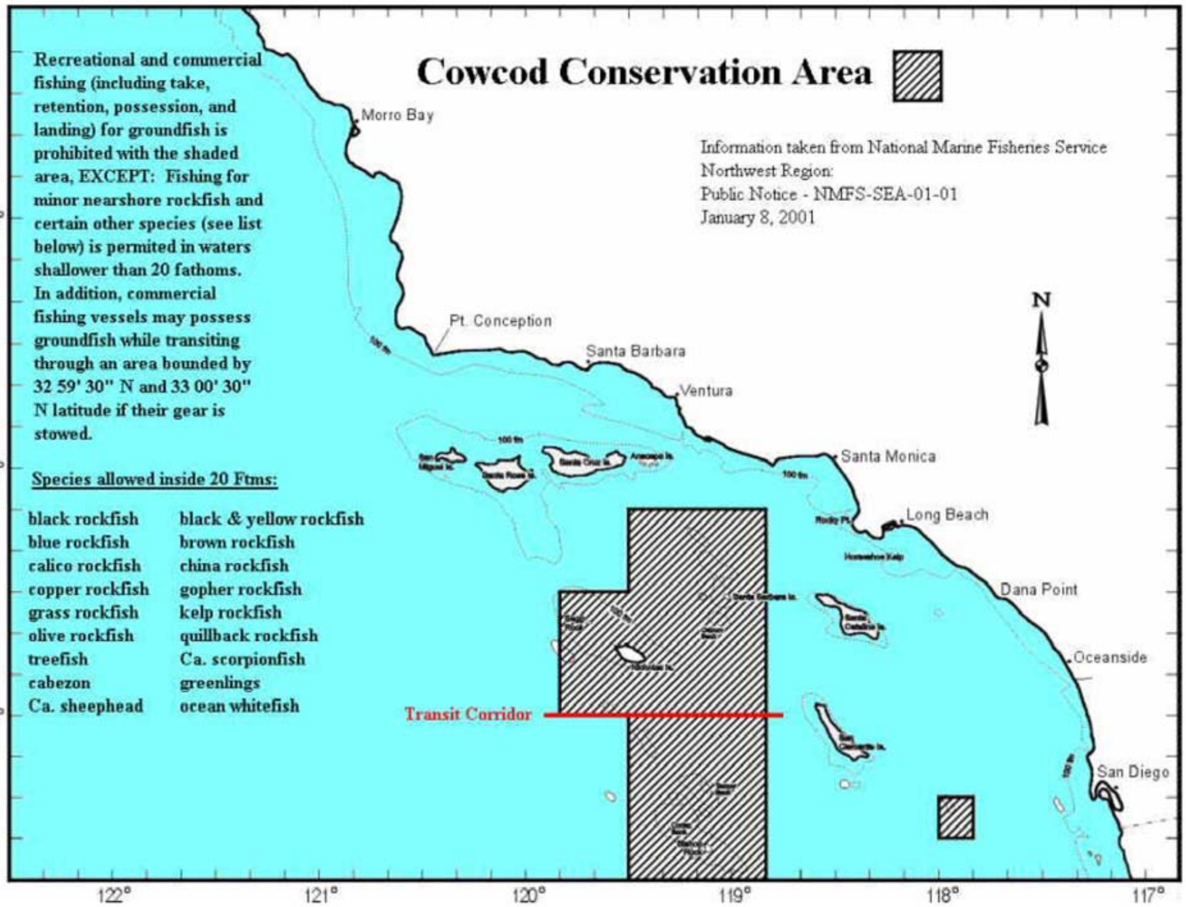


Figure 1-7: Cowcod Conservation Areas

Under the HMS FMP, the PFMC monitors other species for informational purposes. In addition, some species-including great white sharks, megamouth sharks, basking sharks, Pacific halibut, and Pacific salmon - are designated as prohibited catch. If fishers targeting highly migratory species catch these species, they are required to immediately release them (PFMC 2006b). The HMS fishery, with the exception of the swordfish drift gillnet fishery off California, is one of the only remaining open access fishery on the West Coast. However, the PFMC is currently considering a limited entry program to control excess capacity (PFMC 2006b).

Many different gear types are used to catch HMS in California (PFMC 2006b). These include; 1) trolling lines - fishing lines with jigs or live bait deployed from a moving boat, 2) drift gillnets - panels of netting weighted along the bottom and suspended vertically in the water by floats that are anchored to a vessel drifting along with the current, 3) harpoon - a small and diminishing fishery mainly targeting swordfish, 4) pelagic longlines - baited hooks on short lines attached to a horizontal line (the HMS FMP now prohibits West Coast longliners from fishing in the EEZ due to concerns about the take of endangered sea turtles), 5) coastal purse seines - encircling nets closed by synching line threaded through rings on the bottom of the net (usually targeting sardines, anchovies, and, mackerel but also target tuna where available), 6) large purse seines - used in major fisheries in the eastern tropical Pacific and the central and western Pacific (this fishery is monitored by the Inter-American Tropical Tuna Commission, and, in the EEZ by NMFS); and, 7) recreational fisheries - HMS recreational fishers in California include private vessels and charter vessels using hook-and-line to target tunas, sharks, billfish, and dorado (NMFS2006b).

Pacific halibut (*Hippoglossus stenolepis*) is managed by the International Pacific Halibut Commission (IPHC 2007). This large species of halibut is mainly encountered well north of the project area, and, its harvest is prohibited in the SOCAL Range Complex. A smaller relative, the California halibut (*Paralichthys californicus*), is found along the coast of southern California, but is not included in a FMP.

Although EFH mandates are stipulated in federal legislation, EFH habitat defined in FMPs includes state waters. These areas in California (i.e., inshore of 3 nm) are managed under the California Marine Life Management Act (CMLMA) (CDFG 2007c). Four California FMPs have been produced covering market squid, white seabass, nearshore finfish, and abalone (CDFG 2007d,e,f,g).

Market squid (*Loligo opalescens*), discussed previously under the Coastal Pelagics FMP, is the state's largest fishery by tonnage and economic value (CDFG 2007d). Market squid are also important to the recreational fishery as bait and as forage for fish, marine mammals, birds, and other marine life. Squid belong to the class Cephalopoda of the phylum Mollusca. They have large eyes and strong parrot-like beaks. Using their fins for swimming and jets of water from their funnel they are capable of rapid propulsion forward or backward. The squid's capacity for sustained swimming allows it to migrate long distances (CDFG 2007d).

White seabass (*Atractoscion nobilis*), large members of the croaker family, occur in ocean waters off the west coasts of California and Mexico. This highly-prized species is recovering from reduced population levels in late 1900s. The current, California management strategy provides for moderate harvests while protecting young white seabass and spawning adults through seasonal closures, gear provisions, and size and bag limits (CDFG 2007e).

The California Nearshore Fishery Management Plan (CDFG 2007f) covers 28 species that frequent kelp beds and reefs less than 120 ft (36 m) deep off the coast of California and near offshore islands (Table 1-10, from CDFG 2007f).

Table 1-10: Species Managed Under the California Nearshore Fisheries Management Plan

Kelp greenling - *Hexagrammos decagrammus*
Lingcod - *Ophiodon elongatus*
Pacific cod - *Gadus macrocephalus*
Pacific whiting - *Merluccius productus*
Sablefish - *Anoplopoma fimbria*
Black rockfish - *Sebastes melanops*
Black-and-yellow rockfish - *Sebastes chrysomelas*
Blue rockfish - *Sebastes mystinus*
Brown rockfish - *Sebastes auriculatus*
Cabezon - *Scorpaenichthys marmoratus*
Calico rockfish - *Sebastes dallii*
California rockfish - *Scorpena guttatta*
California sheephead – *Semicossyphus pulcher*
China rockfish - *Sebastes nebulosus*
Copper rockfish - *Sebastes caurinus*
Gopher rockfish - *Sebastes carnatus*
Kelp greenling – *Hexagrammos decagrammus*
Kelp rockfish - *Sebastes atrovirens*
Monkeyface prickleback – *Cebidichthys violaceus*
Olive rockfish - *Sebastes serranoides*
Quillback rockfish - *Sebastes maliger*
Rock greenling - *Hexagrammos lagocephalus*
Treefish - *Sebastes serriceps*
Vermilion rockfish - *Sebastes miniatus*
Widow rockfish - *Sebastes entomelas*
Yelloweye rockfish - *Sebastes ruberrimus*
Yellowmouth rockfish - *Sebastes reedi*
Yellowtail rockfish - *Sebastes flavidus*

Thirteen of these species are rockfish - all of which are included in the Pacific Groundfish FMP. Three of the remaining six species are also covered under the Pacific Groundfish FMP. The three species not covered by the Pacific Groundfish FMP are the California sheephead (*Semicossyphus pulcher*), the rock greenling (*Hexagrammos lagocephalus*), and the monkeyface prickleback (*Cebidichthys violaceus*) (CDFG 2007f).

The California sheephead is a large, colorful member of the wrasse family (Love 1996). Male sheephead reach a length of 3 ft (90 cm), a weight of 36 pounds (lb), and have a white chin, black head, and, a pink to red body. Females are smaller, with a brown-colored body (Eschmeyer, Herald, and Hammann 1985). Sheephead populations off southern California have declined because of fishing pressure. Large males are now rare because they are sought by recreational spear fishermen. Sheephead are taken commercially by traps and kept alive for display in restaurant aquaria where patrons select a specific fish for preparation (Leet et al. 2001). The rock greenling is a smaller member of the lingcod family. The monkeyface prickleback, also called the monkeyface eel, is more closely related to rockfish than eels. Its elongate shape is an adaptation to living in cracks, crevices, and under boulders (Love 1996).

The Abalone Recovery and Management Plan (CDFG 2007g) provides a cohesive framework for the recovery of depleted abalone populations in southern California. All of California's abalone species are included in the plan: red abalone, *Haliotis rufescens*; green abalone, *H. fulgens*; pink abalone, *H. corrugata*; white abalone, *H. sorenseni*; pinto abalone, *H. kamtschatkana* (including *H.k. assimilis*); black abalone, *H. cracherodii*; and flat abalone, *H. walallensis*. A recovery and management plan for these species is needed to manage abalone fisheries and prevent further population declines throughout California, and to ensure that current and future populations will be sustainable.

The decline of abalone is due to a variety of factors, primarily commercial and recreational fishing, disease, and natural predation. The recovery of a near-extinct abalone predator, the sea otter, has further eliminated the possibility for an abalone fishery in most of central California. Withering syndrome, a lethal bacterial infection, has caused widespread decline among black abalone in the Channel Islands and along the central California coast. As nearshore abalone populations became depleted, fishermen traveled to more distant locations, until stocks in most areas had collapsed. Advances in diving technology also played a part in stock depletion. The advent of self-contained underwater breathing apparatus (SCUBA) in the mid-1900s gave birth to the recreational fishery in southern California, which placed even more pressure on a limited number of fishing areas.

Following stock collapse, the California Fish and Game Commission closed the southern California pink, green, and white abalone fisheries in 1996, and all abalone fishing south of San Francisco in early 1997. The southern abalone fishery was closed indefinitely with the passage of the Thompson bill (AB 663) in 1997. This bill created a moratorium on taking, possessing, or landing abalone for commercial or recreational purposes in ocean waters south of San Francisco, including all offshore islands.

2 PROPOSED ACTION

2.1 SOCAL RANGE COMPLEX OPERATIONS

The Navy proposes to implement actions within the SOCAL Range Complex to: maintain baseline training and research, development, testing, and evaluation (RDT&E) operations at current levels; increase training and RDT&E operations from current levels as necessary to support fleet readiness; accommodate mission requirements associated with force structure changes and introduction of new weapons and systems to the Fleet; and, implement enhanced range complex capabilities.

These actions potentially include: increased numbers of training operations of the types currently being conducted in the SOCAL Range Complex; expansion of the size and scope of amphibious landing training exercises in the SOCAL Ocean OPAREAS and at San Clemente Island (offshore and on land); conduct of operations on the planned extension of the Shallow Water Training Range (SWTR) in the offshore area of the SCI; development of additional Training Areas and Ranges (TARs) for Naval Special Warfare (NSW) training on the land areas of SCI; increase in Commercial Air Services support for Fleet Opposition Forces (OPFOR) and Electronic Combat (EC) Threat Training; construction and operation of a Shallow Water Mine Field in the offshore and near-shore areas of SCI; and, support of training for Littoral Combat Ship (LCS) warfare missions (including MIW, ASW, and SUW), MH-60R/S helicopter warfare mission areas (including MIW, ASW, SUW, and Combat Search and Rescue (CSAR)), and EA-18G Growler EC aircraft missions throughout the SOCAL Range Complex.

Military activities in SOCAL Range Complex occur (1) on the ocean surface, (2) under the ocean surface, (3) in the air, and (4) on land at SCI. For purposes of scheduling and managing these activities and the ranges, the Range Complex is divided into multiple components.

"W-291" is the Federal Aviation Administration (FAA) designation of the extensive Special Use Airspace (SUA) of the SOCAL Range Complex. This SUA extends from the ocean surface to 80,000 ft. mean sea level (MSL) and encompasses 113,000 nm^3 of airspace. The ocean area underlying the W-291 (i.e., 113,000 nm^3 of sea space) forms the majority of the ocean OPAREA of the SOCAL Range Complex. This OPAREA extends to the sea floor.

Within the area defined by the lateral bounds of W-291, the SOCAL Range Complex encompasses specialize range or training areas in the air, on the surface, or undersea. Depending on the intended use, these specialized range areas may encompass only airspace or may extend from the sea floor to 80,000 ft MSL. A designated air-to-air combat maneuver area is an example of specialized airspace-only range area. Range areas designated for helicopter training in ASW or submarine missile launches, for example, extend from the ocean floor to 80,000 ft. MSL.

The W-291 airspace and associated OPAREAs, including specialized range areas, are described in Table 2-1 and depicted in Figure 2-1. There are several OPAREAS in the SOCAL Range Complex that do not underlay W-291 (Table 2-2). These OPAREAS are used for ocean surface and subsurface training. Military aviation activities also occur in the SOCAL Range Complex outside of W-291. These aviation activities do not include use of live or non-explosive ordnance. For example, amphibious operations involving helicopters and carrier flight operations occur in the SOCAL Range Complex outside W-291.

Table 0-1: W-291 and Associated OPAREAs

Area Designation	Description
Warning Area (W-291)	W-291 is the largest component of SUA in the Navy inventory. It encompasses 113,000 nm^2 (209,276 km^2) located off of the southern California coastline (Figure 2-1), extending from the ocean surface to 80,000 ft above MSL. W-291 supports aviation training and RDT&E conducted by all aircraft in the Navy and Marine Corps inventories. Conventional ordnance use is permitted.
Tactical Maneuvering Areas (TMA) (Papa 1-8)	W-291 airspace includes eight TMAs (designated Papa 1-8) extending from 5,000 to 40,000 ft (1,524 to 12,192 m) MSL. Exercises conducted include Air Combat Maneuvering (ACM), air intercept control aerobatics, and AA gunnery. Conventional ordnance use is permitted.
Air Refueling Areas	W-291 airspace includes three areas which are designated for aerial refueling.
Class “E” airspace (Area Foxtrot)	W-291 airspace includes Class "E" airspace designated as Area Foxtrot, which is activated by the FAA for commercial aviation use as needed (such as during periods of inclement weather or when Lindbergh Field International Airport is utilizing Runway 09).
Fleet Training Area Hot (FLETA HOT)	FLETA HOT is an open ocean area that extends from the ocean bottom to 80,000 ft (24,384 m). The area is used for hazardous operations, primarily surface-to-air and air-to-air ordnance. Types of exercises conducted include AAW, ASW, underway training, and Independent Steaming Exercises (ISE). Conventional ordnance use is permitted.
Over-water parachute drop zones	Three parachute drop zones used by Navy and Marine Corps units are designated within the SOCAL Range Complex. Two of these (Neptune and Saint) lie within the bounds of W-291. One (Leon) lies between W-291 and Naval Base Coronado (NBC).
Missile Range 1 and 2 (MISR-1/MISR-2)	MISR-1 and MISR-2 are located about 60 nm (111 km) south and southwest of NBC, and extend from the ocean bottom up to 80,000 ft MSL. Exercises conducted include rocket and missile firing, ASW, carrier and submarine operations, fleet training, ISE, and surface and air gunnery. Conventional ordnance use is permitted.
Northern Air Operating Area (NAOPA)	The NAOPA is located east of SCI and approximately 90 nm (167 km) west of NBC. It extends from the ocean bottom to 80,000 ft (24,384 m). Exercises in NAOPA include fleet training, multi-unit exercises, and individual unit training. Conventional ordnance is use is permitted.
Electronic Warfare (EW) Range	The EW Range utilizes advanced technology to simulate electronic attacks on naval systems from sites on SCI. The range not is defined as a designated location. Rather it is defined by the electronic nature and extent of the training support it provides. The EW Range supports 50 types of electronic warfare training events for ships and aircraft operating in W-291 airspace and throughout the OPAREAS.
Kingfisher Training Range (KTR)	KTR is a 1-by-2 nm (1.85 x 3.7 km) area in the waters approximately 1 nm (1.85 km) offshore of SCI. The range provides training to surface warfare units in mine detection and avoidance. The range consists of mine-like shapes moored to the ocean bottom by cables.
Laser Training Range (LTR)	LTRs 1 and 2 are offshore water ranges northwest and southwest of SCI, established to conduct over-the-water laser training and testing of the laser-guided Hellfire missile.

Area Designation	Description
Mine Training Range (MTR)	Two MTRs and two mine laying areas are established in the nearshore areas of SCI. MTR-1 is the Castle Rock Mining Range off the northwestern coast of the island. MTR-2 is the Eel Point Mining Range off the midpoint of the southwestern side. In addition, mining training takes place in the China Point area, off the southwestern point of the island, and in the Pyramid Head area, off the island's southeastern tip. These ranges are used for training of aircrews in offensive mine laying by delivery of non-explosive mine shapes (no explosives) from aircraft.
OPAREA 3803	OPAREA 3803 is an area adjacent to SCI extending from the sea floor to 80,000 ft. Operations in OPAREA 3803 include aviation training and submarine training events during JTFEX and COMPTUEX. The SCI Underwater Range lies within OPAREA 3803.
San Clemente Island Underwater Range (SCIUR)	SCIUR is a 5-nm^2 (9.3-km^2) area northeast of SCI. The range is used for ASW training and RDT&E of undersea systems. The range contains six hydrophone arrays mounted on the sea floor that produce acoustic target signals.
Southern California ASW Range (SOAR)	SOAR is located offshore to the west of SCI. The underwater tracking range covers over 670 nm^2 (1,241 km^2), and consists of seven subareas. The range has the capability of providing three-dimensional underwater tracking of submarines, practice weapons, and targets with a set of 84 acoustic sensors (hydrophones) located on the sea floor. Communication with submarines is possible through use of an underwater telephone capability. SOAR supports various ASW training scenarios that involve air, surface, and subsurface units.
SOAR Variable Depth Sonar (VDS) No-Notice Area	The VDS area is used as an unscheduled and no-notice area for training with surface ships' sonar devices. The vertical dimensions are from the surface to a maximum depth of 400 ft (122 m). The VDS overlaps portions of the SOAR and the MINEX training range.
SOCAL Missile Range	SOCAL Missile Range is not a permanently designated area, but is invoked by the designation of portions of the ocean OPAREAS and W-291 airspace, as necessary, to support Fleet live-fire training missile exercises. The areas invoked vary, depending on the nature of the exercise, but generally are extensive areas over water south/southwest of SCI.
Fire Support Areas (FSAs) I and II.	FSAs are designated locations offshore of SCI for the maneuvering of naval surface ships firing guns into impact areas located on SCI. The offshore FSAs and onshore impact areas together are designated as the Shore Bombardment Area (SHOBA).

Table 0-2: Ocean OPAREAs Outside W-291

Ocean Area	Description
Advance Research Projects Agency (ARPA) Training Minefield	The ARPA Training Minefield lies within the Encinitas Naval Electronic Test Area (ENETA), and extends from the ocean bottom to the surface. Exercises conducted are mine detection and avoidance. Ordnance use is not permitted.
Encinitas Naval Electronic Test Area (ENETA)	The ENETA is located about 20 nm (37 km) northwest of NBC. The area extends from the ocean bottom up to 700 ft (213 m) MSL. Exercises conducted include fleet training and ISE. Ordnance use is not permitted.
Helicopter Offshore Training Area (HCOTA)	Located in the ocean area off NBC, the HCOTA is divided into five “dipping areas” (designated A/B/C/D/E), and extends from the ocean bottom to 1,000 ft (305 m) MSL. This area is designed for ASW training for helicopters with dipping sonar. Ordnance use is not permitted.
San Pedro Channel Operating Area (SPCOA)	The SPCOA is an open ocean area about 60 nm (111 km) northwest of the NBC, extending to the vicinity of Santa Catalina Island, from the ocean floor to 1,000 ft (305 m) MSL. Exercises conducted here include fleet training, mining, mine countermeasures, and ISE. Ordnance use is not permitted.
Western San Clemente Operating Area (WSCOA)	The WSCOA is located about 180 nm (333 km) west of NBC. It extends from the ocean floor to 5,000 ft (1,524 m) MSL. Exercises conducted include ISE and various fleet training events. Ordnance use is not permitted.
Camp Pendleton Amphibious Assault Area (CPAAA) and Amphibious Vehicle Training Area (CPAVA)	CPAAA is an open ocean area located approximately 40 nm (74 km) northwest of NBC, used for amphibious operations. No live or non-explosive ordnance is authorized. CPAVA is an ocean area adjacent to the shoreline of Camp Pendleton used for near-shore amphibious vehicle and landing craft training. Ordnance use is not permitted.

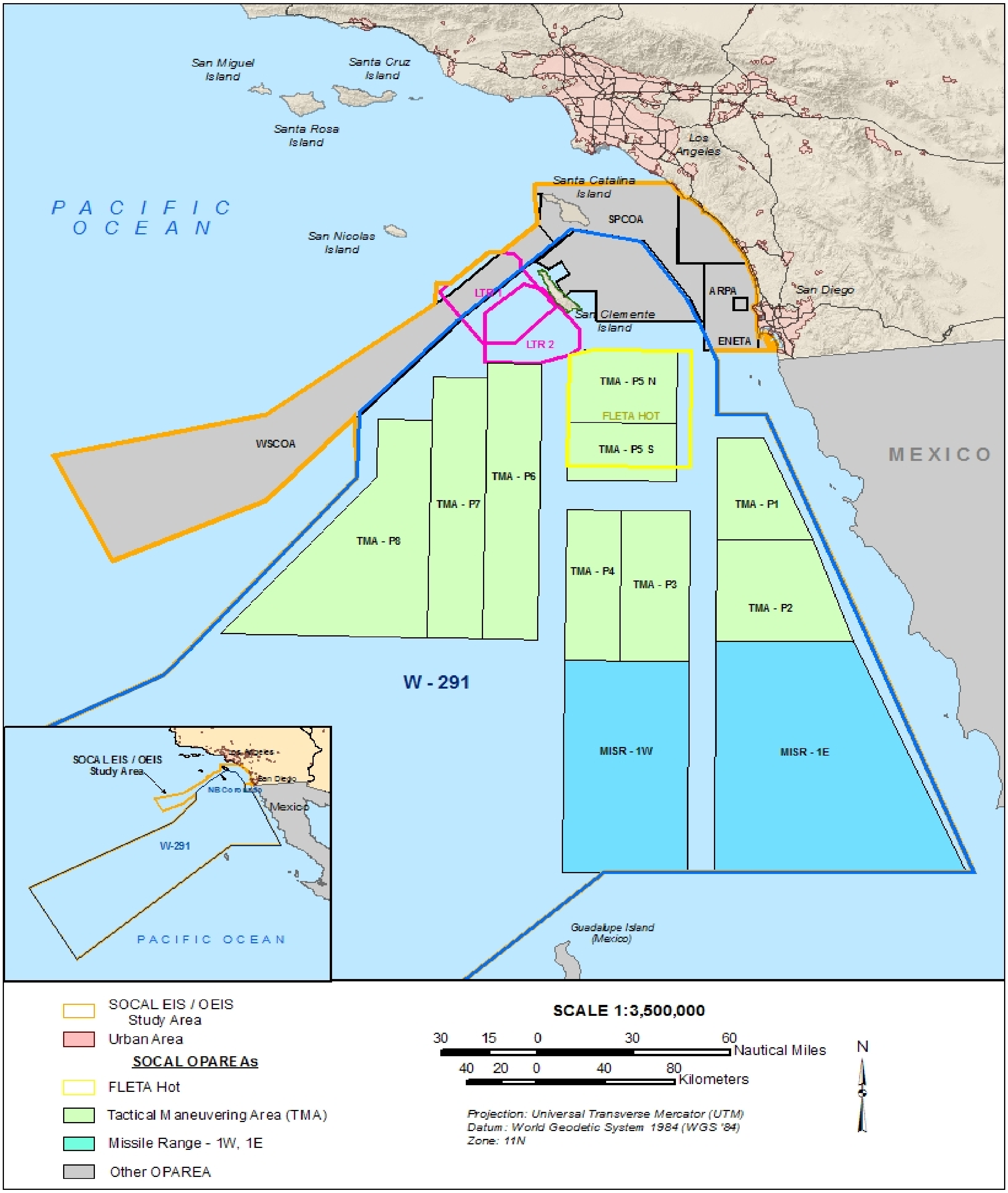


Figure 0-1: SOCAL Range Complex W-291 and Ocean OPAREAs

Table 0-3: San Clemente Island Areas

SCI Ranges	Description
SHOBA Impact Areas	SHOBA is the only range on the western coast of the United States that supports naval surface fire support training using on-the-ground spotters and surveyed targets. The southern one-third of SCI contains Impact Areas I and II, which comprise the onshore portion of SHOBA. (The offshore component provides designated locations [FSAs] for firing ships to maneuver.). The main training activities that occur in SHOBA are naval gun firing, artillery, and air-to-ground bombing. A variety of munitions, both live and non-explosive, are expended in SHOBA. NSW operations also occur in this area.
Naval Special Warfare Training Areas (SWATs)	SCI contains six SWATs. Each includes contiguous land and water areas. The land areas range in size from 100 to 4,400 acres [ac] (.4 to 18 km^2) and are used as ingress and egress to specific Training Areas and Ranges (TARs). Basic and advanced special operations training is conducted within these areas by Navy and Marine Corps units.
NSW Training Areas and Ranges (TARs)	A TAR is an area used for planning and scheduling purposes for specific types of training operations and range activities in the SCI. There are currently 22 TARs, designated as TARS 1-22. All the TARs contain land area, with the exception of two (TAR 7 and 8) which are water drop zones. Three TARs (2, 3, and 5) include beach and nearshore waters, while the rest cover land only. With the exception of the water drop zones, the TARs do not include airspace. TARs are generally small (1-800 ac) and are designed to support NSW training for “actions at the objective.”
Assault Vehicle Maneuver Corridor (AVMC)	The AVMC encompasses three linked areas on SCI: • Assault Vehicle Maneuver Areas (AVMAs), and • Assault Vehicle Maneuver Road (AVMR) plus an AVMR Extension The AVMA accounts for four existing or planned areas for authorized off-road vehicle use. The AVMR is a dirt track that runs the length of the island to allow transit by tactical vehicles through areas that are restricted from off-road use by vehicles.
Artillery Firing Points (AFP) and Artillery Maneuver Points (AMP)	An AFP is a location from which artillery weapons such as the 155mm howitzer are positioned and used in live-fire employment of munitions. Guns are towed by trucks along primary roads, often in convoy with munitions trucks and HMMWVs. Two AFPs are being used at the current time: AFP 1 and AFP 6, both in SHOBA. An AMP is used for non-live fire training in emplacement and displacement of artillery weapons. SCI has four AMPs.
Infantry Operations Area	The Infantry Operations Area, generally located on either side of the AVMC, is on the upland plateau, which is designated for foot traffic by military units. No vehicles are authorized in the off-road areas. Specifically, this area is intended for use by Marine Corps small units during amphibious training events.
Old Airfield (VC-3)	The Old Airfield, called VC-3, located within TAR 15, is approximately 6 nm (11 km) from the northern end of the island. The presence of a number of buildings allows for training of forces in a semi-urban environment. It is suitable for small unit training by NSW and Marine Corps forces.
Missile Impact Range (MIR)	The MIR, located within TAR 16, is in the north-central portion of the island, just south of VC-3. It is situated at the ridge crest of the island’s central plateau. The MIR is 3,200 by 1,000 ft (305 by 975 m) at an elevation of 1,000 ft (305 m) MSL. The MIR contains fixed targets, and is equipped with sophisticated instruments for recording the flight, impacts, and detonations of weapons. Weapons expended on the MIR include the Joint Standoff Weapon (JSOW) and the Tomahawk Land Attack Missile (TLAM).
Naval Auxiliary Landing Field (NALF)	The NALF, located at the northern end of the island, has a single runway of 9,300 ft (2,835 m) equipped with aircraft arresting gear.

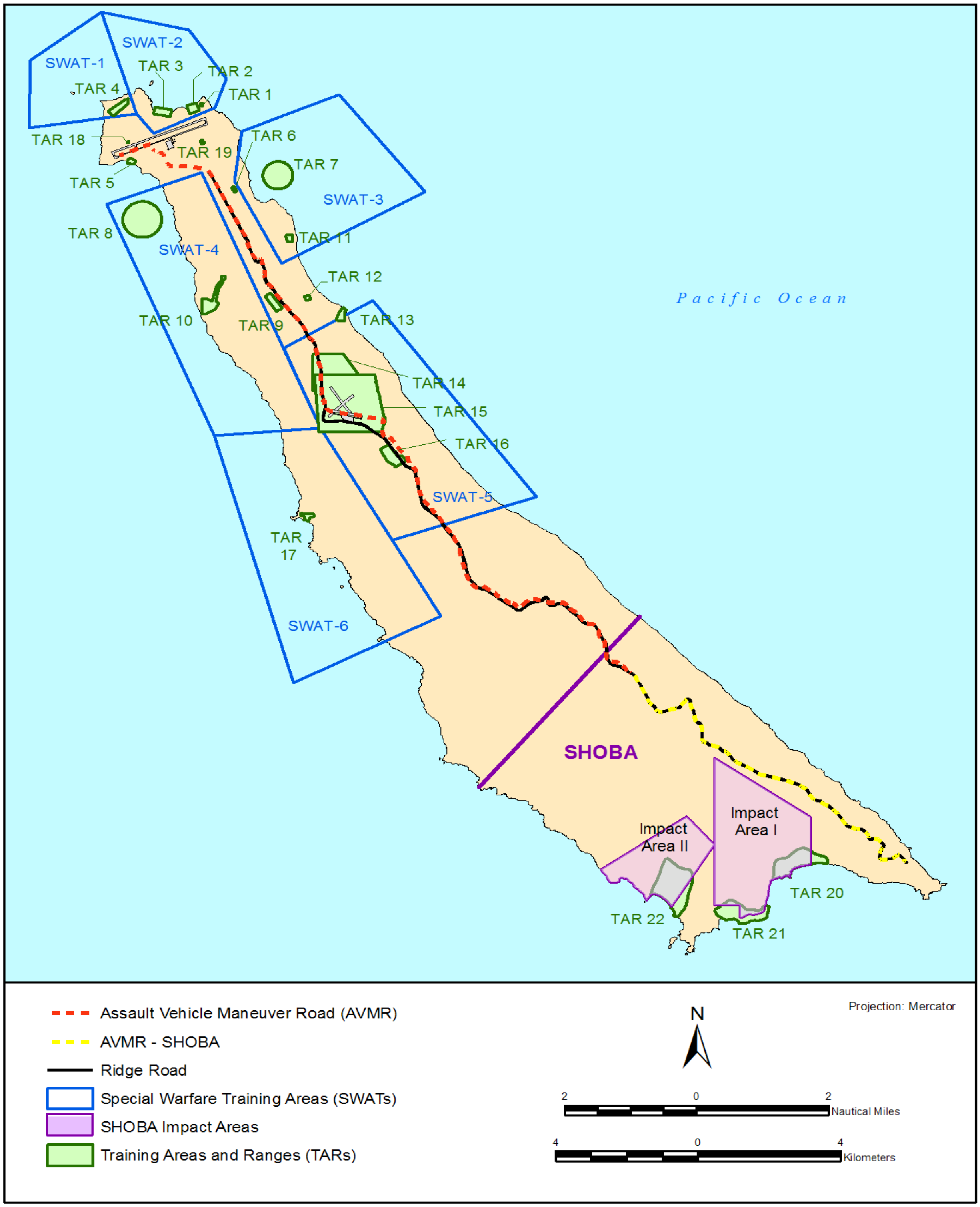


Figure 0-2: SCI Ranges: SWATs, TARs and SHOBA Impact Areas

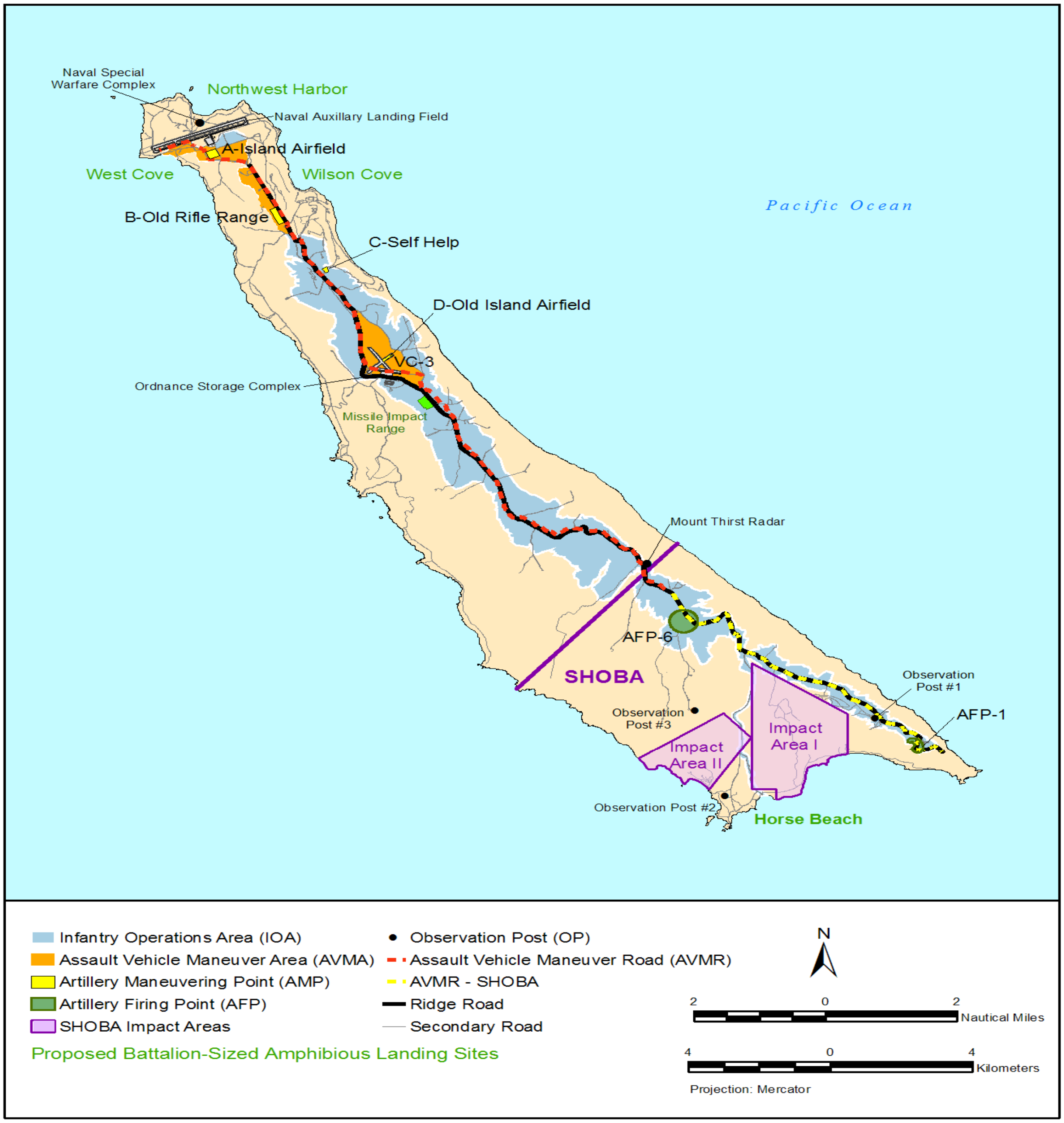


Figure 0-3: San Clemente Island Infantry, Artillery, and Vehicle Range Areas

All of San Clemente Island is dedicated to training and RDT&E activities, utilizing the several distinct ranges at SCI. These land ranges are described above in Table 2-3 and shown in Figures 2-2 and 2-3.

A component part of the SOCAL Range Complex, SCI provides a suite of land ranges and training areas that are integral to training of Pacific Fleet air, surface, and subsurface units; I MEF units; NSW units; and selected formal schools. SCI provides instrumented ranges, operating areas and associated facilities to conduct and evaluate a wide range of exercises within the scope of naval warfare. SCI also provides range areas and services to RDT&E activities. Over 20 Navy and Marine Corps commands conduct training and testing activities at SCI.

2.2 ALTERNATIVES

Three alternatives are analyzed in the SOCAL Range Complex EIS/OEIS: 1) The No Action Alternative – Current Operations; 2) Alternative 1 - Increase Operational Training and Accommodate Force Structure Changes, and 3) Alternative 2 – Increase Operational Training, Accommodate Force Structure Changes, and Implement Range Enhancements.

2.2.1 No-Action Alternative

The Navy has been operating in the SOCAL Range Complex for over 70 years. Under the No Action Alternative, training operations and major range events would continue at current levels. The SOCAL Range Complex would not accommodate an increase in training operations due to the requirements of the FRTP or proposed force structure changes, and it would not implement additional investments associated with the other alternatives. Evaluation of the No-Action Alternative provides a credible baseline for assessing environmental impacts of Alternative 1 and Alternative 2 (Preferred Alternative), as described below.

Operations currently conducted on the SOCAL Range Complex are described below by warfare mission area. Training activities in the SOCAL Range Complex vary from basic individual or unit level events of relatively short duration involving few participants to integrated major range training events such as JTFEX which may involve thousands of participants over several weeks.

Over the years, the tempo and types of operations have fluctuated within the SOCAL Range Complex, due to changing requirements, the dynamic nature of international events, the introduction of advances in warfighting doctrine and procedures, and force structure changes. The factors influencing tempo and types of operations are fluid in nature and will continue to cause fluctuations in training activities within the SOCAL Range Complex.

2.2.1.1 Description of Current Training Operations within the SOCAL Range Complex

2.2.1.1.1 ASW Training

ASW training engages helicopter and sea control aircraft, ships, and submarines operating alone or in combination in training to detect, localize, and attack submarines. ASW training involves sophisticated training and simulation devices including underwater targets and sonobuoys which emit sound through the water. When the object of the exercise is to track the target but not attack it, the exercise is called a Tracking Exercise (TRACKEX). A Torpedo Exercise (TORPEX) takes the operation one step further, culminating in the release of an actual torpedo, which can be either running (EXTORP) or non-running (REXTORP). All torpedoes used in training are have non-explosive warheads. ASW training occurs in W-291 and all ocean operating areas of the SOCAL Range Complex. SOAR is designed specifically for ASW training, with underwater acoustic sensors and communications to allow for the monitoring of training activities and post-mission debriefing feedback to the participants.

2.2.1.1.2 MIW Training

MIW training includes Mine Countermeasures (MCM) Exercises and Mine Laying Exercises (MINEX). MCM training is currently conducted on the Kingfisher Range and offshore areas in the Tanner and Cortez Banks. MCM training engages ships' crews in the use of sonar for mine detection and avoidance, and minefield navigation and reporting. The proposed extension of the SOAR is intended for use in such training. MINEX events involve aircraft dropping non-explosive training shapes, and less frequently submarine mine laying. MINEX events are conducted on the MINEX Training Ranges in the Castle Rock, Eel Point, China Point, and Pyramid Head areas offshore of SCI.

2.2.1.1.3 AAW Training

Surface-to-Air Gunnery Exercise (GUNEX S-A): GUNEX S-A exercises require air services to simulate a threat aircraft or missile towing a target to be fired upon by ship crews utilizing shipboard gun systems.

Air Defense Exercise (ADEX): ADEX is an exercise to train surface and air assets in coordination and tactics for defense of the strike group or other Naval Force from airborne threats.

Simulated Surface-to-Air Missile Exercise (MISSILEX-S): The MISSILEX-S is a non-firing event meeting training requirements for missile engagement of air threats up to the point of actual launch of a missile.

Simulated Air-to-Air Missile Exercise (AAMEX): AAMEXs are non-firing exercises, but may include activities such as air intercept control, where the final objective is to intercept and attack another aircraft.

Air Combat Maneuvers (ACM): ACM includes Basic Fighter Maneuvers (BFM) where aircraft engage in offensive and defensive maneuvering against each other. No ordnance is released during this exercise.

Missile Firing Exercises (MISSILEX): A MISSILEX is an operation in which missiles are fired from either aircraft or ships against aerial targets. Air-to-Air exercises involve a fighter or fighter/attack aircraft firing a missile at an aerial target. Aerial targets are typically launched, controlled, and recovered from SCI while firing operations usually take place in W-291. The preferred launch location for aerial-launched targets is south of SCI, with the hazard pattern extending over portions of the SOAR range.

2.2.1.1.4 ASUW Training

Sinking Exercise (SINKEX): A SINKEX provides an opportunity for ship, submarine, and aircraft crews to deliver live ordnance on a deactivated vessel, which is deliberately sunk using multiple weapons systems. The duration of a SINKEX is unpredictable since it ends when the target sinks, sometimes immediately after the first weapon impact and sometimes only after multiple impacts by a variety of weapons. A SINKEX is conducted only occasionally, typically during a Joint Task Force Exercise (JTFEX), and is conducted under a permit from the U.S. Environmental Protection Agency (EPA).

Surface-to-Surface Gunnery Exercise (GUNEX): A GUNEX takes place in the open ocean to provide gunnery practice for ship crews utilizing shipboard gun systems. Exercises involve a variety of surface targets, both stationary and maneuverable.

Visit Board Search and Seizure (VBSS): These exercises involve the interception of a suspect surface ship by a Navy ship for the purpose of boarding-party inspection or the seizure of suspect ship.

Aircraft Laser Weapons Exercise—Sea: In these training events, helicopters or fighter/attack aircraft expend precision-guided munitions against maneuverable, high-speed, surface targets. Primary operations areas are Laser Training Ranges (LTRs) 1 and 2.

Airborne Surface Attack Exercises: This event involves conducting attacks on surface vessels from naval aircraft. It involves pairs of FA-18, SH-60, or P-3 aircraft delivering ordnance against towed targets.

Surface Firing Exercise: These operations train surface ship crews in high-speed surface engagement procedures against mobile (towed or self-propelled) seaborne targets. Both live and non-explosive training rounds are used against the targets.

2.2.1.1.5 EC Training

Electronic combat operations are conducted in offshore areas and on the Electronic Warfare (EW) Range at the SCIR. Offshore events generally consist of electronic threat simulation and jamming services that are provided to surface ships. Appropriately configured aircraft fly threat profiles against the ships so that crews are trained to detect electronic signatures of various threat aircraft counter jamming of their own electronic equipment by the simulated threat. The EW Range provides air, surface, and subsurface units with operating experience in a dense electronic threat environment similar to what they would face in an actual combat theater. Electronic signals emanate primarily from the Range Electronic Warfare Simulator (REWS), in the north part of SHOBA. Typical EW activities include threat avoidance training, signals analysis, use of airborne and surface electronic jamming devices to defeat tracking radar systems, and the firing of very small simulated surface-to-air missiles (called Smokey SAMs).

2.2.1.1.6 NSW Training

NSW forces (SEALs and Special Boat Units [SBUs]) train to conduct military operations in five Special Operations mission areas: unconventional warfare, direct action, special reconnaissance, foreign internal defense, and counterterrorism. Specific training events include:

Insertion/Extraction: NSW personnel conduct insertion/extraction operations including parachute training of personnel, rubber boats, and equipment, within the Leon Water Drop Zone and in transit to San Clemente Island.

Gunnery Exercises (GUNEX): GUNEX is primarily a ground operation involving an amphibious landing, ground maneuver, live-fire and demolition training by a Marine Corps special operations or NSW units. This category also includes boat-to-shore and boat-to-boat gunnery. Demolition training can be either on land or underwater. A typical GUNEX is a NSW mission conducted against an objective in SHOBA, usually at night, using small arms live-fire and demolitions charges

Basic Training—BUD/S: BUD/S individual training is conducted by the NSW Center. A portion of this training occurs on SCI, including land and underwater demolition, small arms training.

UAV Training: NSW forces train on SCI with UAVs, which provide remotely-piloted aerial reconnaissance.

Other NSW Training Events: NSW training, primarily conducted on SCI, includes: the SEAL Weapons Systems (SWS) course, which provides training in a wide range of underwater and land demolitions; the Special Warfare Combatant Crew (SWCC) course, Seal Qualification Training; and a variety of operational training events for SEAL units and SBUs.

2.2.1.1.7 AMW Training

Amphibious Warfare training includes individual and crew, small unit, large unit, and MAGTF-level events. Individual and crew training includes operation of amphibious vehicles and naval gunfire support training. Small unit training operations include events leading to the certification of a MEU as “Special Operations Capable” (SOC). Such training includes shore assaults, boat raids, airfield or port seizures, and reconnaissance. Larger-scale amphibious exercises are carried out principally by MAGTFs or elements of MAGTFs embarked with ESGs; these include:

Naval Surface Fire Support (FIREX) and Expeditionary Firing Exercise (EFEX): These exercises are required pre-deployment training events, conducted in SHOBA. EFEX is conducted by Marine forces in conjunction with a Fire Support Coordination Center Exercise (FSCEX). The EFEX involves coordination of naval gunfire from surface ships with land-based artillery and CAS. The naval gunfire component trains surface ships in land bombardment, and is known as a FIREX. Amphibious landings operations may be associated with these events. A typical operation involves landing an artillery battery (truck-towed 155mm howitzers) on SCI for live-fire training.

Air Strikes and Close Air Support (CAS): Air strikes are aircraft or missile attacks of ground targets that are located in SHOBA’s Impact Areas I and II. The operations can originate from an aircraft carrier or land bases. CAS operations are air strikes that are integrated with the fire and maneuver of ground forces.

Aircraft Laser Weapons Exercise—Land: These operations train aircrews in the delivery of laser-guided weapons against targets in SHOBA.

Stinger Air-Defense Missile Firing: The Stinger is a small shoulder-fired or vehicle mounted anti-aircraft missile utilized by Marine and NSW forces. Training is conducted from positions on-shore in SHOBA, or by NSW units firing the missiles from boats in the near-shore area.

2.2.1.1.8 Explosive Ordnance Disposal (EOD) Activities

EOD operations are conducted on SCI, primarily in SHOBA and the Missile Impact Range. These operations consist of specially trained personnel conducting sweeps, inspections, and cleanup of Unexploded Ordnance (UXO).

2.2.1.1.9 Combat Search and Rescue (CSAR)

The CSAR operation is usually in conjunction with a larger COMPTUEX or other Fleet exercise. The purpose of the operation is to locate, protect, and evacuate downed aviation crew members from hostile territory. The operation can include reconnaissance aircraft to find the downed aircrew, helicopters to conduct the rescue, and fighter aircraft to perform CAS to protect both the downed aircrews and the rescue helicopters.

2.2.1.1.10 RDT&E

SPAWARSYSCEN conducts RDT&E, engineering, and fleet support for command, control, and communications systems and ocean surveillance. SPAWAR's tests on SCIR include a wide variety of ocean engineering, missile firings, torpedo testing, manned and unmanned submersibles, UAVs, EC, and other Navy weapons systems. Specific events include:

Ship Tracking and Torpedo Tests

Unmanned Underwater Vehicle (UUV) Tests

Sonobuoy Quality Assurance (QA)/Quality Control (QC) Tests

Ocean Engineering Tests

Marine Mammal Mine Shape Location and Research

Radio Frequency (RF) Tests

Unmanned Aerial Vehicles (UAV) Tests

Missile Flight Tests

2.2.1.1.11 Naval Undersea Warfare Center (NUWC) Acoustics Tests:

The San Diego Division of NUWC is a Naval Sea Systems Command (NAVSEA) organization supporting the Pacific Fleet. NUWC operates and maintains the SCI Underwater Range (SCIUR). NUWC conducts tests, analysis, and evaluation of submarine USW exercises and test programs. It also provides engineering and technical support for Undersea Warfare (USW) programs and exercises design cognizance of underwater weapons acoustic and tracking ranges and associated range equipment. It also provides proof testing and evaluation for underwater weapons, weapons systems, and components.

2.2.1.1.12 Naval Auxiliary Landing Field (NALF) SCI Airfield Activities

NALF SCI provides opportunities for aviation training and aircraft access to the island. The airfield is restricted to military aircraft and authorized contract flights. There are no permanently assigned aircraft, and aviation support is limited essentially to refueling. NALF SCI has the primary mission of training Naval Air Force Pacific aircrews in Field Carrier Landing Practice (FCLP). FCLP involves landing on a simulated aircraft carrier deck painted on the surface of the runway near its east end. Other military activities include visual and instrument approaches and departures, aircraft equipment calibration, survey and photo missions, range support, exercise training, RDT&E test support, medical evacuation, and supply and personnel flights.

2.2.1.1.13 Major Range Events

There SOCAL Range Complex hosts "major ranges events." These generally are "capstone" exercises, conducted as required milestones in the pre-deployment certification of naval strike groups, such as an ESG or CSG. Major range events bring together the elements of a naval strike group (e.g., surface combatant ships, support ships, submarines, fixed-wing and helicopter aviation squadrons, and Marine

Corps forces) to training in complex command and control functions, and in coordination of the operations and activities of these component parts of the task force.

Major range exercises must be understood as part of a training continuum that includes individual and crew training, training of smaller formations, and complex, strike group training. In a major range event, most of the operations and activities being directed and coordinated by the strike group commander are identical in nature to the operations conducted in the course in individual, crew, and smaller-unit training events. In a major range event, however, these disparate training tasks are conducted in concert, rather than in isolation. Aspects of training that are unique to major range events involve the exercise of complex command, control, and logistics functions.

Major range events involve a large number of personnel, air, surface, subsurface, and ground assets in a multi-dimensional exercise. These exercises typically employ an exercise scenario developed to test and train the strike group in required naval tactical tasks. While exercise scenarios for different major range events will be similar, they will not be identical. Exercise scenarios would differ based on the strike group's mission and the operating environment it expects to encounter. Thus, a pre-deployment exercise for a CSG or ESG deploying to the western Pacific Ocean may differ from an exercise conducted by a similar strike group deploying to the Indian Ocean or the Arabian Sea.

Examples of major range events include the Composite Training Unit Exercise (COMPTUEX) and Joint Task Force Exercise (JTFEX). The COMPTUEX is an Integration Phase, at-sea, major range event. For the CSG, this exercise integrates the aircraft carrier and carrier air wing with surface and submarine units in a challenging operational environment. For the ESG, this exercise integrates amphibious ships with their associated air wing, surface ships, submarines, and Marine Expeditionary Unit (MEU). Live fire operations that may take place during COMPTUEX include long-range air strikes, Naval Surface Fire Support (NSFS), and surface-to-air, surface-to-surface, and air-to-surface missile exercises. The MEU also conducts realistic training based on anticipated operational requirements and to further develop the required coordination between Navy and Marine Corps forces. Special Operations training may also be integrated with the exercise scenario. The COMPTUEX is typically 21 days in length. The exercise is conducted in accordance with a schedule of events, which may include two 1-day, scenario-driven, "mini" battle problems, culminating with a scenario-driven 3-day Final Battle Problem.

The JTFEX is a dynamic and complex major range event that is the culminating exercise in the Sustainment Phase training for the CSGs and ESGs. For an ESG, the exercise incorporates an Amphibious Ready Group (ARG) Certification Exercise (ARG CERT) for the amphibious ships and a Special Operations Capable Certification (SOCCERT) for the MEU. When schedules align, the JTFEX may be conducted concurrently for an ESG and CSG. JTFEX emphasizes mission planning and effective execution by all primary and support warfare commanders, including command and control, surveillance, intelligence, logistics support, and the integration of tactical fires. JTFEXs are complex scenario-driven exercises that evaluate a strike group in all warfare areas. JTFEX is normally 10 days long, not including a 3-day in-port Force Protection Exercise, and is the final at-sea exercise for the CSG or ESG prior to deployment.

Table 2-4 identifies typical training operations conducted in the SOCAL Range Complex. This table also groups operations according to the location within the Complex where the operation is generally conducted.

Table 0-4: SOCAL Range Complex: Current Operations by Warfare Area and Location

Navy Warfare Area	No.	Operation Type	Short title	Areas
Anti-Air Warfare	1	Aircraft Combat Maneuvers	ACM	W-291 PAPA Areas
	2	Air Defense Exercise	ADEX	W-291
	3	Surface-to-Air Missile Exercise	A-A MISSILEX	W-291
	4	Surface-to-Air Gunnery Exercise	S-A MISSILEX	W-291
	5	Air-to-Air Missile Exercise	S-A GUNEX	FLETA HOT
Anti-Submarine Warfare	6	Antisubmarine Warfare Tracking Exercise - Helicopter	ASW TRACKEX - Helicopter	W-291/SOAR/USWTRs*
	7	Antisubmarine Warfare Tracking Exercise - Maritime Patrol Aircraft	ASW TRACKEX - MPA	W-291/SOAR/USWTRs*
	8	Antisubmarine Warfare Torpedo Exercise - Helicopter	ASW TORPEX - Helicopter	SOAR/USWTRs*
	9	Antisubmarine Warfare Torpedo Exercise - Maritime Patrol Aircraft	ASW TORPEX - MPA	SOAR/USWTRs*
	10	Antisubmarine Warfare Tracking Exercise - Surface	ASW TRACKEX - Surface	W-291/SOAR/USWTRs*
	11	Antisubmarine Warfare Torpedo Exercise - Surface	ASW TORPEX - Surface	SOAR/USWTRs*
	12	Surface Ship Integrated ASW (IAC II)	IAC II	SOAR/USWTRs
	13	Antisubmarine Warfare Torpedo Exercise - Submarine	ASW TORPEX - Sub	SOAR/USWTRs
Anti-Surface Warfare	14	Visit Board Search and Seizure	VBSS	W-291/3803, SOAR
	15	Air-to-Surface Missile Exercise	MISSILEX (A-S)	SOAR
	16	Air-to-Surface Bombing Exercise	BOMBEX (Sea)	SOAR
	17	Air-to-Surface Gunnery Exercise	GUNEX (A-S)	SOAR
	18	Surface-to-Surface Gunnery Exercise	GUNEX (S-S)	FLETA HOT/SOAR
	19	Sink Exercise	SINKEX	W-291
Amphibious Warfare	20	Naval Surface Fire Support	NSFS	SHOBA/SWTR Nearshore
	21	Expeditionary Fires Exercise	EFEX	SHOBA/SWTR Nearshore
	22	Expeditionary Assault - Battalion Landing	BN Landing	SHOBA/SWTR Nearshore
	23	USMC Stinger Firing Exercise	Stinger	SHOBA
	24	Amphibious Landings and Raids (on SCI)	AMW Landings	West Cove, NW Harbor
	25	Amphibious Operations - CPAAA	AMW Operations	CPAAA
Electronic Warfare	26	Electronic Combat Operations	EC OPS	EW Range

Navy Warfare Area	No.	Operation Type	Short title	Areas
Mine Warfare	27a	Small Object Avoidance	SOA	Kingfisher
	27b	Small Object Avoidance - USWTR	SOA/USWTR	SWTR OS
	28	Mine Neutralization	Mine Neutralization	
	29	Mine Laying	Mine Laying	MTRs/SWTRs
Naval Special Warfare	30	NSW Land Demolition	Land Demo	Demolition Range
	31	Underwater Demolition	Water Demo-sm	NW Harbor
	32	Underwater Mat Weave	Water Demo-lg	NW Harbor
	33	Small Arms Training	Small Arms	Small Arms Range
	34	Land Navigation	LANDNAV	Northern Half of SCI
	35	NSW UAV Operations	UAV	North of SHOBA
	36	Insertion/Extraction	Insert	Leon DZ
	37	NSW Boat Operations	NSW Boat Ops	All north of SHOBA
	38	NSW GRU ONE SEAL Platoon Operations	NSW Platoon Ops	All north of SHOBA
	39	NSW GUNEX Full Mission Profile	GUNEX (S-S)	SHOBA/SWTR Nearshore
Strike	40	Bombing Exercise (Land)	BOMBEX (Land)	SHOBA
	41	Combat Search & Rescue	CSAR	All SCI
Non-Combatant Operations	42	Explosive Ordnance Disposal SCI	EOD	SHOBA/MIR
SPAWAR	43	Ship Torpedo Tests	Torp Tests	SOAR
	44	Unmanned Underwater Vehicles	UUV	NOTS Pier Area
	45	Sonobuoy QA/QC Testing	Sonobuoy	SCIUR
	46	Ocean Engineering	Ocean Engineering	NOTS Pier Area
	47	Marine Mammal Mine Shape Location/Research	Mine Location	Mine Training Ranges/NOTS Pier
	48	RF Emissions	RF	Northern Plateau
	49	UAV Tests	UAV	Cancelled 7/20/05
	50	Missile Flight Tests	Missile Flight Tests	Entire Island
	51	Other Tests	Other	SOAR/SHOBA/Kingfisher
NUWC	52	NUWC Underwater Acoustics Testing	NUWC	SCIUR
* There are two USWTR areas: Offshore (OS) and Nearshore (NS)				
Air Operations	53	NALF Airfield Activities	NALF	NALF San Clemente
Major Range Events	NA	Major Range Events (by reference)		

2.2.2 Alternative 1

Alternative 1 is a proposal designed to meet Navy and DOD current and near-term operational training requirements. If Alternative 1 were to be selected, in addition to accommodating training operations currently conducted, the SOCAL Range Complex would support an increase in training operations including Major Range Events and force structure changes associated with introduction of new weapons systems, vessels, and aircraft into the Fleet. Under Alternative 1, baseline-training operations would be increased. In addition, training and operations associated with force structure changes would be implemented for the LCS, MV-22 Osprey, the EA-18G Growler, and the SH-60R/S Seahawk Multi-Mission Helicopter. Force structure changes associated with new weapons systems would include Offensive Mine Counter Measure (OMCM) systems.

2.2.2.1 Additional Operations

Table 2-5 identifies the baseline and proposed increases in operations in the SOCAL Range Complex if Alternative 1 is implemented.

2.2.2.2 Force Structure Changes

The SOCAL Range Complex is required to accommodate and support training with new ships, aircraft, and vehicles as they become operational in the Fleet. In addition, the SOCAL Range Complex is required to support training with new weapons/sensor systems. Several future platforms and weapons/sensor systems that are in development will likely be incorporated into the Navy and Marine Corps training requirement within the 10-year planning horizon. Several of these new technologies are in early stages of development, and thus specific concepts of operations, operating parameters, or training requirements are not available.

2.2.2.3 New Platforms/Vehicles

<u>Littoral Combat Ship</u>

The Littoral Combat Ship (LCS) is a specialized variant of the DD(X) family. It is designed to be a networked, agile, stealthy surface combatant capable of defeating anti-access and asymmetric threats in the littoral (shallow/nearshore) waters. Primary missions of the LCS include surface warfare (SUW) against hostile small boats; mine countermeasures (MCM); littoral anti-submarine warfare (ASW); intelligence, surveillance, and reconnaissance (ISR); homeland defense; maritime interception operations; special operation forces support; and logistics support for movement of personnel and supplies. The LCS will operate with CSGs and Surface Action Groups, in groups of other similar ships, or independently for diplomatic and presence missions. Additionally, the LCS will have the capability to operate cooperatively with the U.S. Coast Guard and Allies. Designed with the mission to operate in littoral waters, the LCS has unique range and training requirements that must be considered.

<u>MV-22 Osprey</u>

The MV-22 is a tilt rotor vertical/short takeoff and landing (V/STOL), multi-mission aircraft developed to fill multi-service combat operational requirements. It replaces the current Marine Corps assault helicopters in the medium lift category (CH-46E and CH-53D), contributing to the dominant maneuver of the Marine landing force and supporting focused logistics in the days following commencement of an amphibious operation. It is designed for combat, combat support, combat service support, and Special Operations worldwide. The ability to rapidly self-deploy and fly significant distances at high speeds provides rapid response to crisis situations and will extend the operational reach for ship-to-objective-maneuver (STOM) and sustained operations ashore (SOA).

<u>EA-18G Growler</u>

The EA-18G Growler is an electronic combat version of the FA-18 E/F that will replace the EA-6B Prowler. The Growler will have an integrated suite of EC systems that will initially be centered on the ICAP III system, but will also include tactical jamming pods, a radar receivers wingtip pods, an advanced crew station, the Airborne Electronically Scanned Array (AESA) multimode radar, and a communications receiver and jammer. The advanced capabilities of the Growler will require greater standoff ranges and broader frequency spectrum access than current systems.

MH-60R/S Seahawk Multi-Mission Helicopter

The MH-60R Seahawk Multi-Mission Helicopter is a planned conversion of all SH-60B, and eventually all SH-60F helicopters, with IOC expected in 2008. The MH-60S will replace all Navy variants of the H-46D by the end of FY 2004, for use in Vertical Replenishment (VERTREP). These new versions will feature advanced radar, missiles, low-frequency sonar and a host of other improvements including the new Organic Airborne Mine Countermeasures (OAMCM) capability.

2.2.2.4 New Weapons Systems

Under the proposed action, the only weapons system being introduced at this time that warrants evaluation in this EIS/OEIS are the Organic Mine Countermeasures Systems (OMCMs). Five OMCM airborne systems will be deployed by the SH-60R/S which include: AN/AQS-20 Sonar, mine detecting set; AN/AES-1 Airborne Laser Mine Detection System (ALMDS); Airborne Mine Neutralization System (AMNS); AN/ALQ-220 Organic Airborne and Surface Influence Sweep (OASIS); and AN/AWS-2 Rapid Airborne Mine Clearance System (RAMCIS). One OMCM System, the Remote Minehunting System (RMS), will be deployed from a surface ship. Another OMCM system, the Long-term Mine Reconnaissance System (LMRS), will be deployed from submarine.

Table 0-5. Proposed Baseline and Proposed Increases in Operations: Alternative 1

Navy Warfare Area	No.	Operation Type	Short title	Areas	# of Operations	
					No Action (baseline)	Alt 1
Anti-Air Warfare	1	Aircraft Combat Maneuvers	ACM	W-291 PAPA Areas	1,021	1,072
	2	Air Defense Exercise	ADEX	W-291	502	511
	3	Surface-to-Air Missile Exercise	A-A MISSILEX	W-291	1	4
	4	Surface-to-Air Gunnery Exercise	S-A MISSILEX	W-291	262	350
	5	Air-to-Air Missile Exercise	S-A GUNEX	FLETA HOT	13	13
Anti-Submarine Warfare	6	Antisubmarine Warfare Tracking Exercise - Helicopter	ASW TRACKEX - Helicopter	W-291/SOAR/USWTRs*	15	16
	7	Antisubmarine Warfare Tracking Exercise - Maritime Patrol Aircraft	ASW TRACKEX - MPA	W-291/SOAR/USWTRs*	152	160
	8	Antisubmarine Warfare Torpedo Exercise - Helicopter	ASW TORPEX - Helicopter	SOAR/USWTRs*	101	122
	9	Antisubmarine Warfare Torpedo Exercise - Maritime Patrol Aircraft	ASW TORPEX - MPA	SOAR/USWTRs*	15	16
	10	Antisubmarine Warfare Tracking Exercise - Surface	ASW TRACKEX - Surface	W-291/SOAR/USWTRs*	45	48
	11	Antisubmarine Warfare Torpedo Exercise - Surface	ASW TORPEX - Surface	SOAR/USWTRs*	77	81
	12	Surface Ship Integrated ASW (IAC II)	IAC II	SOAR/USWTRs	59	48
	13	Antisubmarine Warfare Torpedo Exercise - Submarine	ASW TORPEX - Sub	SOAR/USWTRs	48	50
Anti-Surface Warfare	14	Visit Board Search and Seizure	VBSS	W-291/3803, SOAR	56	78
	15	Air-to-Surface Missile Exercise	MISSILEX (A-S)	SOAR	94	94
	16	Air-to-Surface Bombing Exercise	BOMBEX (Sea)	SOAR	32	35
	17	Air-to-Surface Gunnery Exercise	GUNEX (A-S)	SOAR	47	50
	18	Surface-to-Surface Gunnery Exercise	GUNEX (S-S)	FLETA HOT/SOAR	315	350
	19	Sink Exercise	SINKEX	W-291	2	2
Amphibious Warfare	20	Naval Surface Fire Support	NSFS	SHOBA/SWTR Nearshore	57	60
	21	Expeditionary Fires Exercise	EFEX	SHOBA/SWTR Nearshore	6	7
	22	Expeditionary Assault - Battalion Landing	BN Landing	SHOBA/SWTR Nearshore	0	1
	23	USMC Stinger Firing Exercise	Stinger	SHOBA	0	3
	24	Amphibious Landings and Raids (on SCI)	AMW Landings	West Cove, NW Harbor	11	42
	25	Amphibious Operations - CPAAA	AMW Operations	CPAAA	~3,000	~3,000
Electronic Warfare	26	Electronic Combat Operations	EC OPS	EW Range	748	755
Mine Warfare	27a	Small Object Avoidance	SOA	Kingfisher	44	46

Navy Warfare Area	No.	Operation Type	Short title	Areas	# of Operations	
					No Action (baseline)	Alt 1
	27b	Small Object Avoidance - USWTR	SOA/USWTR	SWTR OS	44	35
	28	Mine Neutralization	Mine Neutralization			
	29	Mine Laying	Mine Laying	MTRs/SWTRs	17	17
Naval Special Warfare	30	NSW Land Demolition	Land Demo	Demolition Range	90	101
	31	Underwater Demolition	Water Demo-sm	NW Harbor	72	85
	32	Underwater Mat Weave	Water Demo-lg	NW Harbor	14	16
	33	Small Arms Training	Small Arms	Small Arms Range	171	205
	34	Land Navigation	LANDNAV	Northern Half of SCI	108	130
	35	NSW UAV Operations	UAV	North of SHOBA	5	15
	36	Insertion/Extraction	Insert	Leon DZ		
	37	NSW Boat Operations	NSW Boat Ops	All north of SHOBA		
	38	NSW GRU ONE SEAL Platoon Operations	NSW Platoon Ops	All north of SHOBA	340	512
	39	NSW GUNEX Full Mission Profile	GUNEX (S-S)	SHOBA/SWTR Nearshore		
Strike	40	Bombing Exercise (Land)	BOMBEX (Land)	SHOBA	176	197
	41	Combat Search & Rescue	CSAR	All SCI	1	10
Non-Combatant Operations	42	Explosive Ordnance Disposal SCI	EOD	SHOBA/MIR	5	5
SPAWAR	43	Ship Torpedo Tests	Torp Tests	SOAR	22	15
	44	Unmanned Underwater Vehicles	UUV	NOTS Pier Area	10	10
	45	Sonobuoy QA/QC Testing	Sonobuoy	SCIUR	117	117
	46	Ocean Engineering	Ocean Engineering	NOTS Pier Area	242	242
	47	Marine Mammal Mine Shape Location/Research	Mine Location	Mine Training Ranges/NOTS Pier	5	20
	48	RF Emissions	RF	Northern Plateau	15	15
	49	UAV Tests	UAV	Cancelled 7/20/05	12	0
	50	Missile Flight Tests	Missile Flight Tests	Entire Island	10	15
	51	Other Tests	Other	SOAR/SHOBA/Kingfisher	36	15
NUWC	52	NUWC Underwater Acoustics Testing	NUWC	SCIUR	46	83
* There are two USWTR areas: Offshore (OS) and Nearshore (NS)						
Air Operations	53	NALF Airfield Activities	NALF	NALF San Clemente	25,120	23,439
Major Range Events	Major range events such as JTFEX and COMPTUEX are “capstone” exercises, comprised of multiple operations identified in this table, conducted in a coordinated fashion under a single strike group commander (see Section 2.2.1.1.13).					

2.2.3 Alternative 2

Alternative 2, if selected would implement all elements of Alternative 1 (accommodating training operations currently conducted; increase in training operations [including Major Range Events], and force structure changes). In addition, under Alternative 2: training operations of the types currently conducted would be increased over the levels identified in Alternative 1 (see Table 2-6) and, range enhancements would be implemented, to include an increase in Commercial Air Services, establishment of a shallow water minefield; and establishment of the shallow water training range in the SOAR extensions, as described below.

Alternative 2 is the preferred alternative.

2.2.3.1 Additional Operations

Table 2-7 identifies the baseline, and proposed increases in operations in the SOCAL Range Complex under Alternative 2.

Table 0-6: Baseline and Proposed Increases in Operations: Alternative 2

Navy Warfare Area	No.	Operation Type	Short title	Areas	# of Operations	
					No Action (Baseline)	Alt 2
Anti-Air Warfare	1	Aircraft Combat Maneuvers	ACM	W-291 PAPA Areas	1,021	1,072
	2	Air Defense Exercise	ADEX	W-291	502	531
	3	Surface-to-Air Missile Exercise	A-A MISSILEX	W-291	1	6
	4	Surface-to-Air Gunnery Exercise	S-A MISSILEX	W-291	262	350
	5	Air-to-Air Missile Exercise	S-A GUNEX	FLETA HOT	13	13
Anti-Submarine Warfare	6	Antisubmarine Warfare Tracking Exercise - Helicopter	ASW TRACKEX - Helicopter	W-291/SOAR/USWTRs*	15	17
	7	Antisubmarine Warfare Tracking Exercise - Maritime Patrol Aircraft	ASW TRACKEX - MPA	W-291/SOAR/USWTRs*	152	165
	8	Antisubmarine Warfare Torpedo Exercise - Helicopter	ASW TORPEX - Helicopter	SOAR/USWTRs*	101	128
	9	Antisubmarine Warfare Torpedo Exercise - Maritime Patrol Aircraft	ASW TORPEX - MPA	SOAR/USWTRs*	15	17
	10	Antisubmarine Warfare Tracking Exercise - Surface	ASW TRACKEX - Surface	W-291/SOAR/USWTRs*	45	48
	11	Antisubmarine Warfare Torpedo Exercise - Surface	ASW TORPEX - Surface	SOAR/USWTRs*	77	85
	12	Surface Ship Integrated ASW	IAC II	SOAR/USWTRs	59	60

Navy Warfare Area	No.	Operation Type	Short title	Areas	# of Operations	
					No Action (Baseline)	Alt 2
		(IAC II)				
	13	Antisubmarine Warfare Torpedo Exercise - Submarine	ASW TORPEX - Sub	SOAR/USWTRs	48	53
Anti-Surface Warfare	14	Visit Board Search and Seizure	VBSS	W-291/3803, SOAR	56	90
	15	Air-to-Surface Missile Exercise	MISSILEX (A-S)	SOAR	94	99
	16	Air-to-Surface Bombing Exercise	BOMBEX (Sea)	SOAR	32	40
	17	Air-to-Surface Gunnery Exercise	GUNEX (A-S)	SOAR	47	60
	18	Surface-to-Surface Gunnery Exercise	GUNEX (S-S)	FLETA HOT/SOAR	315	350
	19	Sink Exercise	SINKEX	W-291	2	3
Amphibious Warfare	20	Naval Surface Fire Support	NSFS	SHOBA/SWTR Nearshore	57	62
	21	Expeditionary Fires Exercise	EFEX	SHOBA/SWTR Nearshore	6	8
	22	Expeditionary Assault - Battalion Landing	BN Landing	SHOBA/SWTR Nearshore	0	2
	23	USMC Stinger Firing Exercise	Stinger	SHOBA	0	4
	24	Amphibious Landings and Raids (on SCI)	AMW Landings	West Cove, NW Harbor	11	61
	25	Amphibious Operations - CPAAA	AMW Operations	CPAAA	~3,000	~3,000
Electronic Warfare	26	Electronic Combat Operations	EC OPS	EW Range	748	775
Mine Warfare	27a	Small Object Avoidance	SOA	Kingfisher	44	48
	27b	Small Object Avoidance - USWTR	SOA/USWTR	SWTR OS	44	36
	28	Mine Neutralization	Mine Neutralization			
	29	Mine Laying	Mine Laying	MTRs/SWTRs	17	18
Naval Special Warfare	30	NSW Land Demolition	Land Demo	Demolition Range	90	101
	31	Underwater Demolition	Water Demo-sm	NW Harbor	72	85
	32	Underwater Mat Weave	Water Demo-lg	NW Harbor	14	18
	33	Small Arms Training	Small Arms	Small Arms Range	171	205

Navy Warfare Area	No.	Operation Type	Short title	Areas	# of Operations No Action (Baseline)	# of Operations Alt 2
	34	Land Navigation	LANDNAV	Northern Half of SCI	108	130
	35	NSW UAV Operations	UAV	North of SHOBA	5	27
	36	Insertion/Extraction	Insert	Leon DZ		
	37	NSW Boat Operations	NSW Boat Ops	All north of SHOBA		
	38	NSW GRU ONE SEAL Platoon Operations	NSW Platoon Ops	All north of SHOBA	340	668
	39	NSW GUNEX Full Mission Profile	GUNEX (S-S)	SHOBA/SWTR Nearshore		
Strike	40	Bombing Exercise (Land)	BOMBEX (Land)	SHOBA	176	215
	41	Combat Search & Rescue	CSAR	All SCI	1	15
Non-Combatant Operations	42	Explosive Ordnance Disposal SCI	EOD	SHOBA/MIR	5	10
SPAWAR	43	Ship Torpedo Tests	Torp Tests	SOAR	22	20
	44	Unmanned Underwater Vehicles	UUV	NOTS Pier Area	10	15
	45	Sonobuoy QA/QC Testing	Sonobuoy	SCIUR	117	120
	46	Ocean Engineering	Ocean Engineering	NOTS Pier Area	242	242
	47	Marine Mammal Mine Shape Location/Research	Mine Location	Mine Training Ranges/NOTS Pier	5	30
	48	RF Emissions	RF	Northern Plateau	15	20
	49	UAV Tests	UAV	Cancelled 7/20/05	12	0
	50	Missile Flight Tests	Missile Flight Tests	Entire Island	10	20
	51	Other Tests	Other	SOAR/SHOBA/Kingfisher	36	20
NUWC	52	NUWC Underwater Acoustics Testing	NUWC	SCIUR	46	139
* There are two USWTR areas: Offshore (OS) and Nearshore (NS)						
Air Operations	53	NALF Airfield Activities	NALF	NALF San Clemente	25,120	24,332
Major Range Events	NA	Major Range Events (by reference)				

2.2.3.2 SOCAL Range Complex Enhancements

Several specific investments and recommendations are required to optimize range capabilities to adequately support training for all missions and roles assigned to the SOCAL Range Complex.

Investment recommendations are based on capability shortfalls (or gaps) and were assessed using the Navy and Marine Corps range required capabilities. Proposed enhancements that pertain to the SOCAL Range Complex are analyzed in the associated EIS/OEIS.

2.2.3.2.1 Commercial Air Services Increase

Under the proposed action, an increase in Commercial Air Services would be implemented. This is a Priority 1 investment because Fleet aircraft are no longer being funded to provide opposition forces (OPFOR) for the CSG and ESG exercises including major range events. In order to provide the required training for CSGs and ESGs, a corresponding increase in Commercial Air Services acting as OPFOR will be required. This would provide for an increase in the number of supersonic and subsonic aircraft within the SOCAL Range Complex. Implementation of the increase is necessary to mitigate for the loss of Fleet aircraft funding and to meet Navy RCD OPFOR requirements.

2.2.3.2.2 Shallow Water Minefield

The Navy plans to construct a shallow water minefield in the SOCAL Range Complex. Multiple site options off Tanner Bank, Cortes Bank, La Jolla and Point Loma have been identified with consideration being given to bathymetry and required capabilities. Of the five areas identified, an area known as Advanced Research Project Agency Training Minefield (ARPA) off La Jolla and historically used for shallow water submarine MCM training is the desired location for expanding MCM training.

Shallow water minefield support of submarine MCM training requires a depth of 250-420 feet, and a sandy bottom and flat contour in an area relatively free from high swells and waves. The size of the area should be a minimum of 2x2-nm and optimally 3x3-nm. Mine shapes would be approximately 500-700 yards apart and 30-35 inches in size, and would consist of a mix of recoverable/replaceable bottom shapes (~10 cylinders weighed down with cement) and moored shapes (~15 shapes, no bottom drilling required for mooring). Shapes would typically need maintenance or cleaning every two years. The MH-60S has similar requirements for shallow water minefield mine training shapes. A fixed shallow water minefield site is not a requirement for Organic Airborne Mine Counter Measures (OAMCM) training however a fixed site would see usage for non-explosive training.

Use of the shallow water minefield would include submarines, surface vessels, and helicopters utilizing a mix of mid to high frequency navigation/mine detecting sonar systems that are either platform based or remotely operated. Airborne laser mine detection systems may also be used to locate surface, moored, and bottom mines. Once located, mine neutralization of permanent shapes by explosive shaped-charge, ordnance, or removal would be by simulation only.

2.2.3.2.3 Shallow Water Training Range (SWTR) Extension

This component of the Proposed Action is to instrument and use two extensions of the current SOAR, one 250-nm^2 area to the west in the area of the Tanner/Cortes Banks, and one 250-nm^2 between SOAR and the southern section of SCI. The instrumentation would be in the form of undersea cables and sensor nodes, which would constitute a SWTR portion of SOAR. The cables and sensors are similar to those that instrument the current deep-water range (SOAR). The combination of deep-water and shallow-water instrumentation provides range uninterrupted coverage of air, surface, and subsurface operations. The instrumented area would be connected to the shore via a single trunk cable.

Phased construction of the SWTR instrumentation array is planned. Construction is scheduled to take place in three increments that would occur over a projected 9-year period (i.e., each phase would take 3 years), beginning with an initial increment of 200 nm2 (370 km2), followed by another 200-nm2 (370-km2) increment, and a final increment of 100 nm2 (185 km2). Because of the size and operational requirements, this section of the range would only be used in a limited manner initially (for the first 3 to 6 years). The analysis conducted in this document addresses full usage of the range once construction has been completed. Before all three phases are complete, range use would be more limited than that described in this document; therefore, effects would be less than those predicted in this analysis.

3 RESOURCE ANALYSIS

Potential effects on EFH and Managed Species from SOCAL operations are described in the following section. The evaluation reflects determinations made in sections of the EIS/OEIS where impacts on the marine environment are quantified, specifically Sections: 3.1 Geology and Soils, 3.3 Hazardous Materials and Wastes, 3.4 Water Quality, 3.5 Acoustic Environment, 3.6 Marine Environment, 3.7 Fish, and 3.14 Socioeconomics (commercial and recreational fishing).

Effects on EFH and Managed Species could be associated with vessel movement, aircraft over-flight, expended materials, hazardous chemicals, detonation of explosive ordnance, weapons training, sensor testing, and sonar use. Navy operations could have direct and indirect effects on individual species, modify their habitats, or alter water quality. The EFH assessment focuses on activities and effects common to offshore operations, but also discusses individual exercises such as Expeditionary Assault, TORPEX, and SINKEX with unique aspects. Mitigation measures and cumulative impacts are described in the final two sections.

3.1 IMPACT DEFINITION

EFH regulations require analysis of potential impacts that could have an adverse effect on EFH and Managed Species (NMFS 2007a). Adverse effect is defined as any impact which reduces the quality and/or quantity of essential fish habitat (NMFS 2004a,b). Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (NMFS 2004a,b).

The EFH regulations in 50 C.F.R. § 600.815(a)(2)(ii) (NMFS 2002a) establish a threshold for determining adverse effects (NMFS 2002b). Adverse effects are more than minimal and not temporary in nature. Temporary effects are those that are limited in duration and allow the particular environment to recover without measurable impact (NMFS 2002b). Minimal effects are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions. Whether an impact is minimal will depend on a number of factors including: the intensity of the impact at the specific site being affected, the spatial extent of the impact relative to the availability of the habitat type affected, the sensitivity/vulnerability of the habitat to the impact, the habitat functions that may be altered by the impact (e.g., shelter from predators), and the timing of the impact relative to when the species or life stage need the habitat.

Thus, for Essential Fish Habitat and Managed Species an adverse effect is: 1) more than minimal, 2) not temporary, 3) causes significant changes in ecological function, and, 4) does not allow the environment to recover without measurable impact.

3.2 VESSEL MOVEMENT

Vessels performing training exercises in the SOCAL Range Complex are primarily large ocean going ships and submarines operating in waters greater than 328 ft (100 m) and small fast moving vessels. Large ocean going vessels (greater than 100 ft (30.4 m) in length) include a host of tactical military ships performing live firing, electronic monitoring, and avoidance maneuvering. Considering the complexity of the training operations and the required logistical mobilization and demobilization requirements, the majority of all ocean operations involve passive transit of vessels within the SOCAL Range Complex. Of the 4,102 ocean operations currently performed within the SOCAL Range Complex 3,000 are amphibious ocean operations. Other than amphibious operations the primary ocean operation components are surface to surface gunnery exercises (315 exercises), and surface to air gunnery exercises (262 exercises). Large ships operating in offshore waters move at approximately 20 knots at full speed but more often operate at significantly slower speeds while engaged in training activities.

Collisions with commercial and navy ships can injure or kill slow-moving marine animals. Most vulnerable are marine mammals and sea turtles that spend extended periods of time at the surface restoring oxygen levels after deep dives (e.g. Right Whale) (NMFS 2005c). Accordingly, the Navy has adopted protective measures to reduce the potential for collisions with surfaced marine animals. These include the use of lookouts trained to detect all objects on the surface of the water, and, reasonable and prudent actions to avoid the close interaction of Navy assets with marine mammals and sea turtles (DON 2007a,b,c,d). Marine fish are highly mobile and would likely sense approaching vessels and be able to avoid being struck (Chapman and Hawkins 1973, Acoustic Ecology 2007).

The noise from Navy vessels could affect fish behavior. However, Navy vessels are quiet compared to commercial vessels of comparable size. Bubble screens are commonly used to reduce propeller noise and other sound reduction mechanisms may be employed (Richardson et al. 1998).

Studies documenting behavioral responses of fish to vessels show that fish may exhibit avoidance responses to engine noise, sonar, depth finders, and fish finders (Jorgensen et al. 2004, Acoustic Ecology 2007). Avoidance reactions are quite variable depending on the type of fish, its life history stage, behavior, time of day, and the sound propagation characteristics of the water (Schwartz 1985). Misund (1997) found that fish ahead of a ship, that showed avoidance reactions, did so at ranges of 160 to 490 ft (50 to 350 m). When the vessel passed over them, some species of fish responded with sudden escape responses that included lateral avoidance and/or downward compression of the school.

The low-frequency sounds of large vessels or accelerating small vessels caused avoidance responses among herring (Chapman and Hawkins 1973). Avoidance ended within 10 seconds after the vessel departed. Twenty five percent of the fish groups habituated to the sound of the large vessel and 75 percent of the responsive fish groups habituated to the sound small boats.

Fish are capable of active avoidance so ship strikes would be a rare event. Behavioral impacts would be transient with return to normal behavior after a ship passes. SOCAL Range Complex vessel movement would not have an adverse effect on fish populations.

3.3 AIRCRAFT OVER-FLIGHT

Aircraft flyovers will be a routine event during training exercises. Most high-performance would fly at altitudes over 5,000 ft (1,524 m). However, aviation exercises can involve aircraft operating at low altitude (less than 1,500 ft (457 m)), at high speeds, for a brief periods, over relatively small areas in vicinity of practice targets. Otherwise, low-level flights are usually restricted to take-offs and landings, and flights by helicopters and observation aircraft.

Airborne sound from a low-flying airplanes or helicopters may be heard by marine animals at the surface or underwater but the acoustic intensity would not be likely to cause physical damage since sound does not transmit well from air to water (USAF 2002, DON 2007a,d).

The sounds from aircraft flying over the ocean could trigger startle responses and swimming away from the aircraft track in some sensitive species of fish in the upper portion of the water column. The primary factor causing abrupt movements of animals is engine noise, specifically changes in engine noise (Richardson et al.1995, Hain et al. 1999). Responses to aircraft noise would be within the range of normal behavior and highly transitory. Therefore, no significant effects on fish are expected.

Aircraft flown in warfare training areas may fly at supersonic speeds (i.e., speeds greater than the speed of sound). At supersonic speeds, air pressure waves combine and produce shock waves known as sonic booms. The penetration of sound pressure waves including sonic booms through an air/water interface is relatively inefficient (Yagla and Stiegler 2003, DON 2007b). Sonic booms would be infrequent and are not expected to have significant effects on marine life.

3.4 FUEL SPILLS

Fish could be harmed by petroleum hydrocarbons spilled as a result of ship or aircraft accidents and weapons and target use (DON 2007a,b,c,d). Oil and diesel fuel pose less risk than jet fuel which is particularly toxic. However, jet fuel floats on sea water and vaporizes quickly so it would not be likely to contact many fish. Assuming that an aerial target disintegrates on contact with the water, toxic components of the fuel would evaporate within several hours to days and/or be degraded by biogenic organisms (e.g., bacteria, phytoplankton, zooplankton) (NRC 1985). Small petro-chemical releases from weapons and targets would be spatially separated and occur at different times, even in areas of highest use (e.g., FLETA HOT and around San Clemente Island).

If a fuel spill occurs, the effects would be mitigated through compliance with standard spill-control responses and wildlife rescue procedures. Fuel dumping by aircraft rarely occurs. Department of the Navy (DON) aircrews are prohibited from dumping fuel below 6,000 ft (1,829 m), except in an emergency situation. Above 6,000 ft (1,829 m), the fuel has enough time to completely vaporize and dissipate and would therefore have a no effect on the sea below. Fuel spills should not be a significant hazard to EFH and Managed Species.

3.5 DISCHARGES FROM SHIPS

The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) prohibits certain discharges of oil, garbage, and other substances from vessels. The MARPOL Convention and its Annexes are implemented by national legislation, including the Act to Prevent Pollution from Ships (APPS) (33 USC 1901 to 1915) and the Federal Water Pollution Control Act (FWPCA) (33 USC 1321 to 1322). These statutes are further implemented and amplified by DON and the Office of the Chief of Naval Operations Environmental and Natural Resources Program Manual (OPNAVINST 5090.1 series), which establishes US Navy policy, guidance, and requirements for the operation of US Navy vessels. The vessels operating on the SOCAL Range Complex would comply with the discharge requirements established in OPNAVINST 5090.1 (series), minimizing or eliminating potential impacts from the discharges of ships.

3.6 EXPENDED MATERIAL

Most weapons and devices used during training exercises would be removed at the conclusion of the exercises. However, some weapons and devices are unrecoverable. This equipment includes: lightsticks, flares, chaff, dye, markers, sensing devices such as sonobuoys and expendable bathythermographs, torpedo accessories, targets, and sunken vessels.

3.6.1 Lightsticks

Lightsticks are small, plastic chemiluminescent devices used as portable light sources during training and rescue operations after dark (United States Air Force (USAF) 1997, 2002). Lightsticks are also used by divers and commercial fishers to mark their fishing gear. Lightsticks contain two solutions which, when mixed together by breaking two small glass ampoules within the plastic casing, produce a light with little or no heat. Their chemical contents are not classified as hazardous waste, although hydrogen peroxide, one of the constituents, is an irritant to mammalian skin and mucous membranes at high concentrations. They do, however, contribute to the overall plastics load and could end up on beaches or in kelp beds.

The release of lightstick chemicals into the marine environment is unlikely since the housing is a tough, pliable plastic. If the lightstick casing were broken, either through degradation over time or by physical destruction, the enclosed small quantity of chemicals would disperse and be rapidly neutralized by sea water. There could be some risk of injury to marine animals if a lightstick, or sharp plastic or glass shards from a broken lightstick were ingested, although this would be a rare event given the relatively small number of lightsticks deployed and the low probability of breakage. Therefore, lightstick use would not result in significant adverse effects.

3.6.2 Flares

Flares are chemical candles that burn at high temperatures creating bright light (USAF 1997, 2002). The typical white light is produced by burning magnesium in an aluminum canister. Other colors of light may also be created by including other metals. Flares cast light at ranges of up to 3,000 ft (914 m) with burn times lasting from three to seven minutes. At the brightest point, the flare light is 0.46 foot-candles. For comparison, the sun at mid-day in summer registers 10,000 to 12,000 foot-candles.

A second type of flare provides infrared (IR) illumination. Unlike the magnesium burning flares which produce light in the visible spectrum, these IR lights have very long wavelengths and are used mainly to enhance night vision capabilities. Because the sun shines infrared light onto the Earth as well as visible light and ultraviolet light; infrared illumination would result in an insignificant adverse effect.

Flares are designed to burn completely (including the aluminum casing), thus reducing the amount of waste material that falls into the ocean. Toxicity of flare debris is not a significant concern because the primary material in flares, magnesium, is not highly toxic (Naval Research Laboratory (NRL) 1999). There have been no documented reports of wildlife consuming flare materials (USAF 2002). The probability of injury from falling dud flares and debris would be extremely remote. Only a small area would be affected by the occasional flare that is not extinguished before hitting the sea surface. The primary constituent of flares and illumination rounds is magnesium, which is nontoxic and occurs naturally in soils. Although impulse cartridges and squibs used in some flares contain chromium and lead, a screening health risk assessment concluded that they do not present a significant health risk in the environment in the quantities proposed to be used (NRL 1999).

Contact with marine flare debris would not cause injury to skin or eyes because exposure would be brief and the materials contained in spent flares are biologically non-explosive. Flares at night would be much brighter than natural moonlight but altered behavior of fish in areas illuminated by flares would be unlikely to have significant consequences, considering the limited duration (3-5 minutes) and extent of flare usage (3,000 ft). Thus, the use of flares would have negligible effect on fish populations and their habitat.

3.6.3 Chaff

Chaff is deployed to confuse radar tracking devices (USAF 2002). Chaff canisters burst in the air releasing millions of aluminum coated glass or silicon fibers. Chaff particles are very light and designed to remain airborne as long as possible. Depending on wind speed and direction, chaff particles may be distributed over a wide area. When finally reaching the water, they may remain suspended on the surface for a while before sinking (NRL 1997, DON 2007b).

A fish surfacing in an area where chaff has fallen on the ocean surface could have its skin covered with the particles (NRL 1999). However, it is unlikely that the concentration of chaff particles would be great enough to restrict mobility. As the animal submerges, the particles would either disperse into the water, or remain temporarily attached. Fish are unlikely to suffer physical effects from chaff lodging in their gills or ingesting toxic quantities of chaff (USAF 1997).

Eventually, chaff particles would sink or be carried away by currents. Ocean floor sediments are largely composed of silicates (crystalline solids such as quartz and feldspar make up a large percentage of the earth’s crust). The ocean water is constantly exposed to these silicates. Likewise, aluminum is a natural component of the ocean environment, entering the water from sediments and through hydrothermal vents. So, the addition of small amounts of these chemicals from chaff would be unlikely to have an effect on water or sediment composition (NRL 1999). Effects of chaff on resident populations of fish are likely to be short-term and would not be expected to adversely affect EFH or Managed Species.

3.6.4 Dyes

During search and rescue training operations brightly-colored fluorescein dye may be deployed to provide visual reference (USAF 2002). The dye, contained in a small plastic bag, may be discharged from aircraft and surface vessels, or by divers. It may also be released at the end of a torpedo run to mark its location (DON 2005b). The dye rapidly disperses on contact with the water and is visible at very low concentrations. At dilute concentrations the dye is relatively non-explosive (USAF 2002). The associated plastic bags may remain on the surface of the water or sink to the bottom, causing a potential ingestion hazard. However, sea dye bags would be a small fraction of the total man-made plastic debris to which local fish are exposed (Kullenberg 1994, Ocean Conservancy 2007). Adverse effects on EFH and fish would not result from the deployment of tactical dyes because of the small amount of dye released, its rapid dissolution in water, and infrequent use.

3.6.5 Marine Markers

Marine markers that produce chemical flames and smoke are used in training exercises to mark a surface position on the ocean. The flame of a marine marker burns like a flare but also produces smoke. The light generated from the marker is bright enough to be seen up to three miles away in ideal conditions, but as with flares is much less intense than the sun. Smoke from marine markers would be rapidly diffused by air movement. The marker itself is not designed to be recovered and would eventually sink to the bottom with similar, minimal effects of flares.

3.6.6 Sonobuoys

Sonobuoys are expendable acoustic devices used to detect subsurface objects and targets. They are powered by seawater-activated batteries containing lead, copper, silver, magnesium, and/or lithium (DON 2005b, 2007b). Seawater enters the battery to activate it, and the battery then powers the deployment of the sonobuoy's flotation unit. Sonobuoys are deployed at the surface and in the water column.

All sonobuoys use a small, lithium-containing calculator-type battery to power the upper electronics unit. If the upper portion of the sonobuoy is lost to the seabed, these small lithium batteries are also lost. Active sonobuoys contain a larger battery pack in the lower electronics unit which also contains lithium – if the lower portion of the sonobuoy is lost to the seabed; these larger lithium battery packs become seabed debris.

If a sonobuoy were damaged, small concentrations of chemical components from the battery would enter the water but would be quickly diffused by the surrounding ocean water (DON 2005b). Modeling of the amount of lead, silver, and copper that could be released from damaged sonobuoys and batteries indicates compliance with EPA Ocean Water Quality Limits (see Water Quality Analysis, Section 3.4.4 of the EIS/OEIS).

Lead, copper, and silver are heavy, naturally-occurring metals, widely distributed in the marine environment. They have relatively low solubility in seawater and slow corrosion rates (D'Itri 1990). The slow rate at which metal components are corroded by seawater translates into slow release rates into the marine environment. Once the metal surfaces corrode, the rate of metal released would decline. Releases of chemical constituents from all metal and non-metal sonobuoy components would be further minimized as a result of natural encrustation of exposed surfaces. Therefore, corrosive components of the sonobuoy would not result in substantial degradation of marine water quality.

The majority of objects that fall to the sea floor become buried in the sediment. Metals like lead, copper, and silver will oxidize in the upper part of the sediment where bioturbation creates oxygen-rich conditions. Below this level, oxidation is less likely, and when leaching does occur, the metals tend to adsorb onto the particulate organic carbon in the sediments (Ankley 1996). Acid volatile sulphide is formed in anoxic zones and complexes with the metal ions in the porewater, rendering the metal relatively nontoxic and less subject to bioaccumulation. Metals can also form complexes with soluble ligands (both organic and inorganic) in pore water (Ankley 1996). Many of the heavier expendable objects are made of metal and tend to sink deeply into the anoxic layer of the sediments.

Magnesium naturally balances ocean pH and assists in normal biological functions of ocean organisms. Many species are equipped with the physiological capability to filter excess magnesium from their system. Lithium chloride can inhibit cell growth if an animal is exposed to high concentrations. However, relatively small amounts of battery chemicals would be released and they would be rapidly diluted by the surrounding sea water. The likelihood of a marine animal being exposed to concentrations great enough to cause damage is small, and little or no impact to marine life is expected.

Under the No Action Alternative, approximately 5,960 sonobuoys per year are planned to be used for training and Quality Assurance/Quality Control (QA/QC) testing (Section 3.3.3.2.1 of the EIS/OEIS). Approximately 3,180 sonobuoys would be used for QA/QC testing east of SCI in the San Clemente Island Underwater Range. Of the 3,180 sonobuoys, approximately 440 would be retrieved from the water to provide additional information about sonobuoy performance across a variety of conditions and sea states. The remainder of the sonobuoys would be used throughout the SOCAL RANGE COMPLEXs during training exercises. Using representative amounts of constituents found in sonobuoys, the total constituents deposited in the water were calculated. For the approximately 5,520 sonobuoys left in the SCIC, approximately 16,200 lb (7,360 kg) of materials would be released into the water.

Based on the known amounts of battery constituents, known battery life (eight hours), and known solubilities, maximum concentrations in seawater were estimated for lead and copper. The amount of lead released is based on a maximum amount of lead in the seawater cell of 0.9 lb (0.4 kg). Metallic lead is converted to lead ion in water. A concentration of 11 micrograms per liter (µg/L) (parts per billion [ppb]) was calculated for lead. The maximum concentration of copper in seawater from a cuprous thiocyanate seawater battery was estimated at 0.015 µg/L (DON 1993).

Lithium batteries, used only in active sonobuoys, consist of an exterior nickel-plated steel jacket containing sulfur dioxide (SO_2), lithium metal, carbon, acetonitrile, and lithium bromide. During battery operation, the lithium reacts with the SO_2 and forms lithium dioxide. The reaction proceeds nearly to completion once the cell is activated, so only a limited amount of reactants are present when the battery life terminates.

Based on estimates for the three types of batteries, marine water quality would not be substantially degraded by the release of metals from batteries (DON 1993). Other components that could affect marine water quality include the metal housing (nickel-plated steel coated with polyvinyl chloride plastic to reduce corrosion), lithium batteries, and internal wiring that, over time, could release chemical constituents into the water. Solid metal components of the sonobuoy are corroded by seawater at slow rates, which translates into slow release rates. Once the metal surfaces corrode, the rate of metal released into the environment would decrease.

About 0.7 ounces (20 grams) of lead solder are used in the internal wiring of each sonobuoy, and 15 ounces (425 grams) of lead are used for the transducer node and lead shot ballast. These lead sources are in the non-ionized metallic form of lead that is insoluble in water, so the lead shot and solder would not be released into the seawater. Various lead salts, such as $PbCl_2$, $PbCO_3$, and PbO H_2, would probably form eventually on the exposed metal surfaces, but these metal salts have very low solubilities: 9.9 grams/liter (g/L), 0.001 g/L, and 0.14 g/L, respectively (DON 1993).

All of the expendable materials would eventually sink to the bottom, but are unlikely to result in any physical impacts to the sea floor because they would sink into a soft bottom and eventually be covered by shifting sediments. Soft-bottom habitats are considered less sensitive than hard bottom habitats, and in such areas, the effects of debris would be minimal because the density of organisms and debris are low. Debris may also serve as a potential habitat or refuge for invertebrates and fish.

In summary, operations involving sonobuoys would result in the accumulation of scuttled sonobuoys on the ocean floor. However, because of the large area over which these sensors are deployed, the density would be quite low. Leaching of metals and chemicals from sonobuoys would have little potential for negative biological effects because of dilution by prevailing currents and low solubility/toxicity in the sediments. Expended sonobuoys eventually become encrusted and/or incorporated into the sediments by natural processes.

3.6.7 Expendable Bathythermographs

Operation of Naval vessels requires the routine determination of water temperature. This is done with an expendable bathythermograph (XBT) - a probe that measures temperature as it falls through the water. Data is relayed to the ship through a thin wire that unreels from the probe as it descends. The wire eventually breaks and the probe is lost (DON 2007a). XBTs do not use batteries and do not contain potentially hazardous materials.

With the exception of a chance encounter by a large marine animal as an XBT descends, it is unlikely that any sea life would ingest an XBT, due to its size and rapid decent. It is also unlikely that an XBT would collide with macroscopic sea life on arrival at the sea floor. The unreeled wire is too fragile to pose a threat of entanglement. Due to the benign nature of their operation and composition, XBTs are not expected to significantly affect marine fish or habitats.

3.6.8 Torpedo Accessories

Torpedo accessories include a control wires, flex hoses, ballast, and, protective nose covers, suspension bands, air stabilizers, and propeller baffles used with air-launched torpedoes. A single-strand control wire pays out from a torpedo as it moves through the water. At the end of a torpedo run, which can be several miles-long, the control wire is released from both the firing vessel and the torpedo to enable recovery of the torpedo. The long, thin-gauge copper wire sinks rapidly and settles on the ocean floor. Torpedoes use a flex hose to protect the control wire. It is also expended after completion of the torpedo run and sinks to the bottom. Practice torpedoes may have lead ballast, steel-jacketed lead ballast, or steel plates that are released to allow them to rise to the surface for retrieval. Air launched torpedoes have a variety of accessories that are expended, including protective nose covers, suspension bands, air stabilizers, and propeller baffles.

The copper wires, plastic flex hoses, ballast, and air-launch accessories left on the ocean bottom after torpedo exercises would not present a significant toxic hazard to marine life (DON 2005b). Encrustation by oxidation or by the growth of colonies of marine life (corals, barnacles, anemones, etc.) slows the rate of chemical diffusion into surrounding water. Over a period of years, torpedo accessories would degrade, corrode, become encrusted and/or be incorporated into the sediments.

Upon completion of a torpedo run, two lead ballast weights would be released. Because each ballast weighs 37 lb (16.8 kg), it would sink rapidly to the bottom and, in areas of soft bottoms, be buried in the sediments. Of the 228 torpedoes estimated for the No Action Alternative (Section 3.4.4.2.1 of the EIS/OEIS), about 150 would be non-running recoverable exercise torpedoes that do not drop ballast weights. The remaining 78 torpedoes would jettison their ballast weights. Therefore, 156 ballasts would be expended annually for ASW.

Lead (Pb) and lead compounds are designated as priority toxic pollutants pursuant to Section 304(a) of the CWA of 1977. The USEPA saltwater quality standard for lead is 8.1 µg/L, continuous, and 210 µg/L maximum concentration (65 Federal Register 31682). Lead is a minor constituent of seawater, with a background concentration of 0.02 to 0.4 µg/L (Section 3.4.4.2.1 of the EIS/OEIS).

The probability that the metallic lead of the ballast weights would mobilize into the sediment or water as lead ions is very low. First, the lead would be jacketed with steel, so the surface of the lead would not be exposed directly to the actions of seawater. Second, even if the lead were exposed, the general bottom conditions of slightly high pH and low oxygen content (i.e., a reducing environment) would prohibit the lead from ionizing. Finally, in areas of soft bottoms, the lead weight would be buried due to the velocity of its impact with the bottom. As a result, releases of soluble lead to bottom waters are expected to be negligible.

Lead has the potential to accumulate in bottom sediments, but the potential concentrations would be well below sediment quality criteria based on thresholds for negative biological effects (see Section 3.4 of the EIS/OEIS). By far the greatest amount of material is likely to be deposited in relatively non-explosive form, as the lead ballast weights that become encrusted with lead oxide and other salts and would be covered by the bottom sediments.

Analysis of possible adverse impact from expended torpedo accessories indicates minimal potential for effects to nearby organisms and no significant bioaccumulation in marine food webs (DON 2005b). Therefore, no adverse effect on the EFH or Managed Species is anticipated.

3.6.9 Targets

At sea targets are usually remotely operated airborne, surface or subsurface traveling units, most of which are designed to be recovered for reuse. A typical aerial target drone is powered by a jet fuel engine, generates radio frequency (RF) signals for tracking purposes, and is equipped with a parachute to allow recovery. There are also recoverable, remotely controlled target boats and underwater targets designed to simulate submarines. If severely damaged or displaced, targets may sink before they can be retrieved.

Targets could accidentally strike marine animals on the sea surface. However, given the large exercise area, few fish would suffer direct contact with targets.

Small concentrations of fuel from targets could enter the water and contaminate limited areas. This would occur in the open ocean away from sensitive EFH such as HAPCs. Target debris on the seafloor would gradually degrade, be overgrown by marine life, and/or be incorporated into the sediments.

Floating debris, such as Styrofoam, may be lost from target boats, but is non-explosive and either degrades over time, or washes ashore as flotsam. A few fish could die from contact or ingestion, but no adverse effect at the population level is anticipated.

3.6.10 Expendable Mobile Acoustic Torpedo Targets

Unlike torpedo targets that simulate submarines (that are recovered at the end of each run) expendable mobile acoustic torpedo targets (EMATTs) scuttle themselves and sink to the sea floor to be left in place. The EMATTs are unlikely to result in any physical impacts to the sea floor. They would sink into a soft bottom or would lie on a hard bottom, where they may provide a substrate for benthic colonization or eventually be covered by shifting sediments. Solid metal components are corroded by seawater at slow rates. Natural encrustation of exposed surfaces would eventually occur as invertebrates grow on the surfaces of the sunken objects. As the exterior becomes progressively more encrusted, the rates at which the metals will dissolve into the surrounding water will also decrease. Rates of deterioration would vary, depending on material and conditions in the immediate marine and benthic environment. Factors such as oxygen content, salinity, temperature and pH all contribute to the manner and speed at which metals will dissolve. Over a period of years, the EMATTs would degrade, corrode, and become encrusted or incorporated into the sediments, thus precluding adverse effects on EFH and Managed Species.

3.6.11 Acoustic Device Countermeasures

Submarines launch acoustic device countermeasures (ADCs) to foil opponents' sensors and weapons. ADCs are the size of small torpedoes and emit acoustic and electro-magnetic signals, which could be detected by elasmobranches (sharks, skates and rays) which can sense the electromagnetic potential from the muscle movements of prey. ADCs are normally retrieved but may be lost or intentionally discarded. Impacts of their operation and the consequences of their ocean disposal are similar to other expended material. Thus, resulting in no significant impact to EFH or managed species.

3.6.12 Sunken Vessels

During sinking exercises (SINKEXs), ordnance is fired at vessels that subsequently sink. The targets are primarily decommissioned naval vessels, such as former amphibious assault ships, destroyers, and frigates. They are empty, cleaned, and, environmentally remediated to U.S. EPA specifications (DON 2006a).

Materials expended during a SINKEX would be primarily metal from the target vessel and shell fragments that quickly settle to the bottom. Sinking debris would not include lines, rope, plastic, or other material with potential to ensnare or entangle marine animals (see Section 3.6.13). Because SINKEXs would not take place in the same location, expended material would be spread over a wide ocean area.

The vessels themselves would settle to the bottom eliminating the marine habitat directly underneath and altering the nature of the environment in the immediate vicinity. However, they would add vertical relief and protected niches especially on sedimentary bottoms and thus act as an artificial reef, enhancing habitat quality.

Only minimal concentrations of hazardous chemicals have been detected in water and sediments around Navy ships that were sunk to create artificial reefs (SPAWAR 2006). Chemical contaminants in fish and invertebrate tissues around sunken Navy vessels have also been analyzed. Johnston et al. (2005) reviewed data and studies on natural reefs, Navy vessel reefs, and other artificial reefs off of the South Carolina coast. Tissues samples in reef fish and invertebrates in proximity to Navy vessel reefs showed chemical concentrations below known effects levels and a risk assessment concluded that there was minimal threat of bioaccumulation by higher food chain predators (dolphins, fish eating birds, diving birds) feeding in the area.

The limited number of SINKEXs would be not be expected to have adverse effects on EFH and Managed Species.

3.6.13 Entanglement

Entanglement in man-made debris is an increasing source of injury and mortality to marine animals throughout the world (Kullenberg 1999). Although most incidents are related to commercial fishing operations (Ocean Conservancy 2007), fish in the SOCAL Range Complex may be exposed to Navy expended material that poses a risk of entanglement. Flare and sonobuoy parachutes, aerial target parachutes, and torpedo control wires and flex hoses are the primary sources of potential entanglement in related to training in the SOCAL Range Complex. Entanglement could cause tissue damage, strangulation, or drowning.

Aerial target parachutes are large and usually recovered during normal operations. The small, expendable parachutes that may be used with flares and sonobuoys are made of non-toxic material, but pose a risk of entanglement as they float on the ocean surface, sink through the water column, or lie on the sea floor. The limited number of parachutes expended during SOCAL Range Complex training operations would be scattered across a large area and should not have a substantial effect on critical habitats or fish assemblages.

Discarded torpedo control wires could snare marine life as they sink or rest on the bottom. The wire has a low breaking strength (40 lb (18 kg) (DON 2004a), but still could pose a potential threat if the wire loops or tangles. However, the wire is more rigid than materials like rope or fishing line which tend to loop and coil in the water. Instead, as the torpedo moves through the water, it leaves the copper wire in a relatively straight line, and the wire continues to fall in this form. The real danger comes from an animal becoming wrapped in the wire and the wire tightening, but because the fall to the ocean floor is essentially a straight line, the threat for looping and tangling is small. Thus, control wires are unlikely to pose significant threat to fish. Discarded flex hose could also present a threat. But, like control wire, it would be unlikely to loop and tangle. So, the discarded torpedo control wires and flex hoses are not likely to pose a significant risk of entanglement to marine life.

3.6.14 Hazardous Chemicals

Expended material would introduce small amounts of potentially hazardous chemicals into the marine environment. The water quality analysis of current and proposed operations indicates that concentrations of constituents of concern associated with material expended in the SOCAL Range Complex are well below water quality criteria established to protect aquatic life (see EIS/OEIS Section 3.4, Water Quality). This should adequately protect for EFH and Managed Species and avoid adverse effects.

3.6.15 Summary

Based on the analysis presented in Section 3.3.3.3.1 of the EIS/OEIS, approximately 50,000 pounds (23,000 kg) per year, or more, of hazardous constituents would be deposited in SOCAL RANGE COMPLEXs as a result of Navy training activities. Distributed over the approximately 120,000 nm^2 of this area, the density of discarded hazardous materials would be less than a pound per year per nm^2. This density of hazardous materials would not have adverse effects on EFH or Managed Species.

A total of about 1.7 million training items would be expended under the No-Action Alternative (see Table 3.2-1, EIS/OEIS). For an ocean floor area of 120,000 nm^2 (222,000 km^2), this would be 14 items per nm^2 (8 items per km^2). Over the entire period of military training, assuming the same amounts of training materials would be used annually for 20 years, the aggregate density of debris on the ocean floor would be 280 items per nm^2 (20 items per km^2). This would be about one item per 3 acres (1.2 hectares) of bottom habitat. At this density, training debris should have no discernable effect on EFH and Managed Species.

3.7 RADIO FREQUENCY EMISSIONS

Aircraft, surface ships, and land-based centers use radio frequency (RF) emissions to transmit data, track targets, and communicate with other personnel. Biological effects of high intensity, long-duration exposure to RF emissions include deep tissue heating, degradation of eye faculties, damage to reproductive organs, and, changes in behavior (DON 2007a,b). Unlike sonar which has the potential to affect marine animals because it propagates well in sea water, RF wavelengths are shorter and quickly attenuate. There would be no or minimal impact on fish since exposure to high intensity RF emissions for a sustained period of time would not occur.

3.8 SOUND GENERATING DEVICES

Aviation exercises include the use of Long Range Acoustic Devices (LRADs). These devices emit a sound within the hearing threshold of humans loud enough to cause hearing loss. The 33-inch wide beam of sound is used for only a few seconds to drive enemy personnel out from ships. This short duration results in annoyance, with no permanent hearing damage to personnel (DON 2007a). Impacts on fish in the vicinity of LRAD transmissions are unlikely because the sound is not sustained and is inefficiently transmitted through the air/water interface.

3.9 LASERS

Lasers are used to guide missiles and other munitions to their targets. Lasers are not pointed toward aircraft, ships, personnel, or at the water. Thus, marine life in the water would not be illuminated by laser beams and there should be no impact on EFH or Managed Species.

3.10 UNDERWATER DETONATIONS

Underwater detonations (UNDETs) during SOCAL Range Complex operations would be associated with Naval Special Warfare (NSW) training and with testing and use of the Improved Extended Echo Ranging (IEER) Sonobuoy. Navy SEAL Basic Underwater Demolitions courses and SEAL platoon training exercises involve a variety of single and multiple charge detonations. The IEER sonobuoy uses a ribbon charge that detonates in the water column. Navy SEAL underwater detonations take place in shallow water. IEER sonobuoy testing and use is conducted in deeper water.

Potential effects of explosive charge detonations on fish and EFH include: 1) disruption of habitat, 2) exposure to chemical by-products, 3) disturbance, injury, or death from the shock (pressure) wave, 4) acoustic impacts, and 5) indirect effects including those on prey species and other components of the food web.

3.10.1 Habitat Disruption

The underwater detonation of explosives may result in physical alteration of fish habitats (Wright and Hopky 1998). Live hard-bottom, artificial reefs, seagrass beds, and kelp beds harbor a wide variety of marine organisms (Cahoon et al. 1990). These habitats support productive biological assemblages and dense aggregations of fish (Thompson et al. 1999). The Navy selects UNDET areas to avoid these key habitats (DON 2005b). SOCAL Range Complex underwater detonations would only take place in waters overlying unconsolidated sediment. Thus, the cratering of soft-bottom seafloor is the only habitat disruption that would result.

Naval Special Warfare (NSW) forces (SEALs) conduct nearshore underwater demolition training at San Clemente Island in depths of 6 to 20 ft (2 to 6 m) at the Northwest Harbor area and at Horse Beach Cove. Detonations would include 5-lb (2.3-kg) C-4 blocks, 20-lb (9-kg) C-4 blocks, haversacks containing 20 lb (9 kg) of C-4, 4.6-lb (2-kg) limpet charges, a Mat Weave made from 10 MK-75 50-lb (23-kg) tubular charges, and an Obstacle Loading charge consisting of 16 haversacks each containing 20 lb (9 kg) of C-4.

Underwater detonations at San Clemente Island take place in areas of sandy bottom, which is not a sensitive habitat, nor are sensitive species present (see EIS/OEIS Sections 3.6 and 3.7). The explosions would disturb surface sediments and displace organisms living on and in the substrate, and in the overlying water column. Mobile species are expected to rapidly move back into the area following detonations, whereas sedentary species may or may not recover to previous abundances depending on the spatial overlap and time interval between detonations. The Marine Environment and Fish evaluations in the EIS/OEIS (Sections 3.6 and 3.7) conclude that impacts of UNDET would be less than significant. Turbidity increases following explosions would be brief, i.e., lasting a few minutes to a few hours, and not expected to extend a substantial distance away. The local sediments are coarse and would rapidly fall out of suspension or be dispersed by waves and currents. Effects on sediment-dwelling organisms, which are regularly exposed to high turbidity as a result of waves and currents, would be insignificant. Increased turbidity could temporarily decrease the foraging efficiency of fish, however, given the dynamic nature of the habitat and the grain size of the material, turbidity is expected to be minimal and localized. Detonation by-products are non-hazardous and would not degrade water quality (see following section, 3.10.2, Chemical By-products). Therefore, habitat disruption from NSW underwater demolition training would be less than significant.

3.10.2 Chemical By-products

Combustion products from the detonation of high explosives - CO, CO^2, H^2, H^2O, N^2, and NH^3 - are commonly found in sea water. The primary constituents that would be released from explosives training are nitroaromatic compounds such as trinitrotoluene (TNT), cyclonite (Royal Demolition Explosive or RDX), and octogen (High Melting Explosive or HMX) (URS et al. 2000). Initial concentrations of explosion by-products are not expected to be hazardous to marine life (DON 2001a) and would not accumulate in the training area because exercises are spread out over time and the chemicals will rapidly disperse in the ocean. Therefore, no adverse effects to EFH from chemical by-products of detonation would be expected.

3.10.3 Pressure Effects

An underwater explosion generates a shock wave that produces a sudden, intense change in local pressure as it passes through the water (DON 1998, 2001a). Pressure waves extend to a greater distance than other forms of energy produced by the explosion (i.e., heat and light) and are therefore the most likely source of negative impacts on marine life (Craig 2001, SIO 2005, DON 2006a).

The shock wave from an underwater explosion is lethal to fish at close range, causing massive organ and tissue damage and internal bleeding (Keevin and Hempen 1997). At greater distance from the detonation point, the extent of mortality or injury depends on a number of factors including fish size, body shape, orientation, and species (Wright 1982, Keevin and Hempen 1997). At the same distance from the source, larger fish are generally less susceptible to death or injury, elongated forms that are round in cross-section are less at risk than deep-bodied forms, and fish oriented sideways to the blast suffer the greatest impact (Yelverton et al. 1975, Wiley et al. 1981, O'Keefe and Young 1984a,b, Edds-Walton and Finneran 2006). Species with gas-filled organs have higher mortality than those without them (Goertner et al. 1994, CSA 2004).

Two aspects of the shock wave appear most responsible for injury and death to fish: the received peak pressure and the time required for the pressure to rise and decay (Dzwilewski and Fenton 2003). Higher peak pressure and abrupt rise and decay times are more likely to cause acute pathological effects (Wright and Hopky 1998). Rapidly oscillating pressure waves may rupture the kidney, liver, spleen, and sinus and cause venous hemorrhaging (Keevin and Hempen 1997). They can also generate bubbles in blood and other tissues, possibly causing embolism damage (Ketten 1998). Oscillating pressure waves may also burst gas-containing organs. The swim bladder, the gas-filled organ used by many pelagic fish to control buoyancy, is the primary site of damage from explosives (Yelverton et al. 1975, Wright 1982). Gas-filled fish swim bladders resonate at different frequencies than surrounding tissue and can be torn by rapid oscillation between high- and low-pressure waves. Swim bladders are a characteristic of bony fish and are not present in sharks and rays. However, hemorrhaging of the liver in sharks exposed to the shock waves from explosives could have deleterious effects on the buoyancy function provided by the livers of these species (Edds-Walton and Finneran 2006). Delayed lethality could result from the accumulation of sub-lethal injuries (DON 200a).

Studies that have documented fish killed during planned underwater explosions indicate that most fish that die do so within one to four hours, and almost all die within a day (Hubbs and Rechnizer 1952, Yelverton et al. 1975). Fitch and Young (1948) found that the type of fish killed changed when blasting was repeated at the same marine location within 24 hours of previous blasting. They observed that most fish killed on the second day were scavengers, presumably attracted by the victims of the previous day's blasts. However, fish collected during these types of studies have mostly been recovered floating on the waters surface. Gitschlag et al. (2000) collected both floating fish and those that were sinking or lying on the bottom after explosive removal of nine oil platforms in the northern Gulf of Mexico. They found that as few as 3% of the specimens killed during a blast may float to the surface. Other impediments to accurately characterizing the magnitude of fish kills included currents and winds that transported floating fish out of the sampling area and predation by seabirds or other fish.

There have been few studies of the impact of underwater explosions on early life stages of fish (eggs, larvae, juveniles). Fitch and Young (1948) reported the demise of larval anchovies exposed to underwater blasts off California, and Nix and Chapman (1985) found that anchovy and smelt larvae died following the detonation of buried charges. Similar to adult fish, the presence of a swim bladder contributes to shock wave-induced internal damage in larval and juvenile fish (Settle et al. 2002). Shock wave trauma to internal organs of larval Pinfish and Spot from shock waves was documented by Govoni et al. (2003). These were laboratory studies, however, and have not been verified in the field.

Data on the effects of underwater explosions on aquatic plants are extremely limited. The potential for injury and mortality to aquatic invertebrates from underwater blasts is a little better known (Keevin and

Hempen 1997). These studies indicate that invertebrates are relatively insensitive to pressure-related damage from underwater explosions, perhaps because they lack gas-containing organs which have been implicated in internal damage and mortality in vertebrates.

The variety of environmental parameters and biological features that can modify the impact of underwater explosions complicates the effort to predict lethal effect ranges in the field (Wright 1982, Keevin and Hempen 1997). Predictive models have, however, been developed over the past three decades (Wiley et al. 1981, Goertner 1982, Young 1991). These are based on measurements of the pressure produced by underwater explosions at increasing distance from the detonation point (O'Keefe and Young 1984, Wright and Hopky 1998, Dzwilewski and Fenton 2003). Different types of explosive materials are normalized in effect range models by establishing an equivalent weight of TNT known as the "Net Explosive Weight" or "n.e.w.".

Young (1991) provides equations that allow estimation of the potential effect on swim bladder fish using a damage prediction method developed by Goertner (1982). Young's parameters include the size of the fish and its location relative to the explosive source, but are independent of environmental conditions (e.g., depth of fish and explosive shot frequency). An example of such model predictions is shown in Table 3-1 which lists estimated fish-effects ranges using Young's (1991) method for swim bladder fish exposed to a 60-lb explosion at depth of 10 ft (3.3 m). The 10% mortality range is the distance beyond which 90% of the fish present would be expected to survive. It is difficult to predict the range of more subtle effects causing injury but not mortality (CSA 2004).

Table 3-1: Estimated Fish-Effects Ranges for 60-lb NEW Underwater Explosion

Weight of Fish	10% Mortality Range	
	ft	m
1 oz	712	217
1 lb	496	151
30 lbs	319	97

Young's model for 90 percent fish survivability applies to simple explosives. However, several of the explosives used in the San Clemente Island NSW training have complicated configurations and blast parameters. Thus, impulse and effects were computed separately for the fish effects analysis in the EIS/OEIS (Section 3.7). In addition, Young's model was based on open, deep-water conditions, where blast effects are predicted more easily. Explosives used in the SOCAL Range Complex NSW training at SCI are detonated in shallow water, just off the shoreline. This restricts the effected area to a small nearshore wedge, rather than a large circular area. Given the difficulty determining the areas of influence in these shallow-water conditions and the lack of definitive estimates of the size of fish populations in such small, nearshore areas, modeling of fish mortality was not done for Northwest Harbor and Horse Beach Cove. However, field studies indicate that previous demolition operations have not diminished or altered the composition of the fish populations (Kushner and Rich 2004). Fish injured or killed at Northwest Harbor and Horse Beach Cove appear to be rapidly replaced because fish were abundant at kelp monitoring sites in 2003 and 2004, and diversity was comparable to other Channel Islands within similar oceanographic regimes such as Catalina and Santa Barbara Islands.

Improved Extended Echo Ranging (IEER) sonobuoys would not be used in the No Action Alternative but would be used in Alternative 1. The IEER sonobuoy uses a ribbon charge that is detonated in the water column. Fish populations in the offshore, deep-water environment where IEER sonobuoys are tested are widely dispersed. Given the limited number of IEER tests spread over a large ocean area, only a very small fractions of fish stocks would be influenced. Thus, adverse effects of IEER sonobuoy detonations on fish are not anticipated.

To summarize, a limited number of fish would be killed in the immediate proximity of explosive charges detonated during NSW training and IEER sonobuoy testing. Additional fish would be injured and could subsequently die or suffer greater rates of predation. Beyond the range of direct physical impacts, there would be short-term, reversible behavioral responses. However, given the relatively small area that would be affected, and the abundance and distribution of the species concerned, no significant effects would be expected. When exercises are completed, the fish stock should repopulate the affected areas. The regional abundance and diversity of fish are unlikely to measurably decrease. While this conclusion is primarily based on qualitative judgments, it is supported by the best scientific information currently available. Reliable, quantitative predictions of population level effects are simply beyond the capacity of contemporary ocean science.

3.10.4 Acoustic Impacts

Sound is the only form of energy that propagates well underwater and is used by many aquatic animals for imaging, navigation, and communication. Light, so commonly employed in sensory perception by terrestrial animals, does not penetrate far in seawater, especially in turbid coastal environments. The following paragraphs present a brief introduction to the acoustic capabilities of fish and the potential for impact from anthropogenic (man-made) sounds. Comprehensive technical reviews are available elsewhere (e.g., Popper 2003, Popper et al. 2004, Hastings and Popper 2005, NRC 2003, 2005, ICES 2005, DON 2005b, Edds-Walton and Finneran 2006, NOAA 2007c,d,e).

Sound is a wave of energy from an impulse or vibration that alternately compresses and decompresses a medium like air or water. A sound wave moves through the medium causing two types of actions; an oscillation of the pressure of the medium and an oscillating movement of particles in the medium.

A sound wave has three basic attributes; frequency, wavelength, and amplitude. Frequency is the number of cycles of compression and decompression per second – expressed in units called Hertz (Hz) equal to one cycle per second. The human voice can generate frequencies between 100 and 10,000 Hz and the human ear can detect frequencies of 20 to 20,000 Hz. Some animals like dogs and bats can hear sounds at much higher frequencies - up to 160,000 Hz. At the other end of the spectrum, whales and elephants can produce and detect sounds at frequencies in the range of 15 to 35 Hz.

Wavelength is the distance between two successive compressions or the distance the wave travels in one cycle of vibration. The amplitude of a sound wave is the distance a vibrating particle is displaced. Small variations in amplitude produce weak or quiet sounds, while large variations produce strong or loud sounds. The amplitude of a sound is directly related to the amount of energy transmitted.

A number of factors determine the energy level of a sound received at a distance from the source. As sound travels through the ocean, the intensity associated with the wavefront diminishes, or attenuates. This decrease in intensity, called propagation or transmission loss, results from absorption, spreading, and scattering. How far sound waves travel before losing so much energy that they cannot cause the medium to oscillate depends on their frequency. High frequencies are more readily absorbed and thus travel shorter distances than low frequencies. The spreading of a wavefront causes the total power associated with the wavefront to be distributed over an increasingly large area with a concomitant decease in intensity. Sound waves can also be diminished by striking boundaries, such as the sea surface, thermocline, seafloor, or biota in the water column.

Ambient noise in the ocean is persistent, world-wide, and comes from all directions (NRDC 1999, NRC 2003, NOAA 2007c,d,e). Background environmental noise has been measured over frequency ranges from below 1 Hz to over 100,000 Hz (100 kHz) (Cato and McCauley 2001, Andrew et al. 2002).

The levels and frequencies of ambient noise in coastal waters are subject to wide variations depending on time and location. Anthropogenic noise is produced by watercraft (from jet skis to supertankers), offshore oil/gas exploration and production, sonar, underwater telemetry and communication, construction projects, and ocean research (Richardson et al. 1995, NRDC 1999). Naturally occurring environmental noises include the sound of wind and waves, tides and currents, rain, thunder and lightning, tectonic and volcanic activity, as well as sounds produced by marine animals. At any given time and place, the ambient noise level is a mixture of these noise types with higher sound levels over consolidated substrate than sand or mud.

Surface shipping is the most widespread source of anthropogenic, low frequency (0 to 1,000 Hz) noise in the oceans (NOAA 2007e). The radiated noise spectrum of merchant ships ranges from 20 to 500 Hz with higher frequencies produced by sonar operations (Richardson et al. 1995). Most ocean going vessels have sonar systems for navigating, depth sounding, and sometimes “fish finding”. Depth sounding sonars usually operate in the 15 kHz to 200 kHz frequency range, while locating, positioning, and navigational sonars use the mid frequency band of 1 kHz to 20 kHz. Long-range sonars generally operate in the 100 Hz to 3 kHz range. Commercial fishing boats may also use pingers to prevent seals, dolphins, and turtles from being caught in nets (Gearin et al. 2000). There are two basic types of pinger devices, harassment devices and deterrent devices. “Acoustic Harassment Devices” are pingers specifically used to deter pinnipeds from preying on captured fish. These devices use high intensity signals in the middle to high frequencies (5-30 kHz; Reeves et al. 2001). “Acoustic Deterrent Device” pingers use low intensity sound signals in the middle to high frequencies (2.5 – 10 kHz) with higher harmonic frequencies (up to 160-180 kHz). They are designed to prevent bycatch of small cetaceans (Reeves et al. 1996, 2001).

Of the estimated 27,000 fish species only a small percentage have been studied in terms of auditory capability or sound production. Of those studied, many fishes produce vocalizations in the low frequency band (50-3000 Hz). Hearing or sound production is documented in 247 species, while actual hearing capabilities data exist for only 100 of the 27,000 fish species (Hastings and Popper, 2005).

Fish have evolved two main sensory organs for detecting sound in the aquatic environment: the inner ear, located in the skull, and the lateral line system along the flanks and on the head (Ladich and Popper 2004). Fish have two inner ears, but no middle or external ear like terrestrial vertebrates. Sound passes directly through the body to the inner ear. The structure of the fish inner ear and the mechanism for converting acoustic energy to electrical signals received by the brain is similar to that found in all other vertebrates. Sensory hair cells translate vibrations into electrical signals conveyed by the nervous system to the brain (Popper et al. 2003). Fish have three fluid-filled otolith organs each containing a dense calcified otolith overlying tissue containing sensory hair cells. The otoliths sense the position of the head in the vertical plane and in other directions relative to the acceleration of the body (Popper and Lu 2000). The otoliths are denser than the surrounding tissues and the water so their sound-induced vibrations are at a different phase and amplitude which creates a shearing movement of the hair cells (Popper and Fay 1999).

The same sensory hair cells as in the ear are found in the lateral line system (Hastings and Popper 1996). They detect particle motion from sound waves over a distance of one to two body lengths, and at low frequencies (lower than 200 Hz). This acoustic input is used for coordinating group movements and maintaining coherent schools (Popper and Fay 1999).

The perception of sound pressure is restricted to fish species with gas-filled swim bladders. Due to the higher compressibility of gas than water, the swim bladder responds effectively to sound pressure fluctuations. In some species of fish, a series of modified vertebra connect the inner ear to the swim bladder acting as a transducer that converts sound pressure waves into particle motion which stimulates the otoliths. Species with no swim bladder (for example, mackerel, tuna, sharks) or a much-reduced one (many benthic species, including flatfish) tend to have relatively low auditory sensitivity.

With regard to auditory capabilities, fish have traditionally been divided into two groups – hearing generalists and hearing specialists. Most fish species do not have known hearing specializations and appear to only detect sounds from about 100 to 1,000 Hz (Hastings and Popper 2005). The best hearing sensitivity of many hearing generalists is at or around 300 Hz (Popper 2003). Hearing specialists perceive acoustic signals over a broader range of frequencies and at lower amplitudes than generalists. They have unique adaptations that facilitate their auditory sensitivity, such the previously mentioned acoustic coupling between the swim bladder and the ear. The auditory capability of most hearing specialists ranges to over 3,000 Hz, with best hearing from about 300 to 1000 Hz (Popper et al. 2003, Ladich and Popper 2004, Ramcharitar and Popper 2004). Specialists detect both the particle motion and pressure components of sound whereas generalists are limited to detection of the particle motion component of low frequency sounds at relatively high sound intensities (Amoser and Ladich 2005). Examples of specialists include goldfish, catfish, squirrelfish, and herrings. Hearing specializations are most often found in freshwater species, while in marine species, specializations are quite rare (Amoser and Ladich 2005). The evolution of hearing specializations appears to have been facilitated by low ambient noise levels found in lakes, slowly flowing waters, and the deep sea (Ladich and Bass 2003, Amoser and Ladich 2005). This evolution most likely came about due to the essential need to detect abiotic noise, avoid approaching predators and detect prey, and to a much lesser degree, communicate acoustically (Amoser and Ladich 2005). Some species like cod and salmon have hearing capabilities in the infrasonic range (< 20 Hz) (Knudsen et al. 1997, Sand et al. 2000, Sonny et al. 2006), while members of the shad family can detect sounds in the ultrasonic range, i.e., over 20 kHz. (Mann 2001, Gregory and Clabburn 2003, Popper et al. 2004, Higgs et al. 2004, Higgs 2005). However, other Clupeids, including species of sardines and anchovies, do not detect ultrasound; with peak hearing sensitivity generally ranging from 200 to 800 Hz.

Studies on the hearing ability of marine fish have mostly shown poor hearing sensitivity. Sharks and rays (Myrberg 2001, Casper et al. 2003, Casper and Mann 2006), scorpionfish, searobins, and sculpins (Lovell et al. 2005), scombrids (i.e. albacores, bonitos, mackerels, tunas) (Iversen 1967, 1969, Song et al. 2006), Atlantic salmon (*Salmo salar*) (Hawkins and Johnstone 1978), and Gulf toadfish (*Opsanus beta*) (Remage-Healey et al. 2006) are all believed to be hearing generalists. While the hearing of relatively few marine species has been investigated, and in a number of fish groups both generalists and specialists exist, it is reasonable to suggest that unless most species are very close (within a few meters) to very high intensity sounds (e.g. seismic air guns or sonar) from which they cannot swim away, short- and long-term effects may be minimal or non-existent (Song et al. 2006).

Experiments on elasmobranch fish have demonstrated poor hearing abilities and frequency sensitivity from 20 to 1,000 Hz with best sensitivity at lower ranges (Myrberg 2001, Casper et al. 2003; Casper and Mann 2006). While only five elasmobranch species have been tested for hearing thresholds it is believed that all elasmobranchs will only detect low frequency sounds because of their lack of a swim bladder. Without an air-filled cavity fish, theoretically, are limited to detecting particle motion and not pressure (Casper and Mann 2006).

The lateral line system of a fish also allows for sensitivity to sound (Hastings and Popper 2005). This system is a series of receptors along the body of the fish that detects water motion relative to the fish that arise from sources within a few body lengths of the animal. The sensitivity of the lateral line system is generally below a few hundred Hz (Hastings and Popper 2005). The only study on the effect of exposure to sound on the lateral line system suggests no effect on these sensory cells (Hastings et al. 1996). While studies on the effect of sound on the lateral line are limited, Hasting et al.'s (1996) work suggests sensitivity of a fish's lateral line system is limited to within a few body lengths and to sounds below a few hundred Hz.

Fish are able to distinguish sounds of different magnitudes and frequencies, detect a sound in the presence of other signals, and determine the direction of a sound source. Beyond the basic ability to detect sound, these higher level capabilities allow fish to discriminate between sounds of predator versus those of prey, sense the direction of a sound emitted by potential predators or prey, and establish the nature of one sound source in the presence of others including anthropogenic masking sounds.

In addition to their ability to hear sounds, fish are known to produce sound (vocalize), generally in the range of about 50 to 8,000 Hz. (URI 2007). The sound is generated by a variety of means to alert competitors, deceive prey, attract mates, and coordinate breeding and spawning (USF 2007). Grunts, croaks, clicks and snaps are produced by rubbing skeletal parts together (e.g., teeth, fins) and by resonating the swim bladder.

Most assessments of the potential impact of noise in the ocean have concerned marine mammals (Bowles et al. 1994, NRC 2003, 2005), but, there is growing interest in acoustic effects on fish (Popper 2003, Popper et al. 2004, Popper and Hastings 2005, Popper et al. 2005, Edds-Walton and Finneran 2006). In addition to the peer-reviewed scientific literature, information on fish hearing and anthropogenic effects is available in technical reviews (e.g., ICES 2005), on government and university web sites (e.g., NMFS 2007b, NOAA 2007b, ONR 2007, URI 2007, UM 2007, USF 2007), and from environmental impact/analysis documents (e.g., DON 2005, 2006, 2007, SIO 2005).

The potential acoustic impacts may be considered in four categorizes: masking - interference with the ability to hear biologically important sounds; stress - physiological responses including elevated heart rate and release of hormones; behavior - disruption of natural activities like swimming, schooling, feeding, breeding, and migration; and, hearing - permanent hearing loss from high intensity/long duration sounds or temporary hearing loss from less intense sounds.

3.10.4.1 Masking

Marine animals rely on sound for numerous life activities (e.g., to alert competitors, locate prey, escape predators, for schooling, and for mating) (Hastings and Popper 2005). A decrease in the ability of fish to detect biologically-relevant sounds because of interference by anthropogenic noise could have significant consequences (Richardson et al. 1995, McCauley et al 2003, NRC 2003, 2005). Laboratory studies have indicated the potential for auditory masking by anthropogenic sounds (DON 2005b).

Navigation by larval fish may be particularly vulnerable to masking. There is indication that larvae of some species navigate to juvenile and adult habitat by listening for sounds indicative of a particular habitat (Higgs 2005). In a study of an Australian reef system it was determined the sound signature emitted from fish choruses were between 800 Hz and 1,600 Hz (Cato 1978) and could be detected 5 to 8 km from the reef (McCauley and Cato 2000). This bandwidth is well within the detectable bandwidth of adults and larvae of many species of reef fish (Kenyon 1996).

Detecting effects of masking under field conditions is complicated. Hearing thresholds represent the lowest levels of sound animals can detect in a quiet environment. But the sea is usually noisy, even in the absence of man-made sounds. Potential consequences of masking, such as altered feeding success, predation rate, and reproductive success are difficult to distinguish from other possible causes including those related to natural cycles and human-related impacts. Consequently, the ecological effect of auditory masking in the ocean is virtually unknown.

The zone of masking is the region within which a noise is strong enough to interfere with detection of biologically-relevant sounds. In general, distant man-made noise is unlikely to mask short-distance acoustic communication. Given that the energy distribution of an explosion covers a broad frequency spectrum, sound from underwater explosions might overlap with some environmental cues significant to marine animals. However, the time scale of individual explosions is very limited, and training exercises involving explosions are dispersed in space and time. Thus, the likelihood of underwater detonations resulting in significant masking is considered low.

Studies have indicated that acoustic communication and orientation of fish may be restricted by noise regimes in their environment (Wysocki and Ladich 2005). Although some species may be able to produce sound at higher frequencies (> 1 kHz), vocal marine fish largely communicate below the range of mid-frequency levels used by most sonar employed in the proposed action. Further, most marine fish species are not expected to able to detect sounds in the mid-frequency range of the operational sonars. The few fish species that have been shown to be able to detect mid-frequencies do not have their best sensitivities in the range of the operational sonars. Thus, these fish can only hear mid-frequency sounds when they are very loud (i.e. when sonars are operating at their highest energy levels and fish are within a few meters). Considering the low frequency detection of most marine species and the limited time of exposure due to the moving sound sources, the most sonar sound sources used in the SOCAL Range Complex would not have the potential to significantly mask key environmental sounds.

3.10.4.2 Stress

Although an increase in background noise is known to cause stress in humans, there have been few studies on fish (Popper 2003, ICES 2005). There is some indication of physiological effects on fish such as a change in hormones levels and altered behavior (Pickering 1981, Smith et al. 2004a,b, Remage-Healey et al. 2006). Only a limited number of studies have measured biochemical responses by fish to acoustic stress. McCauley et al. (2000, 2002) investigated physiological effects of exposure to loud sounds on various fish species, squid, and cuttlefish. No significant increases in physiological stress were detected. Sverdrup et al. (1994) found that Atlantic salmon subjected to acoustic stress released primary stress hormones, adrenaline and cortisol, as a biochemical response. All experimental subjects returned to their normal physiological levels within 72 hours of exposure. Wysocki et al. 2006 report elevated cortisol levels in freshwater fish under laboratory conditions exposed to recorded ship noise versus broad-spectrum (control) noise.

Since stress affects human health, it seems reasonable that stress from loud sound may impact fish health, but available information is too limited to adequately address the issue. However, due to the punctuated nature of EOD exercises, the resulting stress on fish is not likely to jeopardize the health of widespread resident populations.

3.10.4.3 Behavior

Many factors affect how fish react when exposed to noise. The presence of predators or prey, seasonal and daily variations in physiology, spawning or migratory activities, and other factors may make them more or less sensitive to unfamiliar sounds (Popper et al. 2004).

Fish have been observed to change their behavior in response to sound by moving away from a sound source or up and down in the water column (Popper 2003). Studies of caged fish have identified three basic behavioral reactions to sound: startle, alarm, and avoidance (Pearson et al. 1992, McCauley et al. 2000, SIO 2005). The startle response in characterized by fish flexing their bodies powerfully and swimming away at high speed without changing direction. At lower levels of noise, alarm may occur in the absence of a startle response. For schooling fish, alarm involves a general increase in activity and tighter packing with abrupt changes in direction. During avoidance behavior, fish slowly move away from the sound source. The time of year, whether or not the fish have eaten, and the nature of the sound signal may all influence fish response. Changes in sound intensity may be more important to a fish's behavior than the maximum sound level. Sounds that reach their peak intensity rapidly tend to elicit stronger responses from fish than sounds with longer rise times, but equal peak intensities (Schwarz 1985).

Recent studies on the behavioral response of caged fish to low frequency sonar pulses (Popper et al. 2005a, 2007) documented an immediate "startle response" and displacement in the water column for some species. Rainbow trout exhibited only a small initial response and quickly returned to pre-stimulus behavior. Behavioral sensitivity is lowest in flatfish that have no swim bladder and also in salmonids in which the swim bladder is present but somewhat remote from the inner ear (Hastings and Popper 2005). Gadoid fish (cod, whiting) in which the swim bladder is closely associated with the inner ear display a relatively high sensitivity to sound pressure (Turnpenny et al. 1994).

Most studies have been conducted in the laboratory where fish can be readily observed under controlled conditions, but some field studies have been performed. A number of these have investigated the effect of sub-bottom profiling in seismic explorations. These explorations use airguns that release blasts of compressed air producing sounds loud enough to penetrate the ocean floor.

Pearson et al. (1992) used a floating enclosure off the California coast to observe individual responses of rockfish to intense low-frequency seismic survey noise. They observed startle and alarm responses to airgun blasts for two sensitive rockfish species, but not for two other species, as well as subtle changes in the behavior in other species of rockfish. The rockfish returned to their normal behavior within minutes of cessation of the seismic noise stimulus, however, their field data indicated that continuous air-gun noise could reduce catchability of free-ranging rockfish, which moved out of the range of the hooks-and-lines used by fishers (Skalski et al., 1992). Experiments conducted by Skalski et al. (1992), Dalen and Raknes (1985), and, Dalen and Knutsen (1986) demonstrated that some fish were forced to the bottom and others driven from the area in response to low-frequency airgun noise. Other studies have shown no impact of airguns on fish behavior. Wardle et al. 2001 used video cameras to document reef fish behavior after exposure to airgun emissions. The observations showed no apparent damage to fish and no dislocation from the reef during the course of the study.

An investigation by Engås et al. (1996) revealed persistent changes in the horizontal distribution of two important food fish following 5 days of continuous seismic shooting during surveys. The study indicated that fish populations had moved to sites over 18 nm from the shooting area. There was no evidence of fish mortality as a result of the seismic shooting. The decline in fish density in the shooting area persisted for at least 5 days, at which point the study was ended. Slotte et al. (2004) report both horizontal and vertical displacement of pelagic fish during seimic shooting.

Edds-Walton and Finneran (2006) point out that a shift in fish density of even a few days could have significant economic consequences given the restricted time limits placed on fishing for some commercially-important species. And, fish are found in particular locations for ecological or physiological reasons - forcing a departure from those areas can reduce the overall fitness of a population. In their review of the behavior of fish in response to human-generated noise sources, these authors also indicate that avoidance behavior appears to be less likely in territorial fish (like those on coral reefs or defending nest sites) for whom departure from an area would carry a heavy biological price. Fish that are actively feeding on patchy prey or that are part of a spawning aggregation are also less likely to abandon their location in the presence of noise levels that would cause avoidance under other circumstances. Diminished auditory capabilities are more likely to occur in species that do not avoid intense noise sources, although population-level consequences would be directly related to the role that sound plays in the normal behavior of the species involved.

Habituation and sensitization are results of repeated presentations of the same stimuli (NRC 2003). Habituation to repeated presentations of a signal that does not cause physical discomfort or immediate stress is a common adaptive response to almost every sort of stimuli, including noise (NRC 2005). It is not known if marine species habituate to the sound of distant explosions. The natural motility of fish decreases the probability that any particular animal would be exposed to multiple exercises. Therefore, habituation is possible but unlikely due to the brevity, frequency, and variable locations of the exercises. Sensitization is a conditioned response in conjunction with a particular stimulus (including noise) as a result of a previous negative experience for the animal (NRC 2003). Subsequent exposures produce responses that are more marked. Like habituation, the potential for an animal to become sensitized to the noise of underwater explosions exists, particularly if the exposure causes discomfort. However, sensitization becomes less likely because of the brevity, frequency, and variable location of the exercises.

Long-term behavioral impacts can include habitat abandonment. For example, long-term habitat abandonment, observed at a baleen whale calving area (Bryant et al. 1984) and at a killer whale feeding area (Morton and Symonds 2002), resulted from chronic exposures to specific types of anthropogenic sound (dredging operations and seal acoustic harassment devices) over long periods of time. Similar situations have not been established for fish. Repeated disturbance leading to habitat abandonment is not expected due to the infrequent nature and variability of locations of underwater detonations associated with proposed SOCAL Range Complex exercises.

Low frequency pulses of sound have been shown to attract sharks in both coastal and pelagic habitats (Nelson and Johnson 1972, Myrberg 2001). The pulsed sounds are most attractive when pulse presentation is intermittent and not continuous. These low frequency pulses (25-200 Hz) are similar to the sounds produced by struggling prey or actively feeding fish. Nelson and Johnson (1972) found that some sharks exhibited a startle response if they were within a meter of the speaker when pulsing began, but those sharks did not exhibit avoidance behavior after the initial startle reaction. Since low frequency sound travels far in sea water, sharks could be attracted from hundreds of meters away. The resulting concentration of sharks could alter normal behavioral patterns and induce aggressive interactions between sharks that normally would not interact. Myrberg et al. (1972) also suggested that the rotors of low-flying/hovering helicopters could produce pulsed sounds below the water surface at levels sufficient to attract epipelagic sharks.

In summary, sounds that disrupt natural patterns like sheltering, schooling, feeding, breeding, and migration can have significant consequences if basic life functions are appreciably altered. Effects on individuals can have population-level consequences, affecting the viability of fish stocks and the species. However, the difficulty tracking changes in the behavior of free-ranging fish and establishing the subsequent ecological impact limits our ability to establish the long-term ecological consequences of changes in fish behavior in response to anthropogenic noise.

Although some fish in the vicinity of the training exercises may react negatively to the noise of underwater detonations, the noises are relatively short-term and localized. Behavioral changes are not expected to have lasting impacts on the survival, growth, or reproduction of fish populations. As exercises commence, the natural reaction of fish in the vicinity would be to leave the area. When exercises are completed, the fish stock would be expected to repopulate the area. The abundance and diversity of fish is unlikely to decrease measurably as a result of SOCAL Range Complex underwater detonations.

3.10.4.4 Hearing

Studies of acoustic capabilities of fish have been aimed at establishing the range of frequencies (or bandwidth) that a fish can hear, and the “threshold” (lowest level) of the sound detected at each frequency (Hastings and Popper 2005). If, following exposure to intense acoustic input, a higher level of sound is required to detect that frequency, a threshold shift has occurred. For humans, temporary threshold shifts may occur after loud concerts or following exposure to industrial noise. There are two kinds of threshold shifts: temporary threshold shift (TTS) or permanent threshold shift (PTS). A TTS may continue for minutes, hours or days, but the auditory deficit is eventually reversed. With PTS, however, hearing is permanently compromised and never recovers.

Permanent threshold shifts in vertebrates may result from both chronic exposures to high noise levels and from a single, highly traumatic event. People who experience high noise levels on a daily basis and do not wear hearing protection devices can suffer PTS. Very loud sounds (e.g., an explosion) can also cause a PTS or even deafness. In mammals, permanent threshold shifts involve damage to the hair cells of the inner ear, and other auditory structures (Bohne and Harding 2000). In mammals, dead hair cells are not replaced by production of new hair cells, resulting in permanent loss of auditory receptors in the damaged area.

The impact of anthropogenic noise has been studied in a number of fish species. Some investigations have shown damage to fish hearing from loud sounds generated by air-guns used in seismic surveys. For example, McCauley et al. (2002) investigated the effects of exposure to blasts from a seismic air-gun on the pink snapper *Pagrus auratus*. Fish were placed in a large cage in a bay and exposed to air guns over several hours. The fish were allowed to survive for different intervals after exposure, and the ears were then examined for any damage resulting from exposure to the sound. There was extensive damage to the sensory cells of the ear and the level of damage increased the longer the fish were allowed to survive post-exposure. However, Popper et al. (2005b) examined three species, including a salmonid (broad whitefish *Coregonus nasus*), after stimulation with five or twenty blasts of a seismic air gun. The broad whitefish showed no loss of hearing after exposure to the sounds, whereas northern pike *Esox lucius* and lake chub *Couesius plumbeus* showed 10-15 dB of hearing loss, but with complete recovery within 24 hours after exposure. No animals died as a result of exposure.

Other studies also indicate that loud sound may damage the neuromasts of the fish's lateral line and hair cells in the ears (Popper 2003, McCauley et al. 2003, Hastings and Popper 2005) with the probability of harm increasing with the time of exposure (Hastings et al. 1996, Popper et al. 2005). Damage to the sensory cells may not be visible until several days after exposure to the intense sound. There is some evidence that fish subjected to ear and lateral line injury may eventually replace some of the damaged sensory hair cells (Hastings et al. 1996, Lombarte et al., 1993). No information is available on the incidence of permanent threshold shift in fish due to environmental noise. Temporary threshold shifts, however, have been documented in laboratory investigations. Edds-Walton and Finneran (2006) provide an extensive critique of these studies. As they suggest, even a temporary impairment in hearing could have negative results, such as, failure to find food, failed communication with other members of their population, or failure to detect the approach of a predator.

The hearing of fish beyond the lethal range of underwater detonations could be adversely affected. Temporary threshold shifts would be likely and permanent hearing loss could result if sensory cells in the ear and on the lateral line are damaged and do not recover or regenerate. However, blast noises would be highly constrained in time and space, affecting the hearing of only a small percentage of the indigenous fish. Lasting impact on the survival, growth, or reproduction of fish populations would not be expected.

3.10.5 Invertebrate Hearing and Sound Production

Because invertebrates do not have air-filled cavities or sensory cells like those in the ears of fish, they do not have the capacity to detect changes in pressure that accompany sound waves (URI 2007). However, invertebrates are sensitive to particle displacement (Popper et al. 2001). When exposed to sound during experiments, some marine invertebrates show definite responses. Vibrations associated with sound are detected by special water motion receptors known as chordotonal organs. These organs facilitate the detection of potential predators and prey and provide environmental information such as the movement of tides and currents. The fiddler crab and spiny lobster have both been shown to use chordotonal organs to respond to nearby predators and prey. There is very limited data on invertebrate hearing, with only cephalopods (octopus and squid) and decapods (lobster, shrimp, and crab) thought to sense low-frequency sound (Offutt, 1970, Budelmann and Williamson 1994, Lovell et al. 2005). Packard et al. (1990) reported sensitivity to sound vibrations between 1-100 Hz for three species of cephalopods. Wilson et al. 2007 documents a lack of physical or behavioral response for squid exposed to experiments using high intensity sounds designed to mimic killer whale echolocation signals.

Like fish, invertebrates produce sound for the purpose of communication. Sound is used in territorial behavior, to deter predators, to find a mate, and to pursue courtship (Zelick et al. 1999, Popper et al. 2001). Most marine invertebrates known to produce sounds do so by rubbing parts of their body together. Spiny lobsters, for example, make a rasping sound with their antennae that can startle predators. Snapping shrimp produce loud enough sounds to stun prey by closing a large, specialized claw at a very high speed. This causes the water to form a bubble of vapor that collapses energetically. Light, also produced when the bubble collapses, has been referred to as 'shrimpoluminescence' by researchers (URI 2007).

3.10.6 Indirect Impacts

In addition to directly affecting fish, underwater detonations could affect other species in the food web including prey species. For example, sharks may consume sea turtles and small marine mammals and could be indirectly affected by explosive impacts to those prey items.

The effects of underwater explosions would differ depending upon the type of prey species in the area of the blast. As previously indicated, fish with swim bladders are more susceptible to blast injuries than fish without swim bladders. Invertebrate species, however, like squid, do not possess air-filled cavities, and therefore are less prone to near-field blast effects (Voss 1965), although impulsive noise has been implicated in mortality of deep water species (Guerra et al. 2004).

In addition to physical effects of an underwater blast, prey may have behavioral reactions to underwater sound. For instance, squid may exhibit a strong startle reaction to detonations that may include swimming to the surface, jetting away from the source, and releasing ink (McCauley et al. 2000). This startle and flight response is the most common secondary defense among animals (Hanlon and Messenger 1996). The noise from underwater explosions may induce startle reactions and temporary dispersal of schooling fish and squid if they are within close proximity. The abundances of fish and invertebrate prey species near the detonation point could be diminished for a few hours before being repopulated by animals from adjacent waters. No lasting effect on prey availability or the pelagic food web is expected.

3.11 WEAPONS TRAINING

EFH and Managed Species could be affected from shock waves and noise associated with weapons use, from sound generated as the projectile travels to the target, and from shock waves, sound, and debris created by impact and/or explosion of the weapon.

3.11.1 Bombing

Typically, bombing exercises (BOMBEX) at sea involve one or more aircraft bombing a target simulating a hostile surface vessel (DON 2005c). Most of the bombs used in SOCAL Range Complex exercises will be practice bombs without explosive warheads (DON 2007b). Weapons with non-explosive warheads would generate physical shock entering the water but would not explode. The shock from practice bombs hitting the sea surface would cause a small number of fish kills or injuries and minor acoustic displacement but would not jeopardize fish populations. Based on the density of fish in the area, the annual mortality associated with non-explosive missiles, targets, and mines hitting the water during training exercises is estimated in Section 3.7.2.2.1 of the EIS/OEIS to be <3 lb (1.35 kg) of the commercial fish catch in the SOCAL Range Complex.

Practice bombs entering the water would be devoid of combustion chemicals found in the warheads of explosive bombs. After sinking to the bottom, the physical structure of bombs would be incorporated into the marine environment by natural encrustation and/or sedimentation.

Aircraft need to qualify with both explosive and non-explosive ordnance. Air-to-ground bombing using explosive ordnance is mostly conducted at land ranges. However, some live bombs are dropped at sea. Exploding bombs are also used in other exercises such as SINKEX.

As with underwater detonations, the range within which fish may sustain injury or death from an exploding bomb would depend on environmental parameters, the size, location, and species of the fish, and its internal anatomy (e.g., whether it has a swim bladder) (DON 2005c). Fish without swim bladders are far more resistant to explosions than those with swim bladders (Keevin and Hempen 1997).

Propelled fragments are produced by an exploding bomb. In close proximity to the explosion, fish could be killed outright or sustain injury from propelled fragments (Stuhmiller et al. 1990). However, studies of underwater bomb blasts have shown that fragments are larger than those produced during air blasts and decelerate much more rapidly (O'Keeffe and Young 1984, Swisdak Jr. and Montaro 1992), reducing the risk to marine life.

Explosive bombs will be fused to detonate on contact with the water and it is estimated that 99 percent of them will explode within 5 ft (1.5 m) of the ocean surface (DON 2005c). Table 3-2, based on Young's (1991) model, displays 10-percent mortality (90-percent survival) ranges for the largest explosive bombs that may be deployed during at-sea exercises.

Table 3-2: Estimated Fish-Effects Ranges for Explosive Bombs

Warhead Weight NEW (lb-TNT)	10 % Mortality Range by Weight of Fish		
	1 ounce	1 pound	30 pounds
500-lb	1,289 ft (393 m)	899 ft (274 m)	578 ft (176 m)
1,000-lb	1,343 ft (409 m)	937 ft (286 m)	602 ft (184 m)
2,000-lb	1,900 ft (579 m)	1,325 ft (404 m)	852 ft (260 m)

Table 3-2, as expected, reflects the fact that smaller fish are more subject to mortal effects from underwater explosions than larger fish. It also shows the non-linear relationship of the model equations relating explosive weight to range of effect. A four-fold increase in NEW increases the 10% mortality range by one and one-half times (doubling the area of effect).

Unlike the nearshore, shallow-water San Clemente Island NSW underwater explosive training areas, live bombing exercises would take place in deep water, so fish-effects range models would be appropriate for estimating the impact on fish populations. Computations reported in the Fish Section (3.7.2.2.1) of the EIS/OEIS indicate for the No Action Alternative an estimated 763 lb (329 kg) of fish would be killed annually in training with explosive-warhead bombs. This represents 0.061 percent the commercial fish catch in the SOCAL Range Complex.

Fish would be killed or injured from detonation of explosive bombs in relatively small areas compared to the vast expanse of the SOCAL Range Complex. Beyond the range of physical effects, the natural reaction of fish would be to leave the area. When the exercise concludes, the area would be repopulated and the fish stock would rebound. The overall impact to water column habitat would be localized and transient. The abundance and diversity of fish within SOCAL Range Complex is unlikely to measurably decrease as a result of bombing exercises.

Acoustic impacts on fish during live bomb exercises would be similar to those discussed earlier for underwater detonations associated with underwater detonations. Although some fish in the vicinity of the exercises might react negatively to the noise of bomb explosions, the limited number of these events and the relatively small areas affected should minimize the effect on local fish populations. Chemical by-products of bomb detonations would not pose a hazard to marine animals since the chemicals will be diluted prevailing currents and the exercises will be dispersed in time and space.

Noise produced during weapons use may disrupt the behaviors of marine species in the immediate area. Because of the localized nature and short duration of the exercise, there would be no lasting impact on prey availability, as only small portions of the prey population would be affected and populations would rapidly replenish. Due to the shallow detonation depth (<5 ft (1.5 m) below the surface, bombs dropped in waters deeper than 100 m (328 ft) would have negligible effects on the seafloor and on the animals that dwell there. The detonation of large bombs in shallow water is very unlikely.

Fragments from detonated bombs would settle to the sea floor where solid metal components would be corroded by seawater at slow rates. Over time, natural encrustation of exposed surfaces would occur, reducing the rate at which subsequent corrosion occurs. Rates of deterioration would vary, depending on the type of material and on environmental conditions. Due to the large area of the SOCAL Range Complex, expended ordnance would be widely scattered on the ocean floor and would have a minimal impact on the benthic environment.

The proposed bombing exercises would not adversely affect the quality or quantity of EFH within SOCAL Range Complex. The disruption to habitat components that support feeding, resting, sheltering, reproduction, or migration of fish would be slight or non-existent.

3.11.2 Naval Gun Fire

Potential effects from the use of Naval gun systems have been analyzed in a variety of environmental documents (DON 2000, 2001a, 2002a, 2004a,b, 2007a). The 5-inch gun has the largest warhead fired during routine gunnery exercises. Most training uses non-explosive 5-inch rounds. The surface area of the ocean impacted by a non-explosive 5-in round has been estimated to be 129 cm^2 (20 in^2) (DON 2007a). So the approximately 6,000 non-explosive 5-in rounds fired annually in the SOCAL Range Complex would create a cumulative impact area of 77 m^2 (833 ft^2). Considering the vast expanse of the SOCAL Range Complex, few fish would be directly struck by a shell from a 5-inch gun.

Explosive rounds would have the greatest potential for impacts to fish in surface waters. As previously indicated, biological effects of an underwater explosion depend on many factors, including the size, type, and depth of both the animal and the explosive, the depth of the water column, the standoff distance from the charge to the animal, and the sound-propagation properties of the environment. Potential impacts can range from brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin and Hempen 1997).

Table 3-3 provides an estimation of the potential range of lethal effects on swim bladder fish based on Young's (1991) model for five-inch explosive projectiles. These rounds have a NEW of TNT of approximately 8 lbs (3.6 kg) and are assumed to detonate at a depth of 5 ft (1.3 m). Behavioral reactions of fish would extend over a substantially larger area. The overall impacts to water-column habitat would, however, be minor as fish would return following the exercise. The abundance and diversity of fish and the quality and quantity of fish habitat within the range is unlikely to decrease as a result of gun fire training.

Table 3-3: Estimated Fish-Effects Ranges for 5-in Naval Gunfire Rounds

Weight of Fish	10% Mortality Range	
	ft	m
1 oz	405	123
1 lb	282	86
30 lbs	181	55

Accurate measurements of the size of the debris field from the underwater explosion of 5-inch shells are not available. However, the shells are typically fused to explode at the sea surface. This, combined with the high downward velocity of the shell at impact, suggests that the debris field from the exploding shell would be restricted in size. As with exploding bombs, the shell fragments rapidly decelerate through contact with the surrounding water. The possibility that the exploding shell fragments and debris would significantly affect EFH and fish populations is considered negligible.

Contaminants released from the detonation of exploding shells would be similar to those discussed previously for bombs. Thus, it is unlikely that the explosive compounds or their combustion products would pose a threat to fish or EFH.

Unexploded five-inch shells and non-explosive ordnance practice shells would not be recovered and would sink to the bottom. The rapid-detonating explosive (RDX) material of unexploded ordnance would not be exposed to the marine environment, as it is encased in a non-buoyant cylindrical package. Should the RDX be exposed on the ocean floor, it would break down within a few hours (DON 2001a). It does not bioaccumulate in fish or in humans. Over time, the RDX residue would be covered by ocean sediments or diluted by ocean water.

Solid-metal components of unexploded ordnance and non-explosive ordnance would be corroded by seawater at slow rates, which comparable slow release rates. Exposure of fish to chemical constituents from all metallic and non-metallic ordnance components would be further reduced as a result of natural encrustation of external surfaces. Consequently, the release of contaminants from unexploded ordnance and non-explosive ordnance would not result in substantial degradation of marine water quality.

3.11.2.1 Acoustic Impacts of Naval Gunfire

Naval gunfire could have acoustic effects from: 1) noise generated by firing the gun (muzzle blast), 2) vibration from the blast propagating through the ship's hull, 3) sonic-booms generated by the shell flying through the air, and 4) noise from the impact and explosion of the shell.

Firing a deck gun produces a shock wave in air that propagates away from the muzzle in all directions, including toward the air/water surface. Direct measurements of shock wave pressures transferred through the air/water interface from the muzzle blast of a 5-inch gun are well below levels known to be harmful at shallow depths (DON 2000, Yagla and Stiegler 2003). Navy watch standers would observe waters surrounding the ship to ensure significant biological aggregations are not in proximity to the ship during firing exercises. Noise produced during gunfire may disturb fish in the vicinity of the ship. Because the noise is brief, no extended disruption of fish behavior is expected.

Gun fire sends energy through the ship structure, into the water, and away from the ship. This effect was also investigated in conjunction with the measurement of 5-inch caliber gun blasts described above (DON 2000, Yagla and Stiegler 2003). The energy transmitted through the ship to the water for a typical round was found to be about 6% of that from the air blast impinging on the water. Therefore, noise transmitted from the gun, through the hull into the water should have negligible impact on marine life.

The sound generated by a shell in its flight at supersonic speeds above the water is transmitted into the water in much the same way as a muzzle blast (Pater 1981). The region of underwater noise influence from a single traveling shell is relatively small, diminishes quickly as the shell gains altitude, and is of short duration. The penetration of sound through the air\water interface is relatively limited (Miller 1991, Yagla and Stiegler 2003). Studies reviewed in DON 2007a indicate only a small number of submerged species would be exposed to the pressure waves from sonic booms from 5-inch shells fired during routine training exercises.

The potential exists for energy from multiple sonic booms to accumulate over time from multiple, possibly rapid firings of a gun. However, because the area directly below the shells' path, where the conditions are correct for energy to enter the ocean is small, it is highly unlikely that the energy from more than two or three shells would be additive.

Behavioral effects from the noise of Naval gunnery shells exploding would be similar to that already described for other types of underwater explosions. Although fish in the vicinity of the explosion may exhibit avoidance reactions, the noises generated are relatively short-term and localized, and behavioral disruptions would not be expected to have lasting impacts on the survival, growth, or reproduction of fish populations.

3.11.3 Small Arms Fire

Small arms rounds and Close-In Weapons System (CIWS) rounds fired directly into the water decelerate to non-lethal velocity within 56 cm (22 in) of the water's surface after impact (DON 2007a, b). The Point Mugu Sea Range EIS/OEIS (DON 2002a) analyzed the impacts associated with CIWS operations. The maximum area of water surface that might be struck by the 20 mm CIWS rounds was estimated by taking the cross-sectional surface area of a 20 mm round multiplied by the total number of rounds fired during a typical year. Local marine mammal densities were then multiplied by the maximum area of water surface that might be hit by a round. The analyses determined that the probability of a marine mammal being hit or injured by a CIWS operation would be very low; so low that it could take hundreds of thousands of years before a marine mammal would be hit. Similarly, given the large area of the SOCAL Range Complex, limited fish mortality and injury would be expected from CIWS and other small arms fire.

Few fish would be directly hit by bullets striking the water during small arms exercises. Bullets rapidly decelerate on contact with water, presenting minimal threat to fish swimming below the surface. The shock waves generated by bullets hitting the water is not expected to be great enough to cause harm to marine animals (DON 2007a,b). Fish in the area would be startled by the sound, but should return to normal behavior shortly after the exercise.

Fish feeding in the vicinity of the small arms fire exercises could potentially ingest expended shells, shell fragments, or shell casings. The shiny metallic surface of a newly discharged shell casing and its movement through the water may trigger a feeding response. If ingested, the casing could lodge in the digestive system and interfere with food consumption and digestion. However, the probability of such events is low and significant consequences at the level of fish populations would not be likely. Spent shell casings deposited on the sea floor could also be mistaken for food, although, discharged casings will remain shiny for only a short period, reducing the potential for ingestion by fish.

Expended bullets may release small amounts of iron, aluminum, and copper into the sediments and the overlying water column as bullets corrode. Although, elevated levels of these elements can cause toxic reactions in exposed animals, high concentrations in sediments would be restricted to a small zone around the bullet, and releases to the overlying water column would be quickly diluted. The projectiles for 5.56-mm and 7.62-mm gun ammunition have lead cores; however, no significant releases of lead into the water through dissolution are expected because of the neutral pH of ocean waters and sediments (DON 2005d). Based on the low probability of ingestion and/or absorption of lead from bullet cores, slight to non-existent effects on fisheries are expected.

3.11.4 Torpedo Exercises

Torpedo exercises (TORPEXs) entail aircraft, surface ship, or submarine crews attacking targets with torpedoes (DON 2004c, 2005b). Submarines practice launching non-explosive training torpedoes against surface ship targets. When a torpedo “hits” its target, or runs out of fuel if it misses its intended target, it drops ballast weights (see previous expended material section) or inflates a gas chamber and floats to the surface to be recovered by a ship. Torpedoes used in aviation exercises typically employ recoverable exercise torpedoes which do not have fuel or propulsion. Attempts are made to recover all torpedoes.

No ordnance would be detonated during a TORPEX, so the physical force that marine organisms are exposed to would be limited to that produced by torpedo launching and movement. Due to the small area of torpedo traverse, the number of fish strikes by torpedoes would be low.

The primary potential impact to the marine environment would be the release of combustion products into the ocean from torpedo fuel. Torpedo exhaust products, nitrogen oxides, carbon monoxide, carbon dioxide, hydrogen, nitrogen, methane, ammonia, and hydrogen cyanide, would be rapidly dissolved, disassociated, or dispersed in the water column (DON 2004c). Carbon dioxide, nitrogen, methane and ammonia are naturally-occurring in seawater. Carbon monoxide and hydrogen have low solubility in seawater and would bubble to the surface dissipating into the air. Trace amounts of nitrogen oxides may be present, but are usually below detectable limits.

Hydrogen cyanide (HCN) does not normally occur in seawater, and if present in high-enough concentration, could pose a potential risk to marine biota. The US Environmental Protection Agency national water-quality criterion for HCN in marine waters is 1 part per billion for both acute and chronic effects. In order for the HCN concentration to be below this threshold and be considered non-toxic, marine life would need to be outside an estimated 6.3 m (21 ft) zone of influence around the torpedo’s path until such time that the HCN is diffused into the water (DON 2004c). Because HCN has extremely high solubility in seawater, the HCN will rapidly diffuse to levels below one ppb and thus would pose no significant threat to marine organisms. For a substantial quantity of torpedo fuel to be released into the ocean, the torpedo would have to be subjected to stresses beyond its structural design limits and catastrophically fail. Such stress is very unlikely to occur.

The Mk 50 torpedo uses lithium metal fuel. Its operation does not result in a routine discharge. A breach of the lithium-fueled boiler systems is extremely rare, but might occur at an estimated rate of once per year worldwide. Based on an analysis of worst-case scenarios, the Navy concluded that a breach of the lithium boiler system at any point in the torpedo run would not have a significant impact on the marine environment (DON 2004c).

3.11.5 ADC and EMATT Exercises

Lithium sulfur dioxide (LiSO2) battery cells power both ADCs and EMATTs. Since they are expended, battery chemical could eventually be released into the marine environment (DON 2005b). Lithium is the 17th most abundant element in seawater. In addition to it being found naturally in seawater, currents would rapidly diffuse its concentration around ADCs or EMATTs, thus minimizing the potential impact. The lithium metal contained in the ADC or EMATT is extremely reactive with water. When the lithium reacts with water it causes an exothermic (heat liberating) reaction that generates soluble hydrogen gas and lithium hydroxide. The hydrogen gas eventually enters the atmosphere and the lithium hydroxide dissociates, forming lithium ions and hydroxide ions. The hydroxide is neutralized by the hydrolysis of the acidic sulfur dioxide, ultimately forming water. Sulfur dioxide, a gas that is highly soluble in water, is the major reactive component in the battery. The sulfur dioxide ionizes in the water, forming bisulfite (HSO3) that is easily oxidized to sulfate in the slightly alkaline environment of the ocean. Sulfur is present as sulfate in large quantities in the ocean. Chemical reactions of the lithium sulfur dioxide batteries would be highly localized and short-lived. Ocean currents would greatly diffuse concentrations of the chemicals leached by the ADC or EMATT batteries. For these reasons the lithium sulfur dioxide batteries would not significantly affect water quality, marine fish, or EFH.

3.11.6 Missile Exercises

In these exercises, missiles are fired by aircraft, ships, and Naval Special Warfare (NSW) operatives at a variety of airborne and surface targets. Missiles used in most aviation exercises are non-explosive versions and do not explode upon contact with the target or sea surface. Practice missiles do not use rocket motors or their potentially hazardous rocket fuel. The main environmental impact would be the physical structure of the missile itself entering the water.

Intact missiles and aerial targets falling from the sky would impact the ocean surface with great force, producing shock waves that could kill and injure fish. In Section 3.2.2.y of the EIS/OEIS, the pressure levels known to cause injury and mortality were used to estimate effects of shock pulses created by falling missiles and targets. Calculations were also made for sea surface impact effects from non-explosive bombs and practice mines dropped from aircraft. For all of the exercises of these types in the SOCAL Range Complex, an amount of fish equivalent to <1 lb (0.45 kg) of commercial fish catch would be killed annually.

Exploding warheads may be used in air-to-air missile exercises, but to avoid damaging the aerial target, the missile explodes in the air, disintegrates, then, falls into the ocean. Regions of missile target practice are monitored by Navy personnel to identify marine animals and avoid areas of significant concentration.

The quantity of fish killed or injured by practice missiles or their debris striking the water would be a very small fraction of the indigenous fish community.

3.11.7 Expeditionary Assault

Expeditionary Assault involves a seaborne force assaulting across a beach in a combination of helicopters, vertical takeoff and landing (VTOL) aircraft, landing craft air cushion (LCAC), amphibious assault vehicles (AAVs), expeditionary fighting vehicle (EFV) and landing craft. More robust expeditionary assault operations include support by Naval surface fire support (NSFS), close air support (CAS), and Marine artillery.

The large vehicles and landing craft crossing shallow water and the beach in an amphibious assault could damage EFH. Before each major amphibious landing exercise is conducted, a hydrographic survey is performed to map out the precise transit routes through sandy bottom areas. During the landing, the crews follow established procedures, such as having a designated lookout watching for other vessels, obstructions to navigation, and significant concentrations of marine animals. Sensitive habitats such as rocky reefs, seagrass beds, and kelp beds would be avoided.

Although amphibious landings are restricted to specific areas of designated beaches, amphibious landings in nearshore sandy subtidal habitat could lead to a temporary adverse impact on Managed Species due to death or injury, loss of benthic epifauna and infauna that may serve as prey, and increased turbidity. Increases in turbidity could temporarily decrease the foraging efficiency of fish, however, given the dynamic nature of the habitat and the grain size of the material, turbidity is expected to be minimal and localized. Artillery rounds that fall short of land would destroy patches of sandy bottom habitat kill or injure nearby marine life. However, the overall impacts on marine biological resources would be limited because sandy beach habitats support relatively few organisms and are adapted to recover quickly from disturbance.

3.11.8 Shallow Water Minefield

Multiple possible sites off Tanner Bank, Cortes Bank, La Jolla, and Point Loma have been considered for a shallow water minefield. Of these, an area known as Advanced Research Project Agency Training Minefield (ARPA) off La Jolla (and historically used for shallow water submarine MCM training) is the desired location for expanding MCM training.

Shallow water minefield support of submarine MCM training requires a depth of 250-420 feet, and a sandy bottom and flat contour in an area relatively free from high swells and waves. The size of the area would be a minimum of 2x2 nm and optimally 3x3 nm. Mine shapes would be approximately 500-700 yards apart and 30-35 inches in size, and would consist of a mix of recoverable/replaceable bottom shapes (~10 cylinders weighed down with cement) and moored shapes (~15 shapes, no bottom drilling required for mooring). Localized, temporary impacts on water quality and sessile benthic fauna would occur during installation of the mine shapes; however, based on the project criteria, no adverse impact on Managed Species or EFH would be expected.

3.11.9 Shallow Water Training Range (SWTR) Extension

This component of the Proposed Action is to instrument and use two extensions of the current SOAR, one 250-nm^2 (463-km^2) area to the west in the area of the Tanner/Cortez Banks, and one 250-nm^2 (463-km^2) area between SOAR and the southern section of SCI. The instrumentation would be in the form of undersea cables and sensor nodes, which would constitute a SWTR portion of SOAR. The cables and sensors are similar to those that instrument the current deep-water range (SOAR). The combination of deep-water and shallow-water instrumentation provides range uninterrupted coverage of air, surface, and subsurface operations. The instrumented area would be connected to the shore via a single trunk cable. Installation of additional acoustic sensors in the nearshore and offshore shallow water extensions has the potential to have localized impacts on fish. These impacts would generally consist of fish fleeing the construction area, and would not have of adverse effects at the population level.

3.11.10 Sinking Exercises

During a SINKEX, Navy crews fire live and non-explosive ordnance at a target vessel that has been towed to a location in the SOCAL Range Complex. Target vessels are empty, cleaned, and, environmentally remediated to U.S. EPA specifications. A wide variety of assets may be involved, including aircraft, helicopters, surface ships, and submarines (DON 2006a).

The numbers and types of weapons used in a SINKEX depend on training requirements and the size of the target vessel, but could include air-to-surface missiles and bombs, surface-to-surface missiles, torpedoes, and naval gun fire. The total net explosive weight (NEW) expended would not exceed 20,000 lb (9,072 kg) per target during the exercise. The NEW of any individual weapon would not exceed 1000 lb (454 kg) (DON 2006a).

Prior to conducting an exercise, a Notice to Mariners and a Notice to Airmen delineating the exercise area and time would be published. Extensive range clearance operations would be conducted prior to the exercise, ensuring that no shipping is within the range of weapons being fired. In addition, for 90 minutes prior to the commencement of the exercise and between certain series of weapon firings, a 2.5 nm exclusion zone would be surveyed by visual and acoustic means to detect the presence of protected marine mammals and sea turtles. A safety zone would also be established which extends from the exclusion zone at 2.5 nm out another 2 nm. Together, the exclusion and safety zones extend out 4.5 nm from the target.

In the rare event that the deployed ordnance does not sink the target, EOD personnel would scuttle the ship, typically the following day, using charges placed in locations that would breech the hull to sink the unstable ship. Whether guided or unguided, the majority of ordnance would hit the target. Of all the weapons used, only the torpedo is designed to explode in the water column.

The transfer of pressure waves and acoustic energy from detonation of ordnance within the target should have minimal impact on adjacent marine life (DON 2006a). Effects from gun fire shells, bombs, and missiles that fall short of the target and torpedoes striking the vessel, as discussed previously, could cause mortality or injure pelagic marine life, but should not have significant, long-term, biological consequences. Although SINKEX can have an adverse effects on Managed Species, all vessel sinkings are conducted in water at least 1,000 fathoms (6,000 feet) deep and at least 50 nautical miles from land to avoid impacts to sensitive EFH,. Thus, SINKEX operations would not destroy or adversely effect sensitive benthic habitats, but may alter soft bottom habitats and may provide a beneficial use by providing consolidated habitat in the deep water environment.

3.12 SONAR USE

Antisubmarine warfare (ASW) and mine warfare (MIW) exercises include training sonar operators to detect, classify, and track underwater objects and targets. There are two basic types of sonar: passive and active. Passive sonars only listen to incoming sounds and, since they do not emit sound energy in the water, lack the potential to acoustically affect the environment. Active sonars emit acoustic energy to obtain information about a distant object from the reflected sound energy. Active sonars are the most effective detection systems against modern, ultra-quiet submarines and sea mines in shallow water.

Modern sonar technology has developed a multitude of sonar sensor and processing systems. In concept, the simplest active sonars emit acoustic pulses (“pings”) and time the arrival of the reflected echoes from the target object to determine range. More sophisticated active sonars emit a ping and then scan the received beam to provide directional as well as range information. Only about half of the U.S. Navy's ships are equipped with active sonar and their use is generally limited to training and maintenance activities - 90% of sonar activity by the Navy is passive (DON 2007e).

Active sonars operate at different frequencies, depending on their purpose. High frequency sonar (>10 kHz) is mainly used for establishing water depth, detecting mines, and guiding torpedoes. At higher frequencies, sound energy is greatly attenuated by scattering and absorption as it travels through the water. This results in shorter ranges, typically less than five nautical miles. Mid frequency sonar is the primary tool for identifying and tracking submarines. Mid frequency sonar (1 kHz - 10 kHz) suffers moderate attenuation and has typical ranges of 1-10 nautical miles. Low frequency sonar (<1 kHz) has the least attenuation, achieving ranges over 100 nautical miles. Low frequency sonars are primarily used for long-range search and surveillance of submarines. Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) is the U.S. Navy's low frequency sonar system (DON 2001b, 2005surtass). It employs a vertical array of 18 projectors using the 100-500 Hz frequency range.

Sonars used in ASW are predominantly in the mid frequency range (DON 2007e). ASW sonar systems may be deployed from surface ships, submarines, and rotary and fixed wing aircraft. The surface ships are typically equipped with hull mounted sonar but may tow sonar arrays as well. Helicopters are equipped with dipping sonar (lowered into the water). Helicopters and fixed wing aircraft and may also deploy both active and passive sonobuoys and towed sonar arrays to search for and track submarines.

Submarines also use sonars to detect and locate other subs and surface ships. A submarine's mission revolves around stealth, and therefore submarines use their active sonar very infrequently since the pinging of active sonar gives away their location. Submarines are also equipped with several types of auxiliary sonar systems for mine avoidance, for top and bottom soundings to determine the submarine's position in the water column, and for acoustic communications. ASW training targets simulating submarines may also emit sonic signals through acoustic projectors.

Sonars employed in MIW training are typically high frequency (greater than 10 kHz). They are used to detect, locate, and characterize mines that are moored, laid on the bottom, or buried (DON 2002c, 2005b, c,d). MIW sonars can be deployed from multiple platforms including towed systems, unmanned underwater vehicles (UUVs), surf zone crawlers, or surface ships.

Torpedoes use high-frequency, low-power, active sonar. Their guidance systems can be autonomous or electronically controlled from the launching platform through an attached wire. The autonomous guidance systems are acoustically based. They operate either passively, exploiting the emitted sound energy by the target, or actively, ensonifying the target and using the received echoes for tracking and targeting.

Military sonars for establishing depth and most commercial depth sounders and fish finders operate at high frequencies, typically between 24 and 200 kHz.

3.12.1 Low Frequency Sonar

Low frequency sound travels efficiently in the deep ocean and is used by whales for long-distance communication (Richardson et al. 1995, NRC 2003, 2005). Concern about the potential for low frequency sonar (<1 kHz) to interfere with cetacean behavior and communication has prompted extensive debate and research (DON 2001b, 2005b, 2007e, NRC 2000, 2003).

Some studies have shown that low frequency noise will alter the behavior of fish. For example, research on low frequency devices used to deter fish away from turbine inlets of hydroelectric power plants showed stronger avoidance responses from sounds in the infrasound range (5-10 Hz) than from 50 and 150 Hz sounds (Knudsen et al. 1992, 1994). In test pools, wild salmon exhibit an apparent avoidance response by swimming to a deeper section of the pool when exposed to low frequency sound (Knudsen et al. 1997).

Turnpenny et al. (1994) reviewed the risks to marine life, including fish, of high intensity, low frequency sonar. Their review focused on the effects of pure tones (sine waves) at frequencies between 50-1000 Hz. Johnson (2001) evaluated the potential for environmental impacts of employing the SURTASS LFA sonar system. While concentrating on the potential effects on whales, the analysis did consider the potential effects on fish, including bony fish and sharks. It appears that the swimbladders of most fish are too small to resonate at low frequencies and that only large pelagic species such as tunas have swimbladders big enough to resonate in the low frequency range. However, investigations by Sand and Hawkins (1973), and Sand and Karlsen (1986) revealed resonance frequencies of cod swim bladders from 2 kHz down to 100 Hz.

Hastings et al. (1996) studied the effects of low frequency underwater sound on fish hearing. More recently, Popper et al. (2005a, 2007) investigated the impact of U. S. Navy SURTASS LFA sonar on hearing and on non-auditory tissues of several fish species. In this study, three species of fish in Plexiglas cages suspended in a freshwater lake were exposed to high intensity LFA sonar pulses for periods of time considerably longer than likely LFA exposure. Results showed no mortality and no damage to body tissues either at the gross or histological level. Some individuals exhibited temporary hearing loss but recovered within several days of exposure. The study suggests that SURTASS LFA sonar does not kill or damage fish even in a worst case scenario.

Although some behavioral modification might occur, adverse effects from low frequency sonar on fish are not expected.

3.12.2 Mid Frequency Sonar

ASW training operations would use mid frequency (1-10 kHz) sound sources. Most fish only detect sound below this range (Popper, 2003; Hastings and Popper, 2005). Thus, it is expected that few fish species would be able to detect the ASW mid frequency sonar.

Some investigations have been conducted on the effect on fish of acoustic devices designed to deter marine mammals from gillnets (Gearin et al. 2000, Culik et al. 2001). These devices generally have a mid frequency range, similar to the sonar devices that would be used in ASW exercises. Adult sockeye salmon exhibited an initial startle response to the placement of inactive acoustic alarms designed to deter harbor porpoise. The fish resumed their normal swimming pattern within 10 to 15 seconds. After 30 seconds, the fish approached the inactive alarm to within 30 cm (1 ft). The same experiment was conducted with the alarm active. The fish exhibited the same initial startle response from the insertion of the alarm into the tank; however, within 30 seconds, the fish were swimming within 30 cm (1 ft) of the active alarm. After five minutes of observation, the fish did not show any reaction or behavior change except for the initial startle response. This demonstrated that the alarms were either inaudible to the fish, or the fish were not disturbed by the mid frequency sound.

Jørgensen et al. (2005) carried out experiments examining the effects of mid frequency (1 to 6.5 kHz) sound on survival, development, and behavior of fish larvae and juveniles. Experiments were conducted on the larvae and juveniles of Atlantic herring, Atlantic cod, saithe *Pollachius virens*, and spotted wolffish *Anarhichas minor*. Swimbladder resonance experiments were attempted on juvenile Atlantic herring, saithe, and Atlantic cod. Sound exposure simulated Naval sonar signals. These experiments did not cause any significant direct mortality among the exposed fish larvae or juveniles, except in two (of a total of 42) experiments on juvenile herring where significant mortality (20-30%) was observed. Among fish kept in tanks one to four weeks after sound exposure, no significant differences in mortality or growth related parameters (length, weight and condition) between exposed groups and control groups were observed. Some incidents of behavioral reactions were observed during or after the sound exposure - ‘panic’ swimming or confused and irregular swimming behavior. Histological studies of organs, tissues, or neuromasts from selected Atlantic herring experiments did not reveal obvious differences between control and exposed groups.

The work of Jørgensen et al. (2005) was used in a study by Kvadsheim and Sevaldsen (2005) to examine the possible ‘worse case’ scenario of sonar use over a spawning ground. They conjectured that normal sonar operations would affect less than 0.06% of the total stock of a juvenile fish of a species, which would constitute less than 1% of natural daily mortality. However, these authors did find that the use of continuous-wave transmissions within the frequency band corresponding to swim bladder resonance will escalate this impact by an order of magnitude. The authors therefore suggested that modest restrictions on the use of continuous-wave transmissions at specific frequencies in areas and at time periods when there are high densities of Atlantic herring present would be appropriate.

Studies have indicated that acoustic communication and orientation of fish may be restricted by noise regimes in their environment (Wysocki and Ladich 2005). Although some species may be able to produce sound at higher frequencies (> 1 kHz), vocal marine fish largely communicate below the range of mid-frequency levels used in the proposed action. Further, most marine fish species are not expected to able to detect sounds in the mid-frequency range of the operational sonars used in the proposed action. The few fish species that have been shown to be able to detect mid-frequencies do not have their best sensitivities in the range of the operational sonars. Thus, these fish can only hear mid-frequency sounds when they are very loud (i.e. when sonars are operating at their highest energy levels and fish are within a few meters). Considering the low frequency detection of most marine species and the limited time of exposure due to the moving sound sources, the mid frequency sound sources used in the proposed action do not have the potential to significantly mask key environmental sounds.

Experiments on fish classified as hearing specialists (but not those classified as hearing generalists) have shown that exposure to loud sound can result in temporary hearing loss, but it is not evident that this may lead to long-term behavioral disruptions in fish that are biologically significant (Amoser and Ladich 2003, Smith et al. 2004 a,b). There is no information available that suggests that exposure to non-impulsive acoustic sources results in significant fish mortality at the population level.

In summary, while some marine fish may be able to detect mid frequency sounds, most marine fish are hearing generalists and have their best hearing sensitivity below mid frequency sonar. If they occur, behavioral responses would be brief, reversible, and not biologically significant. Sustained auditory damage is not expected. Sensitive life stages (juvenile fish, larvae and eggs) very close to the sonar source may experience injury or mortality, but area-wide effects would likely be minor. The use of Navy mid frequency sonar would not compromise the productivity of fish or adversely affect their habitat.

3.12.3 High Frequency Sonar

Although most fish cannot hear sound frequencies over 10 kHz, some shad and herring species can detect sounds in the ultrasonic range, i.e., over 20 kHz. (Mann et al., 2001; Higgs et al., 2004). Ross et al., (1995, 1996) reviewed the use of high frequency sound to deter alewives from entering power station inlets. The alewife, a member of the shad family (Alosinae) which can hear sounds at ultrasonic frequencies (Mann et al., 2001), uses high frequency hearing to detect and avoid predation by cetaceans. Studies conducted on the following species showed avoidance to sound at frequencies over 100 kHz: alewife (*Alosa pseudoharengus*) (Dunning et al., 1992; Ross et al., 1996), blueback herring (*A. aestivalis*) (Nestler et al., 2002), Gulf menhaden (*Brevoortia patronus*) (Mann et al., 2001) and American shad (*A. sapidissima*) (Popper and Carlson, 1998). The highest frequency to solicit a response in any marine fish was 180 kHz for the American shad (Gregory and Clabburn, 2003; Higgs et al., 2004).

Since high-frequency sound attenuates quickly in water, high levels of sound from mine hunting sonars would be restricted to within a few meters of the source. Even for fish able to hear sound at high frequencies, only short-term exposure would occur, thus high frequency military sonars are not expected to have significant effects on resident fish populations.

Because a torpedo emits sonar pulses intermittently and is traveling through the water at a high speed, individual fish would be exposed to sonar from a torpedo for a brief period. At most, an individual animal would hear one or two pings from a torpedo and would be unlikely to hear pings from multiple torpedoes over an exercise period. Most fish hear best in the low- to mid-frequency range and therefore are unlikely to be disturbed by torpedo pings.

The effects of high frequency sonar, on fish behavior, for species that can hear high frequency sonar, would be transitory and of little biological consequence. Most species would probably not hear these sounds and would therefore experience no disturbance.

3.12.4 Conclusion

While the impact of anthropogenic noise on marine mammals has been extensively studied, the effects of noise on fish are largely unknown (Popper 2003, Hastings and Popper 2005). There is a dearth of empirical information on the effects of exposure to sound, let alone sonar, for the vast majority of fish. The few studies on sonar effects have focused on behavior of individuals of a few species and it is unlikely their responses are representative of the wide diversity of other marine fish species (ICES 2005, Jorgensen et al. 2005). The literature on vulnerability to injury from exposure to loud sounds is similarly limited, relevant to particular species, and, because of the great diversity of fish, not easily extrapolated. More well-controlled studies are needed on the hearing thresholds for fish species and on temporary and permanent hearing loss associated with exposure to sounds. The effects of sound may not only be species specific, but also depend on the mass of the fish (especially where any injuries are being considered) and life history phase (eggs and larvae may be more or less vulnerable to exposure than adult fish). The use of sounds during spawning by some fish, and their potential vulnerability to masking by anthropogenic sound sources, also requires further investigation. No studies have established effects of cumulative exposure of fish to any type of sound or have determined whether subtle and long-term effects on behavior or physiology could have an impact upon survival of fish populations. The use of sounds during spawning by some fish and their potential vulnerability to masking by anthropogenic sound sources requires closer investigation.

With these caveats and qualifications in mind, the limited information currently available suggests that populations of fish are unlikely to be affected by the projected rates and areas of use of military sonar. Thus, significant harm to fish is not anticipated from Navy sonar used in SOCAL Range Complex training.

3.13 RESEARCH, DEVELOPMENT, TESTING, AND EVALUATION

SOCAL Range Complex operations include a wide variety of Research, Development, Testing, and Evaluation (RDT&E) of underwater weapons, weapons systems, and components. Specific events include: Ship Tracking and Torpedo Tests; Unmanned Underwater Vehicle (UUV) Tests; Sonobuoy Quality Assurance (QA)/Quality Control (QC) Tests; Ocean Engineering Tests; Marine Mammal Mine Shape Location and Research; Radio Frequency (RF) Tests; Unmanned Aerial Vehicles (UAV) Tests Missile Flight Tests; and, Naval Undersea Warfare Center (NUWC) Acoustics Tests. With the exception of Marine Mammal Mine Shape Location and Research, the potential impact of various elements of RDT&E activities are considered in sections dealing with common components of offshore operations (e.g., weapons and sonar use).

Marine Mammal Mine Shape Location and Research involves the deployment of trained bottlenose dolphins and California sea lions to locate and retrieve non-explosive mine shapes. No ordnance is involved. The recoverable mine shapes emit pings for retrieval purposes. The only aspect of the training that has potential effects on fish is the use of the high frequency (28–45 kHz) pingers that are attached to non-explosive mines to allow recovery. High frequency sounds attenuate rapidly in seawater, and would be inaudible or only faintly audible to most fish (see Section 3.8 (Fish) of the EIS/OEIS). Any disturbance effects would be localized, short-term, and insignificant in an ecological context.

The Marine Communities and Fish evaluations in the EIS/OEIS (Sections 3.5 and 3.8) conclude that the only RDT&E activity that has the potential for adverse effects on marine animals is Underwater Acoustics Testing involving mid frequency sonar. Effects of mid frequency sonar on fish would be less than significant.

3.14 IMPACT SUMMARY

The SOCAL Range Complex covers a vast area from coastal beaches to 600 nautical miles (1,111 km) offshore encompassing approximately 120,000 nm^2 (411,588 km^2). The wide dispersion in time and space of Navy training operations superimposed on the variable temporal and seasonal distributions of the fish species present, minimizes the potential for interaction with local populations. Given the limited extent, duration, and magnitude of potential impacts, adverse effects on EFH and Managed Species are not expected (Table 3-4).

Table 3-4: Impact Summary

Action or Activity	Impact Assessment
Vessel Movement	Ship strikes on fish would be rare. Behavioral alterations would occur only close to a ship and involve short-term redistributions with little potential for adverse effect on fish populations.
Aircraft Over-Flight	Response of fish to aircraft over-flight would be within the range of normal behavior. Sonic booms would be sporadic and are not expected to have significant effects on underwater life.
Fuel Spills	Infrequent fuel spills, mitigated through standard spill control responses and wildlife rescue procedures, should not jeopardize EFH or Managed Species.
Discharges from Ships	Navy vessels would comply with National and International conventions, minimizing or eliminating potential impacts from discharges.
<u>Expended Material</u>	Expended material poses a risk from direct contact, ingestion, entanglement, and exposure to hazardous chemicals.
Lightsticks	Deploying a limited number of lightsticks over the large SOCAL Range Complex would have an insignificant biological effect.
Flares	Light from flares would not be bright enough or sustained enough to interfere with ecological processes. Flare debris is unlikely to injure fish, modify water quality, or degrade benthic sediments.
Chaff	Fish would not suffer lasting physical effects from chaff particles coating the skin, passing through the gills or from ingestion.
Dye	Dye would be rapidly dispersed and is non-toxic. The plastic bags containing the dye would pose a small ingestion hazard compared to the total load of man-made plastic to which local fish are exposed.
Markers	Light generated from marine markers is intense but brief, and associated smoke would be rapidly diffused by air movement. Marker debris would sink to the bottom and be encrusted and/or incorporated into the sediments.
Sonobuoys	The relatively small amounts of battery chemicals released if a sonobuoy were damaged would be quickly diluted to non-toxic concentrations. The physical components of expended sonobuoys would not pose a threat to marine life.
XBTs	It is possible, but unlikely, that fish would ingest an Expendable Bathythermograph, due to its size and rapid decent. XBTs would slowly degrade, corrode, and/or be buried by sediments on the seafloor.
Torpedo Accessories	Control wires, flex hoses, ballast weights, and other torpedo accessories left on the ocean bottom after torpedo exercises would not be a toxic hazard.
Targets	Airborne, surface or subsurface targets are designed to be recovered. If severely damaged, however, they may sink before retrieval is possible - but would not harm Managed Species or EFH.
EMATTs	Expendable Mobile Acoustic Torpedo Targets sink to the bottom after use, eventually settling into sediments or becoming encrusted on hard-bottom substrates with minimal impact.
ADCs	Acoustic Device Countermeasures are normally retrieved but may be lost or intentionally discarded. The consequences of their residence on the sea floor would be similar to other expended material.
	Clean, empty target vessels would settle to the bottom eliminating marine habitat directly underneath. They would subsequently function as artificial reefs possibly

Sunken Vessels	enhancing habitat quality.
Entanglement	Torpedo control wires and flex hoses resist looping and are unlikely to snare marine life. Small, expendable parachutes used with flares and sonobuoys pose a risk of entanglement, but the limited number deployed should not have adverse effects on fish populations or their habitats.
Hazardous Chemicals	The small amounts of potentially hazardous chemicals introduced into the ocean from expended material would not endanger aquatic life.
Radio Frequency Emissions	Fish would not be exposed to high intensity RF emissions for a sustained period of time.
Sound Generating Devices	Effects on fish from Long Range Acoustic Devices are unlikely since sound is not effectively transmitted through the air/water interface.
Lasers	Marine life in the water would not be illuminated by laser beams.
Underwater Detonation	Underwater detonation will only take place in waters overlying soft sediments. Displacement of bottom sediments and increased turbidity will be temporary and localized. Disturbed area recovery would be relatively rapid. Explosion by-products would not pose a risk to marine life and would not bioaccumulate. A limited number of fish would be killed by the shockwave or debris from explosive detonations. Some fish would be injured and could subsequently die or suffer greater rates of predation. However, the overall impact would be local and transient. When exercises are completed, the fish stock would repopulate the area. Fish abundance and diversity are unlikely to measurably decrease. Given the limited time scale of individual explosions and their broad distribution in time and space, masking of acoustic environmental cues and physiological stress should not be significant. Behavioral responses including alarm, avoidance, and interruption of communication would not substantially effect the ability of fish or their prey to survive, grow, or reproduce. The potential for permanent hearing loss is unknown, but temporary auditory deficits may occur, with normal hearing returning over a period of minutes to days.
Bombing	Most bombs used in training exercises will be practice bombs without explosive warheads. The shock from practice bombs hitting the sea surface could result in a small number of fish kills or injuries and minor acoustic displacement, but would not substantially affect fish populations. Practice bombs would not introduce combustion chemicals into the ocean. After sinking to the bottom, the physical structure of bombs would be incorporated into the marine environment by natural encrustation and/or sedimentation. Some fish would be killed or injured from the pressure wave created by the exploding bomb and by propelled fragments. Beyond the area of physical effects, the natural reaction of fish would be to leave, but the fish stock would be repopulated when the exercise concludes. The overall impact to water column habitat would be brief and would be restricted to a small area. The abundance and diversity of fish within SOCAL Range Complex are unlikely to measurably decrease as a result of bombing exercises.
Naval Gun Fire	Gun fire shells rapidly decelerate on contact with water. Few fish would be directly struck, but the shock wave from exploding rounds would cause death, injury, and behavioral disruptions. The overall impacts would be minor with fish returning after the exercise. Debris sinking to the bottom would have negligible

	influence on the benthic environment.
Torpedo Exercises	Ordnance would not be detonated during torpedo exercises. Due to the small size of the transit area of torpedoes, the probability of fish strikes would be low. Concentrations of combustion products from torpedo fuel would be below levels hazardous to marine life. Release of fuel from catastrophic torpedo failure is highly unlikely.
EMATT and ADC Exercises	Chemicals from lithium sulfur dioxide batteries used to power EMATTs and ADCs could be released into the marine environment. Chemical reactions would be localized and short-lived with insignificant impact on water quality.
Missile exercises	Missiles used in most training exercises are non-explosive. The main environmental impact would be the physical structure of the missile itself entering the water. Practice missiles do not use rocket motors or their potentially hazardous rocket fuel. The number of fish adversely affected by missile exercises would be a small fraction of the indigenous community.
Shallow Water Minefield	Localized, temporary impacts on water quality and sessile benthic fauna would occur during installation of mine shapes, but no adverse effect on Managed Species or EFH would be expected.
Shallow Water Training Range Extension	Installation of additional acoustic sensors would cause fish to leave the area, but would not have adverse effects at the level of fish populations.
Expeditionary Assault	Landing craft crossing shallow water and artillery shells that fall short could damage EFH. However, the biological impact would be limited because sandy beach habitats support relatively few organisms and those present are adapted to recover quickly from disturbance.
Sinking Exercises	Pressure waves from detonation of ordnance within target vessels should be relatively contained. Gun fire, bombs, and missiles that fall short of the target, and torpedoes striking the vessel, would affect nearby marine life, but would not have significant, long-term biological consequences.
SONAR Exercises	U.S. Navy low frequency sonar does not appear to have the potential to kill or injure marine fish. Temporary hearing loss and behavioral modifications have been demonstrated in laboratory studies, but field populations should not be compromised given the limited use of low frequency sonar. Most fish species would be not able to detect mid frequency sonar at the lower end of its range. For those who can, short-term behavioral responses such as startle and avoidance are possible which could adversely affect sensitive species during critical times such as breeding and spawning. The resulting ecological consequences are unknown, but major effects at the population level would not be anticipated. Most fish would not be able to detect high frequency sonar sounds. High frequencies quickly attenuate in water, restricting potential adverse effects to within a few meters of the source. Area-wide impacts are unlikely.
Research, Development, Testing, and Evaluation	The only RDT&E test with the potential to impact fish is Underwater Acoustics Testing, which involves mid frequency sonar use. Effects would be less than significant (see following SONAR summary).

3.15 ALTERNATIVES COMPARISON

Three alternatives are analyzed in the SOCAL Range Complex EIS/OEIS: 1) The No Action Alternative – Current Operations; 2) Alternative 1 - Increase Operational Training and Accommodate Force Structure

Changes, and 3) Alternative 2 – Increase Operational Training, Accommodate Force Structure Changes, and Implement Range Enhancements. As described in the Impact Definition section (3.1), for Essential Fish Habitat and Managed Species an adverse effect is: 1) more than minimal, 2) not temporary, 3) causes significant changes in ecological function, and, 4) does not allow the environment to recover without measurable impact.

On the basis of impact determinations in the EIS/OEIS (Sections: 3.1-3.14) and this EFH assessment, none of the three alternatives would be expected to have adverse effects on EFH and Managed Species (Table 3-5).

Table 3-5: Alternatives Comparison – Effects on EFH and Managed Species

Alternative	Impact Assessment
No Action Alternative - Current Operations	No Adverse Effects. • Vessel movement, aircraft over-flight, fuel spills, discharges from ships, expended materials, radio frequency emissions, sound generating devices, and lasers would have less than significant effects on Managed Species and EFH. • Munitions constituents and other materials from training devices and training and testing exercises would have no effect or result in short-term, localized impacts. • Small numbers of fish would be killed by shock waves from practice mines, non-explosive bombs, non-exploding gunfire rounds, and intact missiles and targets hitting the water surface. Minor, acoustic displacement would also occur, but would not substantially affect local fish populations. • Underwater detonation would only take place in waters overlying soft sediments. Disturbance of bottom sediments and increased turbidity would be temporary and localized with less than significant impacts on EFH and Managed Species. • Relatively small numbers of fish would be killed by bombs exploding near the surface, but effects on EFH would be less than significant since live bombing exercises are conducted away from sensitive habitats or HAPCs. • Landing craft crossing shallow water would have short-term impacts on small areas of sandy bottom. The biological effect would be limited because this type of habitat is naturally resilient and recovers quickly from disturbance. • Only a few species of fish would detect the relatively high frequencies generated by tactical sonar - effects of sonar use on EFH and Managed Species would be less than significant. • No long-term changes in diversity or abundance of Managed Species. • No loss or degradation of Essential Fish Habitat or HAPCs.
Alternative 1 - Increased Operational Training and Force Structure Changes	No Adverse Effects. Impacts as described in the No Action Alternative plus the following: • Effects of sonar used in the Surface Ship ASW Integrated Anti-submarine Warfare exercises on Managed Species would be less than significant. • Relatively small numbers of fish would be killed by Improved Extended Echo Ranging (IEER) sonobuoy detonation in ASW exercises, but effects on fish populations would be insignificant. • Battalion-sized amphibious landings and USMC Amphibious Warfare exercises added in Alternative 1 involve types of activities common to many exercises discussed above, and would have less than significant effects on EFH. • Small increases in the number of Offshore Operations, Underwater Demolitions exercises, and RDT&E tests would have insignificant

	impacts on Managed Species and EFH.
Alternative 2 (Preferred Alternative) - Increased Operational Training, Force Structure Changes, and Range Enhancements	<u>No Adverse Effects.</u> Impacts same as described for No Action Alternative plus Alternative 1. • Small increases in the number of Offshore Operations, Underwater Demolitions exercises, and RDT&E tests would result in less than significant impacts on EFH and Managed Species. • Increased Commercial Air Services, use of the Shallow Water Mine Minefield, extension of the Shallow Water Training Range would have similar, less than significant impacts associated with other offshore testing and training operations.

4 MITIGATION MEASURES

The Navy has established standard protective measures to minimize potential environmental impacts from training exercises. Some of these mitigation measures are generally applicable and others are designed to apply to certain geographic areas during certain times of year, for specific types of Navy training. Mitigation measures covering habitats and species occurring in the SOCAL Range Complex have been developed through various environmental analyses conducted by the Navy for land and sea ranges and adjacent coastal waters (see DON BAs, EAs, OEAs, EISs, and OEISs in the Reference Section). Consultations with the NMFS on previous training events that included the SOCAL Range Complex have produced mitigation measures specifically designed to protect local threatened and endangered species (e.g., NMFS 2002c). In addition, the Navy also has a Protective Measures Assessment Protocol (PMAP) initiative in place which is intended to ensure the latest protected species/habitats mitigation data and guidance are available to the operators conducting training exercises (DON 2004a, 2006f). These mitigation measures are typically promulgated through the use of Navy messages issued to all units and commands participating in an exercise as well as to non-Navy participants (other DOD services and NATO allies) to encourage their overall use.

Each element of the EIS/OEIS includes mitigation measures specific to that resource area (e.g., Water Resources Section 3.1.2.4). General mitigation measures that help minimize impacts on Managed Species and EFH include: using non-explosive versions of ordnance and passive acoustical and tracking tools, avoiding protected and/or sensitive habitats, including HAPCs, conducting most exercises during daylight hours in calm seas, and visual monitoring to assure an area is clear of significant concentrations of sea life including fish before ordnance or explosives are used. In addition, zones of influence (or buffer zones) have been designated for various types of training operations. For example, underwater detonations may not be conducted if marine mammals or sea turtles are detected within 1,000 yards (914 m) of a 60-lb mine neutralization charge site (DON 2005d). Furthermore, no detonations may take place: within 1,000 m (1,094 yd) of any artificial reef, shipwreck, or live hard-bottom community; within 3,000 m (1.6 nm) of shoreline; or, within 6,000 m (3.2 nm) of an estuarine inlet (DON 2005d). General and specific mitigation measures are also presented in Navy environmental documents covering specific types of training exercises, individual Range exercises, and joint exercises covering multiple ranges (see DON references in the Reference Section).

5 CUMULATIVE IMPACTS

Federal and Department of the Navy regulations implementing NEPA (42 USC § 4321 *et seq*. and 32 C.F.R. § 775 respectively) require that the cumulative impacts of a proposed action be assessed. CEQ Regulations implementing the procedural provisions of NEPA define cumulative impact as: the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future action 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 CFR § 1508.7).

In general, a particular action or group of actions must meet all of the following criteria to be considered a cumulative impact: effects of several actions occur in a common locale or region; effects on a particular resource are similar in nature, such that the same specific element of a resource is affected in the same specific way; and, effects are long-term as short-term impacts dissipate over time and cease to contribute to cumulative impacts.

Human uses of the SOCAL Range Complex include prior, current, and future Navy activities, navigation, transportation, coastal development, oil/gas exploration and development, sand and mineral mining, dredge and fill operations, beach nourishment, cooling water intake and discharge, wastewater discharge, mariculture, recreational and commercial fishing, and whale-watching. Potential threats to EFH and Managed Species include degradation of water quality, habitat modification, pollution (chemicals, marine debris, etc.), introduction of exotic species, disease, natural events, and global climate change (Field et al. 2003, Jackson et al. 2001, IEF (In Ex Fishing) 2006).

Fishing and non-fishing activities, individually or in combination, can adversely affect EFH and Managed Species (NOAA 1998, Dayton et al. 2003, Morgan and Chuenpagdee 2003, Levin et al. 2006). Potential impacts of commercial fishing include over-fishing of targeted species and bycatch, both of which negatively affect fish stocks (Barnette 2001, NRC 2002, Dieter et al. 2003). Mobile fishing gears such as bottom trawls disturb the seafloor and reduce structural complexity (Auster and Langton 1998, Johnson 2002). Indirect effects of trawls include increased turbidity; alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing, and generation of marine debris (Hamilton 2000). Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats. Recreational fishing also poses a threat because of the large number of participants and the intense, concentrated use of specific habitats (Coleman et al. 2004).

Removal of fish by fishing can have a profound influence on individual populations, their survival, and shifts in community composition. In a recent study of retrospective data, Jackson et al. (2001) analyzed paleoecological records from marine sediments from 125,000 years ago to present, archaeological records from 10,000 years before present, historical documents, and ecological records from scientific literature sources over the past century. Examining this longer term data and information, they concluded that ecological extinction caused by overfishing preceeds all other pervasive human disturbance to coastal ecosystems including pollution, degradation of water quality, and anthropogenic climatic change.

Natural stresses include storms and climate-based environmental shifts, such as harmful algal blooms and hypoxia (DON 2005a). Disturbance from ship traffic and exposure to biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them vulnerable to parasites and diseases that would not normally compromise natural activities or be fatal (Pew Oceans Commissions 2003).

Potential cumulative impacts of Navy training exercises include release of chemicals into the ocean, introduction of debris into the water column and onto the seafloor, mortality and injury of marine organisms near the detonation or impact point of ordnance or explosives, and, physical and acoustic impacts of vessel activity. The incremental contribution by the proposed action or alternatives to impacts on the marine environment is expected to be insignificant. The overall effect on fish stocks would be negligible compared to the impact of commercial and recreational fishing in the SOCAL Range Complex. After completion of an exercise, repopulation of an area by fish should take place within a matter of hours. Implementation of mitigation measures designed to avoid significant or long-term impacts would further protect marine life and the environment.

Because of the transient nature of the training exercises and the minor, localized potential effects, there would not be incremental or synergistic impacts on present or reasonably foreseeable future uses of the SOCAL Range Complex. The proposed action and alternatives would not make a significant contribution to the regional cumulative impacts on EFH or Managed Species.

6 REFERENCES

Acoustic Ecology Institute 2007. http://www.acousticecology.org/.

Allen, L. G, 2006. Pollution. p. 595-610. In: The Ecology of Marine Fishes: California and Adjacent Waters. 2006.

Allen, L. G., A. M. Findlay, and C. M. Phalen 2002. Structure and standing stock of fish assemblages of San Diego Bay, California from 1994 to 1999. Bulletin of Southern California Academy of Science 101(2):49-85.

Allen, L. G., D. J. Pondella, II, and M. H. Horn, editors. 2006. The Ecology of Marine Fishes: California and Adjacent Waters. University of California Press, Los Angeles. 660 p.

Allen, L. G. and J. N. Cross. 2006. Surface Water. Chapter 12. pp. 320-341 in: Allen, L. G., D. J. Pondella II and M. H. Horn (eds.). The Ecology of Marine Fishes: California and Adjacent Waters. University of California Press: Berkeley, CA. 670 pp.

Amoser, S. and F. Ladich 2003. Diversity in noise-induced temporary hearing loss in otophysine fishes. J. Acoust. Soc. Am. 113: 2170–2179.

Amoser, S. and F. Ladich 2005. Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? The Journal of Experimental Biology 208: 3533-3542.

Andrew, R. K., M. M. Howe, J. A. Mercer, and, M. A. Dzieciuch 2002. Ocean ambient noise. Acoustics Research Letters Online 3(2): 65-70.

Ankley, G. T. 1996. Evaluation of metal/acid volatile sulfide relationships in the prediction of metal bioaccumulation by benthic macroinvertebrates. Environmental Toxicological Chemistry, 15: 2138-2146.

Auster, P. J. and R. W. Langton 1998. The Effect of Fishing on Fish Habitat. National Undersea Research Center. Univ. of Connecticut. Groton, CT. 51 p.

Barnette, M. C. 2001. A Review of the Fishing Gear Utilized Within the Southeast Region and their Potential Impacts on Essential Fish Habitat. National Marine Fisheries Service. Southeast Regional Office. St. Petersburg, Fl. 68p.

Benjamin S. G. and J. A. Carton 1999. Interannual and Decadal Variability in the Tropical and Midlatitude Pacific Ocean. Journal of Climate. Vol.12:Issue 12. p. 3402-3418.

Bohne, B. A. and G. W. Harding 2000. Degeneration in the cochlea after noise damage: primary versus secondary events. Am. J. Otol. 21(4):505-509.

Bowles, A. E., M. Smultea, B. Würsig, D. P. DeMaster, and D. L. Palka 1994. Relative Abundance and Behavior of Marine Mammals Exposed to Transmissions from the Heard Island Feasibility Test. Acoust. Soc. Am. 96(4): 2469-2484.

Briggs, J. C. 1974. Marine zoogeography. McGraw-Hill, New York.

Bryant, P. J., C. M. Lafferty, and S. K. Lafferty 1984. Reoccupation of Laguna Guerrero Negro, Baja California, Mexico, by Gray Whales, In: The Gray Whale *Eschrichtius robustus*, M. L. Jones et. al. (eds.). Academic Press. pp. 375-386.

Budelmann, B. U. and R. Williamson 1994. Directional sensitivity of hair cell afferents in the octopus statocyst. Journal of Experimental Biology 187:245-259.

California Department of Fish and Game (CDFG) 2000. Biological Characteristics of Nearshore Fishes of California. CDFG Marine Region. http://www.dfg.ca.gov/mrd/lifehistories/index.html.

CDFG 2007a. CDFG Web Site. http://www.dfg.ca.gov.

CDFG 2007b. Rockfish. http://www.dfg.ca.gov/mrd/rockfish.html.

CDFG 2007c. Guide to California's Marine Life Management Act. Michael L. Weber and Burr Heneman. http://www.fgc.ca.gov/mlma/home.html.

CDFG 2007d. Market Squid Fishery Management Plan. http://www.dfg.ca.gov/mrd/msfmp/index.html.

CDFG 2007e. White Seabass Fishery Management Plan. http://www.dfg.ca.gov/mrd/wsfmp/index.html.

CDFG 2007f. Nearshore Fishery Management Plan. http://www.dfg.ca.gov/mrd/nfmp/index.html.

CDFG 2007g. Abalone Recovery Management Plan. http://www.dfg.ca.gov/mrd/armp/

Canadian Forces Maritime Experimental and Test Ranges (CFMETR) 2005. Environmental Assessment Update. Prepared by: Environmental Sciences Group. Royal Military College. Kingston, Ontario, Canada. 652 p.

Casper, B. M., P. S. Lobel, and H. Y. Yan 2003. The hearing sensitivity of the little skate, *Raja erinacea*: A comparison of two methods. Environmental Biology of Fishes 68: 371-379.

Casper, B. M and D. A. Mann 2006. Evoked potential audiograms of the nurse shark (*Ginglymostoma cirratum*) and the yellow stingray (*Urobatis jamaicensis*). Environmental Biology of Fishes 76:101–108.

Cato, D. H. 1978. Marine biological choruses observed in tropical waters near Australia. Journal of the Acoustical Society of America 64:736–743.

Cato, D. H. and R. C. McCauley 2001. Ocean ambient noise from anthropogenic and natural sources in the context of marine mammal acoustics. J. Acoust. Soc. Amer. 110: 2751.

Chapman, C. J., and A. D. Hawkins 1973. A field study of hearing in cod (*Gadus morhua* L.). J. Comp. Physiol. 85: 147-167.

Coleman, F. C., W. F. Figueira, J. S. Ueland, and L. B. Crowder 2004. The Impact of United States Recreational Fisheries on Marine Fish Populations. Science 305: 1958-1960.

Continental Shelf Associates, Inc. (CSA) 2004. Explosive removal of offshore structures - information synthesis report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2003-070. 181p. + app.

Craig Jr., J. C. 2001. Appendix D, Physical Impacts of Explosions on Marine Mammals and Turtles. In: Final Environmental Impact Statement, Shock Trial of the WINSTON CHURCHILL (DDG81). U.S. Department of the Navy. NAVSEA.

Cross, J. N., and L. G. Allen 1993. Fishes. Pages 459-540 in M. D. Folley, D. J. Reish, and J. W. Anderson, eds. Ecology of the Southern California Bight, a synthesis and interpretation. Berkeley: University of California Press.

Culik, B. M., S. Koschinski, N. Tregenza, and G. M. Ellis 2001. Reactions of Harbour Porpoises (*Phocoena phocoena*) and Herring (*Clupea harengus*) to Acoustic Alarms. Marine Ecology Progress Series 211:255-260.

D'Itri, F. M. 1990. The biomethylation and cycling of selected metals andmetalloids in aquatic sediments. Pp. 163-214 in: Baudo, R., J. P. Giesy and H. Muntau (eds.). 1990. Sediments: Chemistry and toxicity of in-place pollutants. Lewis Publishers, Inc. Ann Arbor, Michigan.

Dalen J., and A. Raknes 1985. Scaring effects on fish from three-dimensional seismic surveys. Report No. FO 8504. Institute of Marine Research. Bergen, Norway.

Dalen J., and G. M. Knutsen 1986. Scaring effects in fish and harmful effects on eggs, larvae and fry by offshore seismic exploration. In: Merklinger, H.M. (Ed.), Progress in Underwater Acoustics. Plenum Press, New York, pp. 93–102.

Dayton, P. K., S. Thrush, and S. A. Coleman 2003. Ecological Effects of Fishing in Marine Ecosystems of the United States. Prepared for the Pew Ocean Commission. 52p.

Demarchi, M. W., W. B. Griffiths, D. Hannay, R. Racca, and S. Carr 1998. Effects of Military Demolitions and Ordinance Disposal on Selected Marine Life. LGL. Sidney, B.C. for Department of National Defense. Esquimalt, B.C. 114 p.

Department of the Navy (DON) 1993. Report on Continuing Action. Standard Range Sonobuoy Quality Assurance Program. San Clemente Island, California. Program Executive Office, Antisubmarine Warfare.

DON 1998. Final Environmental Impact Statement. Shock Testing the SEAWOLF Submarine. Naval Sea Systems Command. Washington, D.C. 637 p..

DON 2000. Deck Gun Noise Blast Test Results Aboard the USS Cole. Naval Surface Warfare Center, Dahlgren, MD.

DON 2001a. Final Environmental Impact Statement, Shock Trial of the USS WINSTON S. CHURCHILL (DDG-81). Washington, D.C. Naval Sea Systems Command. 597p.

DON 2001b. Final Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active LFA (SURTASS/LFA) Sonar. Washington, D.C. Available at www.surtass-lfa-eis.com/Download/index.htm.

DON 2002a. Final Environmental Impact Statement/Overseas Environmental Impact Statement Point Mugu Sea Range. March 2002.

DON 2002b. Biological Assessment for Explosive Ordnance Disposal (EOD) Mine Warfare Exercises in the East Coast Operating Areas. Naval Facilities Engineering Command. Norfolk, Virginia. July 2002.

DON 2004a. Protective Measures Assessment Protocol (CD). Fleet Forces Command. Version 1.1. November 2004.

DON 2004b. Environmental Assessment/Overseas Environmental Assessment for Virtual At-Sea Training/Integrated Maritime Portable Acoustic Scoring and Simulator (Vast/Impass) System. May 2004.

DON 2004c. TORPEX OEA GOMEX. Commander U.S. Atlantic Fleet. April 2004.

DON 2005a. Marine Resources Assessment for the Southern California Operating Area. https://portal.navfac.navy.mil/portal/page?_pageid=181,3986942&_dad=portal&_schema=PORTAL

DON 2005b. Draft Overseas Environmental Impact Statement/Environmental Impact Statement. Undersea Warfare Training Range. October 2005. http://projects.earthtech.com/USWTR/USWTR_index.htm.

DON 2005c. Overseas Environmental Assessment for Air-To-Ground Bombing Exercises (BOMBEX) in Southeastern OPAREAs. January 2005.

DON 2005d. Biological Assessment for explosive charge detonating associated with mine warfare training in the east coast Naval operating areas. Prepared for U. S. Naval Fleet Forces Command by Naval Facilities Engineering Command Atlantic.

DON 2005e. Supplemental Environmental Impact Statement. Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar. November 2005.

DON 2006a. SINKEX. Programmatic Overseas Environmental Assessment (OEA) for Sinking Exercises (SINKEXs) in the Western North Atlantic Ocean. November 2006.

DON 2006b. Fleet Implements Environmental Protective Measures. Currents. Summer 2006.

DON 2007a. Overseas Environmental Assessment. Surface Routine Training Exercises in East and Gulf Coast Operation Areas and Seaward. January 2007.

DON 2007b. Overseas Environmental Assessment Air Routine Training Exercises in East and Gulf Coast Operation Areas and Seaward. January 2007.

DON 2007c. Environmental Screening Submarine Routine Training Exercises in East and Gulf Coast Operation Areas and Seaward. January 2007.

DON 2007d. Draft Composite Training Unit Exercises and Join Task Force Exercises. EA/OEA. U.S. Pacific Fleet. February 2007.

DON 2007e. United States Navy. Whales and Sonar. http://www.whalesandsonar.navy.mil.

Dieter, B. E., D. A. Wion, and R. A. McConnaughey 2003. Mobile fishing gear effects on benthic habitats: A bibliography. NOAA Tech. Memo. NMFS-AFSC-135, 206 p.

Dzwilewski, P. T. and G. Fenton 2003. Shock wave/sound propagation modeling results for calculating marine protected species impact zones during explosive removal of offshore structures. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2003-059. 39 p.

Edds-Walton, P. L. and J. J. Finneran 2006. Evaluation of Evidence for Altered Behavior and Auditory Deficits in Fishes Due to Human-generated Noise Sources. SPAWAR Systems San Diego, California. Tech. Rep. 1939. 50p.

Engas, A., S. Lokkeborg, E. Ona, and A. Soldal 1996. Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*). Can. J. Fish. Aquat. Sci. 53: 2238-2249.

Engas, A. and S. Lokkeborg 2002. Effects of seismic shooting and vessel generated noise on fish behavior and catch rates. Bioacoustics 12:313-315.

Egner, S. A. and D. A. Mann 2005. Auditory sensitivity of sergeant major damselfish *Abudefduf saxatilis* from post-settlement juvenile to adult. Marine Ecology Progress Series 285: 213–222.

Environmental Science Group, RMC and Environmental Chemistry Group, UBC (ESG 1998). An Environmental Impact Assessment of Otto Fuel Torpedo Exhaust Gases, Canadian Forces-Maritime Experimental and Test Ranges Nanoose, British Columbia.

Eschmeyer, W. N., E. S. Herald, and H. Hammann 1985. A Field Guide to Pacific Coast Fishes of North America. Houghton Mifflin Company. Boston. 336 p.

Field, J. C., D. F. Boesch, D. Scavia, R. Buddemeier, V. R. Burkett, D. Cayan, M. Fogarty, M. Harwell, R. Howarth, C. Mason, L. J. Pietrafesa, D. Reed, T. Roye, A. Sallenger, M. Spranger, J. G. Titus 2003. Potential Consequences of Climate Variability and Change on Coastal Areas and Marine Resources. In: Climate Change Impacts in the United States. US Global Change Research Program: 461-487. http://www.usgcrp.gov/usgcrp/Library/nationalassessment/foundation.htm.

Fitch, J. E., and P. H. Young 1948. Use and effect of explosives in California coastal waters. Calif. Fish Game 34:53-70.

Folley, M. D., D. J. Reish, and J. W. Anderson 1993. Ecology of the Southern California Bight, a synthesis and interpretation. Berkeley: University of California Press.

Froese, R., and D. Pauly, eds. 2004. FishBase. World Wide Web Electronic Publication. www.fishbase. org. Accessed 23 May 2005. http://www.fishbase.org/search.cfm.

Gearin, P. J., M. E. Gosho, J. L. Laake, L. Cooke, R. L. DeLong, and K. M. Hughes 2000. Experimental Testing of Acoustic Alarms (Pingers) to Reduce Bycatch of Harbour Porpoise in the State of Washington. J. Cet. Res.Manag. 2(1):1-9.

General Oceanics, Inc. 1986. Blake Plateau current measurement study. New Orleans, Louisiana: Minerals Management Service.

Gitschlag, G. R., M. J. Schirripa, and J. E. Powers 2000. Estimation of fisheries impacts due to underwater explosives used to sever and salvage oil and gas platforms in the U.S. Gulf of Mexico: Final report. OCS Study MMS 2000-087. Prepared by NMFS. U.S .Dept. of the Interior, Minerals Mgmt. Servvice. New Orleans, LA. 80 p.

Goertner, J. F. 1982. Prediction of Underwater Explosion Safe Ranges for Sea Mammals. NSWC/WOL TR 82-188. Naval Ordnance Laboratory. Silver Spring, MD.

Goertner, J. F., M. L. Wiley, G. A. Young, and W. W. McDonald 1994. Effects of underwater explosions on fish without swimbladders. Naval Surface Warfare Center, Dahlgren Division, White Oak Detachment, Silver Spring, MD. NSWC TR 88-114.

Govoni, J. J., L. R. Settle, and M. A. West 2003. Trauma to Juvenile Pinfish and Spot Inflicted by Submarine Detonations. J. Aquatic Anim. Health 15:111–119.

Gregory, J. and P. Clabburn 2003. Avoidance behaviour of *Alosa fallax fallax* to pulsed ultrasound and its potential as a technique for monitoring clupeid spawning migration in a shallow river. Aquatic Living Resources 16: 313–316.

Guerra, A., A. F. Gonazalez, F. Rocha, J. Gracia, and M. Vecchione 2004. El Tiempo Antes De La Grande Explosion. Edición Española de Scientific American:35 - 37.

Hanlon, R. T. and J. B. Messenger 1996. Cephalopod Behaviour, Cambridge University Press, Cambridge, UK.

Hastings, M. C., A. N. Popper, J. N. Finneran, and P. J. Lanford 1996. Effects of low-frequency underwater sound on hair cells of the inner ear and lateral line of the teleost fish *Astronotus ocellatus*. J. Acoust. Soc. America 99(3): 1759-1766.

Hastings, M. C. and A. N. Popper 2005. Effects of Sound on Fish. Report to California Department of Transportation, January 2005. 82pp. http://www.dot.ca.gov/hq/env/bio/files/Effects_of_Sound_on_Fish23Aug05.pdf.

Hawkins, A.D. 1986. Underwater sound and fish behavior. Pp. 114-151. In: T. Pitcher (ed.). The behavior of Teleost Fishes. Baltimore, MD: The Johns Hopkins University Press.

Hawkins, A. D. and A. D. F. Johnstone 1978. The hearing of the Atlantic salmon, *Salmo solar*. Journal of Fish Biology 13: 655-673.

Hayward, T. L. 2000. El Niño 1997-98 in the coastal waters of southern California: a timeline of events. California Cooperative Oceanic Fisheries Investigations Reports 41:98-116.

Hickey, B.M. 1993. Physical oceanography. Pages 19-70 in M. D. Folley, D. J. Reish, and J. W. Anderson, eds. Ecology of the Southern California Bight, a synthesis and interpretation. Berkeley: University of California Press.

Higgs, D. M. 2005. Auditory cues as ecological signals for marine fishes. Marine Ecology Progress Series 287: 278-281.

Higgs, D. M., D. T. Plachta, A. K. Rollo, M. Singheiser, M. C. Hastings, and A. N. Popper 2004. Development of ultrasound detection in American shad (*Alosa sapidissima*). The Journal of Experimental Biology 207: 155-163

Hoenig, J. M. and S. H. Gruber 1990. Life-history patterns in the elasmobranches: implications for fisheries management. In: Pratt, H. L. Jr., S. H. Gruber, and T. Taniuchi (eds.): 1-16.

Horn, M. H., and L. G. Allen 1978. A distributional analysis of California coastal marine fishes. Journal of Biogeography 5:23-42.

Horn, M. H. and J. S. Stephens, Jr. 2006. Climate Change and Overexploitation. P. 621-660. In: The Ecology of Marine Fishes: California and Adjacent Waters. 2006.

Horn, M. H., L. G. Allen, and R. N. Lea 2006. Biogeography. Chapter 1. pp. 3-25. In: Allen, L. G., D. J. Pondella II, and M. H. Horn (eds). The Ecology of Marine Fishes: California and Adjacent Waters. University of California Press, Berkeley, California.

Hubbs, C. L. and A. B. Rechnitzer 1952. Report on experiments designed to determine effects of underwater explosions on fish life. Cal. Fish and Game 38:333-366.

ICES 2005. Report of the Ad-hoc Group on Impacts of Sonar on Cetaceans and Fish (AGISC) CM 2006/ACE. Second Edition. 25p.

IEF (In Ex Fish) 2006. The Role of Anthropogenic and Non-anthropogenid Forcing Factors on the Biology of Exploited Species. 16 p. http://www.inexfish.org/publications/reports.html.

International Pacific Halibut Commission (IPHC) 2005. http://www.iphc.washington.edu/halcom/default.htm.

Iversen, R. T. B. 1967. Response of the yellowfin tuna (*Thunnus albacares*) to underwater sound. Pages 105-121 in W.N. Tavolga (editor), Marine Bio-Acoustics II. Pergamon Press, New York.

Iversen, R. T. B. 1969. Auditory thresholds of the scombrid fish *Euthynnus affinis*, with comments on the use of sound in tuna fishing. Proceedings of the FAO Conference on Fish Behaviour in Relation to Fishing Techniques and Tactics, October 1967. FAO Fisheries Reports No. 62 Vol. 3. FRm/R62.3.

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. 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. Science: 293 (629-638).

Johnson, J. S. 2001. Final overseas environmental impact statement and environmental impact statement for Surveillance Towed Array Sensor Low Frequency Active (SURTASS-LFA) Sonar. Volumes 1 and 2.

Johnson, K. A. 2002. A Review of National and International Literature on the Effects of Fishing on Benthic Habitat. NOAA Tech. Memo. NMFS-F/SPO-57.

Johnston, R. K., H. Halkola, W. J. William, R. G. Gauthier, and R. George 2005. In, M. Bell, and R. Martore 2005. The Ecological Risk of Using Former Navy Vessels to Construct Artificial Reefs. Naval Warfare Center, San Diego, CA, 597pp. http://www.epa.gov/Region4/air/lead/documents/TheEcologicalRiskofUsingformerNavy

Jørgensen, R., N. O. Handegard, H. Gjøsæter, and A. Slotte 2004. Possible vessel avoidance behaviour of capelin in a feeding area and on a spawning ground. Fisheries Research 69: 251-261.

Jørgensen, R., K. K. Olsen, I.-B. Falk-Petersen, and P. Kanapthippilai 2005. Investigations of Potential Effects of Low Frequency Sonar Signals on Survival, Development and Behaviour of Fish Larvae and Juveniles. Norwegian College of Fishery Science University of Tromsø. 49pp.

Keevin, T. M., and G. L. Hempen 1997. The Environmental Effects of Underwater Explosions with Methods to Mitigate Impacts. U.S. Army Corps of Eng. St. Louis, MO. 118p.

Kennett, J. P. 1982. Marine Geology. Prentice-Hall, Inc., Englewood Cliffs, NJ.

Kennish, M. J., ed. 2001. Practical Handbook of Marine Science, Third Edition, CRC Press, Boca Raton, LA.

Kenyon, T. N. 1996. Ontogenetic changes in the auditory sensitivity of damselfishes (pomacentridae). Journal of Comparative Physiology 179: 553-561.

Ketten, D. R. 1998. Marine Mammal Auditory Systems: A Summary of Audiometric and Anatomical Data and its Implications for Underwater Acoustic Impacts. NOAA Tech. Memo. NMFS-SWFSC-256. 97p.

Knudsen, F. R., C. B.Schreck, S. M. Knapp, P. S. Enger, and O. Sand 1997. Infrasound produces flight and avoidance response in Pacific juvenile salmonids. J. Fish Biol. 51, 824-829.

Knudsen, F. R., Enger, P. S., and O. Sand 1992. Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, *Salmo salar* L. J. Fish Biol. 40, 523-534.

Knudsen, F. R., P. S. Enger, and O. Sand 1994. Avoidance response to low frequency sound in downstream migrating Atlantic salmon smolt, *Salmo salar* L. J. Fish Biol. 45: 227-233.

Kullenberg, G. 1999. Marine Mammals and Marine Debris. The Pilot. June 1999.

Kvadsheim, P. H. and E. M. Sevaldsen 2005. The Potential impact of 1 – 8 kHz active sonar on stocks of juvenile fish during sonar exercises. Forsvarets Forskningsinstitutt, PO Box 25, NO-2027, Kjeller, Norway.

Ladich F. and A. H. Bass 2003. Underwater sound generation and acoustic reception in fishes with some notes on frogs. Pages 173-193 in Collin, S.P. and N.J. Marshall (editors), Sensory Processing in Aquatic Environments. Springer-Verlag, New York.

Ladich, F. and A. N. Popper 2004. "Parallel evolution in fish hearing organs." In Evolution of the Vertebrate Auditory System, edited by G. A. Manley, A. N. Popper, and R. R. Fay (Springer-Verlag, New York), pp. 98-127.

Lalli, C. M. and T. R. Parsons 1995. “Introduction,” in Biological Oceanography: An Introduction, Butterworth Heinemann, Ltd., Oxford, Great Britian, pp. 8-10.

Leet, W. S., C. M. Dewees, R. Klingbeil, and E. J. Larson 2001. California’s Living Marine Resources. California Department of Fish and Game. December 2001. 591 p.

Levin, P. S., E. E. Holmes, K. R. Piner, and C. J. Harvey 2006. Shifts in a Pacific Ocean fish assemblage: the potential influence of exploitation. Conserv. Biol. 20(4) 1181-1190.

Lluch-Belda, D., D. B. Lluch-Cota, and S. E. Lluch-Cota 2003. Scales of interannual variability in the California current system: associated physical mechanisms and likely ecological impacts. California Cooperative Oceanic Fisheries Investigations Reports 44:76-85.

Lombarte, A., H. Y. Yan, A. N. Popper, J. S. Chang, and C. Platt 1993. Damage and regeneration of hair cell ciliary bundles in a fish ear following treatment with gentamycin. Hear. Res. 4:166-174.

Longhurst, A. 1981. “Analysis of Marine Ecosystems,” Academic Press. NY, New York.

Love, M. S. 1996. Probably More Than You Want to Know About Fishes of the Pacific Coast. Second Ed. Really Big Press. Santa Barbara, Ca. 383p. http://id-www.ucsb.edu/lovelab.

Love, M. S. 2006. Subsistence, Commercial, and Recreational Fisheries. P. 567-594. In: The Ecology of Marine Fishes: California and Adjacent Waters. 2006.

Love, M. S., M. Yoklavich, and L. Thorsteinson 2002. The Rockfishes of the Northeast Pacific. University of California Press, Berkeley, California.

Lovell, J. M., M. M. Findlay, R. M. Moate, J. R. Nedwell, and M. A. Pegg 2005. The inner ear morphology and hearing abilities of the Paddlefish (*Polyodon spathula*) and the Lake Sturgeon (*Acipenser fulvescens*). Comparative Biochemistry and Physiology, Part A 142: 286– 296.

Lovell, J. M., M. M. Findlay, R. M. Moate, and H. Y. Yan.2005. The hearing abilities of the prawn *Palaemon serratus*. Comparative Biochemistry and Physiology, Part A. 140: 89-100.

Lundquist, C. J., L. W. Botsford, L. Morgan, J. M. Diehl, T. Lee, D. R. Lockwood, and E. L. Pearson 2000. Effects of El Niño and La Niña on local invertebrate settlement in northern California. California Cooperative Oceanic Fisheries Investigations Reports 41:167-176.

Mann, K. H. and J. R. Lazier 1991. Dynamics of Marine Ecosystems: Biological-Physical Interactions in the Oceans, Blackwell Scientific, Boston.

Mann, D. A., D. M. Higgs, W. N. Tavolga, M. J. Souza, and A. N. Popper 2001. Ultrasound detection by clupeiform fishes. J. Acoust. Soc. Am. 109:3048-3054.

Marine Technology Society Journal (MTAJ) 2004. Human-generated Ocean Sound and the Effects on Marine Life. Volume37, Number 4.

McCain, B. 2003. Essential fish habitat west coast groundfish draft revised appendix. Seattle, Washington: National Marine Fisheries Service.

McCauley R. D. and D. H. Cato 2000. Patterns of fish calling in a nearshore environment in the Great Barrier Reef. Philosophical Transaction of the Royal Society of London B 355:1289–1293.

McCauley, R., J. Fewtrell, A. Duncan, C. Jenner, M-N. Jenner, J. Penrose, R. Prince, A. Adhitya, J. Murdoch, and K. McCabe 2000. Marine seismic surveys – a study of environmental implications. J. Austral. Petrol. Prod. Explor. Assoc. 40:692-708.

McCauley, R. D., J. Fewtrell, A. J. Duncan, and A. Adhitya 2002. Behavioral, physiological and pathological responses of fishes to air gun noise. Bioacoustics 12(2/3):318-321.

McCauley, R. D., Fewtrell, J. and A. N. Popper 2003. High intensity anthropogenic sound damages fish ears. J. Acoust. Soc. Am. 113: 638-642.

Mearns, A. J., M. J. Allen, M. D. Moore, and M. J. Sherwood 1980. Distribution, abundance, and recruitment of softbottom rockfishes (Scorpaenidae: Sebastes) on the southern California mainland shelf. California Cooperative Oceanic Fisheries Investigations Reports 21:180-190.

Miller, A. J. 1996. Recent advances in California Current modeling: Decadal and interannual thermocline variations. In: California Cooperative Fisheries Investigations Reports. 37: 69-79.

Miller, G. S. 1991. The bow shock environment from a 16-inch projectile flyby. Naval Surface Weapons Center Technical Report TR91-621. Naval Surface Weapons Center. Silver Spring, MD.

Misund, O. A. 1997. Underwater acoustics in marine fisheries and fisheries research. Review of Fish Biology and Fisheries 7:1-34.

Mitson, R. B. and H. P. Knudsen 2003. Causes and effects of underwater noise on fish abundance estimation. Aquatic Living Resources 16 (2003) 255–263.

MMS (U.S. Minerals Management Service) 1990. Atlantic Outer Continental Shelf: Final Environmental Report on Proposed Exploratory Drilling Offshore North Carolina, MMS, Atlantic OCS Region, Environmental Assessment Section. Herndon, VA.

MMS 2002. Gulf of Mexico OCS oil and gas lease sale 181, Eastern Planning Area, Final Environmental Impact Statement. Volume 1 & 2. OCS EIS/EA MMS 2002-051. New Orleans: Minerals Management Service.

Moiseev, S. I. 1991. "Observation of the Vertical Distribution and Behavior of Nektonic Squids Using Manned Submersibles." Bull. Mar. Sci. 49. no. 1-2. pp. 446-456.

Morgan, L.E. and R. Chuenpagdee 2003. Shifting gears, addressing the collateral impacts of fishing methods in U.S. waters. Marine Conservation Biology Institute. 40 pp.

Morton, A. B. and H. K. Symonds 2002. "Displacement of *Orcinus orca* (L.) by High Amplitude Sound in British Columbia, Canada," ICES Journal of Marine Science, vol. 59: 71-80.

Moser, H. G., R. L. Charter, W. Watson, D. A. Ambrose, J. L. Butler, S. R. Charter, and E. M. Sandknop 2000. Abundance and distribution of rockfish (*Sebastes*) larvae in the Southern California Bight in relation to environmental conditions and fishery exploitation. California Cooperative Oceanic Fisheries Investigations Reports 41:132-147.

Myrberg, A. A., Jr. 2001. The acoustical biology of elasmobranchs. Environ. Biol. Fishes, 60(1-3):31-46.

Myrberg, A. A., Jr., S. J. Ha, S. Walewski, and J. C. Banbury 1972. Effectiveness of acoustic signals in attracting epipelagic sharks to an underwater sound source. Bull. Mar. Sci. 22:926-949.

National Marine Fisheries Service (NMFS) 2002. The Final Rule for Essential Fish Habitat. Federal Register 67(12):2343-2383. http://www.nero.noaa.gov/hcd/efhfinalrule.pdf.

NMFS 2001. Regional council approaches to the identification and protection of Habitat Areas of Particular Concern. Silver Spring, Maryland: National Marine Fisheries Service Office of Habitat Conservation.

NMFS 2002a. The final rule for essential fish habitat. Federal Register 67(12):2343-2383. http://www.nero.noaa.gov/hcd/efhfinalrule.pdf

NMFS 2002b. Considerations for Conducting a Thorough Analysis of Options to Minimize Adverse Effects. NMFS Office of Habitat Conservation. October 2002. 5p.

NMFS 2004a. Preparing Essential Fish Habitat Assessments: A Guide for Federal Action Agencies. National Oceanic and Atmospheric Administration. February 2004.

NMFS 2004b. Essential Fish Habitat Consultation Guidance (Version 1.1). April 2004. Office of Habitat Conservation. Silver Spring, MD.

NMFS 2005a. Final Groundfish Essential Fish Habitat (EFH) Environmental Impact Statement. National Marine Fisheries Northwest Region. December 2005. http://www.nwr.noaa.gov/Groundfish-Halibut/Groundfish-Fishery-Management/NEPA-Documents/EFH-Final-EIS.cfm.

NMFS 2005b. Description of Fishing Gears Used on the U.S. West Coast. Pacific Coast Groundfish Fishery Management Plan. Essential Fish Habitat Designation and Minimization of Adverse Impacts. Final Environmental Impact Statement. December 2005. Volume 2 of 4. Appendix 8 of Appendix A.

NMFS 2005c. Environmental Assessment/Overseas Environmental Assessment to Implement the Operational Measures of the North Atlantic Right Whale Ship Strike Reduction Strategy. Preliminary Draft. June 2005. 117p.

NMFS 2007a. Guide to Essential Fish Habitat Designations. http://www.nero.noaa.gov/hcd/list.htm.

NMFS 2007b. NMFS Web Site. http://www.nmfs.noaa.gov/.

National Oceanic and Atmospheric Administration (NOAA) 1998. Ecological Effects of Fishing. Stephen K. Brown, Peter J. Auster, Liz Lauck, and Michael Coyne. NOAA's State of the Coast Report. Silver Spring, MD: NOAA.

NOAA 2000. Groundfish Fishery Failure. http://www.noaanews.noaa.gov/stories/s357.htm.

NOAA 2007a. What is an El Nino. http://www.pmel.noaa.gov/tao/elnino/el-nino-story.html

NOAA 2007b. NOAA Fisheries Web Site. http://www.noaa.gov/fisheries.html.

NOAA 2007c. Southwest Fisheries Science Center. http://swfsc.noaa.gov/default.aspx

NOAA 2007d. Ocean Acoustics Program. http://www.nmfs.noaa.gov/pr/acoustics/.

NOAA 2007e. Explorations: Sound in the Sea. http://www.oceanexplorer.noaa.gov/explorations/sound01/sound01.html.

National Research Council (NRC) 1985. Oil in the Sea: Inputs, Fates, and Effects. National Academy Press.

NRC 1994. Low-frequency Sound and Marine Mammals: Current Knowledge and Research Needs. Washington, D.C.: Nat. Acad. Press.

NRC 2000. Marine Mammals and Low Frequency Sound: Progress Since 1994. National Academy Press, Washington, DC.

NRC 2002. Effects of trawling and dredging on seafloor habitats. National Academy Press. 126 p.

NRC 2003. Ocean Noise and Marine Mammals. National Academies Press. Washington, D.C.

NRC 2005. Marine Mammals Populations and Ocean Noise. Determining When Noise Causes Biologically Significant Effects. National Academies Press. Washington, D.C. 126p.

NRL 1999. Environmental Effects of RF Chaff- A Select Panel Report to the Undersecretary of Defense for Environmental Security. Washington, D. C.

Natural Resources Defense Council (NRDC) 1999. Sounding the Depths: Supertankers, Sonar, and the Rise of Undersea Noise. Natural Resources Defense Council, Inc., New York. Available at www.nrdc.org.

Naval Research Lab (NRL) 1997. Effects of Aluminized Fiberglass on Representative Chesapeake Bay Marine Organisms. November 23.

Nelson, D. R. and R. H. Johnson 1972. Acoustic attraction of Pacific reef sharks: Effect of pulse intermittency and variability. Comp. Biochem. Physiol. A, 42:85-95.

Nix, P. and P. Chapman 1985. Monitoring of underwater blasting operations in False Creek, B.C. Pp. 194-210. In: C.D. Greene, F.R. Englehardt, and R.J. Paterson (eds.). Effects of explosives in the marine environment. Can. Oil & Gas Lands Admin., Environ. Prot. Branch, Ottawa, Ont. Tech. Rep. 5.

O'Keeffe, D. J. and G. A. Young 1984. Handbook on the Environmental Effects of Underwater Explosions. Report NSWC TR 83-240. Naval Surface Warfare Center. Dahlgren, VA.

Ocean Conservancy 2007. A Scientific Study of Marine Debris. http://www.oceanconservancy.org/site/PageServer?pagename=mdm_debris&JServSessionIdr004=8urjm2tmo2.app5b.

Office of Naval Research (ONR) 2007. Marine Life Sciences. http://www.onr.navy.mil/sci_tech/34/341/marine_life_sciences.asp.

O'Keeffe, D. J. and G. A. Young 1984. Guidelines for Predicting the Effects of Underwater Explosions on Swimbladder Fish. Report NSWC TR 82326. Naval Surface Weapons Center, Silver Spring, MD.

Offutt, G. C. 1970. Acoustic stimulus perception by the American lobster (*Homarus americanus*) (Decapoda). Experientia 26:1276-1278.

Pacific Fishery Management Council (PFMC) 2003. Final Coastal Pelagic Species Fishery Management Plan. http://www.pcouncil.org/hms/hmsfmp.html#final.

PFMC 2005. Description and Identification of Essential Fish Habitat for the Coastal Species Fishery Management Plan. Coastal Species Fishery Management Plan. Pacific Fisheries Management Council. http://www.pcouncil.org/cps/cpsfmp.html.

PFMC 2006a. The Pacific Coast Groundfish Fishery Management Plan as Amended through Amendment 19. National Oceanic and Atmospheric Administration. 167p. http://www.pcouncil.org/groundfish/gffmp.html.

PFMC 2006b. The U. S. West Coast Fisheries for Highly Migratory Species Management Plan as Amended by Amendment 1. National Oceanic and Atmospheric Administration. December 2006. 153p. http://www.pcouncil.org/hms/hmsfmp.html.

PFMC 2006c. Measures to Prohibit Fishing in the EEZ off the West Coast. CPS FMP Amendment 12. 143p. http://www.pcouncil.org/cps/cpsfmp/cpsa12.html.

PFMC 2006d. Rebuilding Plans for Seven Depleted Species. http://www.pcouncil.org/groundfish/gffmp/gfa16-4.html.

PFMC 2007a. Pacific Fisheries Management Council Web Site. http://www.pcouncil.org/.

PFMC 2007b. Amendment 1 to the Highly Migratory Species Management Plan: Bigeye Tuna. January 2007. http://www.pcouncil.org/hms/hmsfmp.html#amendment.

Packard, A., H. E. Karlsen, and O. Sand 1990. Low frequency hearing in cephalopods. Journal of Comparative Physiology A: Neuroethology, Sensory, Neural, and Behavioral Physiology 166(4): 501-505.

Pater, L. L. 1981. “Gun Blast Far Field Peak Overpressure Contours”, Technical Report NSWC TR 79-442, Naval Surface Weapons Center, Silver Springs, MD.

Pearson, W. J., J. R. Skalski, and C. I. Malme 1992. Effects of sounds from a geophysical survey device on behaviour of captive rockfish (Sebastes sp.). Can. J. Fish. Aquat. Sci. 49: 1343.1356.

Perry, B., P. M. DiGiacomo, and B. Holt 2007. Oceanography of the Southern California Bight. http://seis.natsci.csulb.edu/bperry/scbweb/credits.htm.

Pew Oceans Commission 2003. America’s Living Oceans: Charting a Course for Sea Change. 166p.

Pickard, G. L. and W. J. Emery 1990. Descriptive Physical Oceanography: An Introduction. Pergamon Press Ltd, Oxford.

Pickering, A. D. 1981. Stress and Fishes. Academic Press. New York, NY.

Pondella, D. J. and L. G. Allen 2000. The nearshore fish assemblages of Santa Catalina Island. Pages 394-400 in Proceedings of the fifth California Islands symposium. D. R. Browne, K. L. Mitchell, and H. W. Chaney, eds. Santa Barbara: Santa Barbara Museum of Natural History.

Popper, A. N. 2003. Effects of anthropogenic sounds on fishes. Fisheries 28(10): 24-31.

Popper, A. N. and T. J. Carlson 1998. Application of sound and other stimuli to control fish behavior. Transactions of the American Fisheries Society 127(5): 673-707.

Popper, A. N. and R. R. Fay 1999. The auditory periphery in fishes. Pages 43-100 in R. R. Fay and A. N. Popper, eds. Comparative Hearing: Fish and Amphibians. Springer-Verlag, New York, NY.

Popper, A. N. and Z. Lu 2000. Structure-function relationships in fish otolith organs. Fisheries Research 46:15-25.

Popper, A. N., M. Salmon, and K. W. Horch 2001. Acoustic detection and communication by decapod crustaceans. Journal of Comparative Physiology 187(2): 83-89.

Popper, A. N., R. R. Fay, C. Platt, and O. Sand 2003. Sound detection mechanisms and capabilities of teleost fishes. In S. P. Collin and N. J. Marshall, eds. Sensory Processing in Aquatic Environments. Springer-Verlag, New York. pp. 3-38.

Popper, A. N., D. T. T. Plachta, D. A. Mann, and D. Higgs 2004. Response of clupeid fish to ultrasound: a review. ICES Journal of Marine Science, 61: 1057-1061.

Popper, A. N., J. Fewtrell, M. E. Smith, and R. D. McCauley 2004. Anthropogenic Sound: Effects on the Behavior and Physiology of Fishes. Marine Technological Society Journal 37: 35-40.

Popper, A. N., M. B. Halvorsen, D. Miller, M. E., Smith, J. Song, L. E. Wysocki, M. C. Hastings, A. S Kane, and P. Stein 2005a. Effects of SURTASS Low Frequency Active sonar on fish. Journal of the Acoustical Society of America 117: 2440.

Popper, A. N., M. E. Smith, P. A. Cott, B. W. Hanna, A. O. MacGillivray, M. E. Austin, and D. A. Mann 2005b. Effects of exposure to seismic airgun use on hearing of three fish species. J. Acoust. Soc. Am., 117:3958-3971.

Popper, A. N., T. J. Carlson, A. D. Hawkins, B. L. Southall, and R. L. Gentry 2006. Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper. 15p.

Popper, A. N., M. B. Halvorsen, A. Kane, D. L. Miller, M. E. Smith, J. Song, P. Stein, and L. Wysocki 2007. The effects of high-intensity, low-frequency active sonar on rainbow trout. The Journal of the Acoustical Society of America 122(1): 623-635.

Ramcharitar J. and A. N. Popper 2004. Masked auditory thresholds in sciaenid fishes: A comparative study. Journal of the Acoustical Society of America 116 (3): 1687–1691.

Reeves, R. R., A. J. Read, and G. Notarbartolo di Sciara 2001. Report of the Workshop on Interactions between Dolphins and Fisheries in the Mediterranean: Evaluation of Mitigation Alternatives. Istituto Centrale per la Ricerca Scientifica e Tecnologica Applicata al Mare, Rome, Italy. pp.44.

Reeves, R. R., R. J. Hofman, G. K. Silber, and D. Wilkinson 1996. Acoustic deterrence of harmful marine mammal-fishery interactions: proceedings of a workshop held in Seattle,WA, 20-22 March 1996. NOAA Tech. Memo. NMFS-OPR-10. 70p. www.nmfs.noaa.gov/pd/pdfs/acoustics/interactions.pdf.

Remage-Healey, L., D. P. Nowacek, and A. H. Bass 2006. Dolphin foraging sounds suppress calling and elevate stress hormone levels in a prey species, the Gulf toadfish. The Journal of Experimental Biology 209, 4444-4451.

Richardson, W. J., C. R. Greene Jr., C. L. Malme, and D. H. Thomson 1995. Marine Mammals and Noise. Academic Press, New York.

Ross, Q. E., D. J. Dunning, J. K Menezes, M. J. Kenna, and G. W. Tiller 1995. Reducing impingement of alewives with high frequency sound at a power plant on Lake Ontario. North American Journal of Fisheries Management, 15: 378–388.

Ross, Q. E., D. J. Dunning., R. Thorne, J. K. Menezes, G. W. Tiller, and J. K. Watson 1996. Responses of alewives to high-frequency sound at a power plant intake in Ontario, North American Journal of Fisheries Management, 16: 548–559.

Sand, O. and A. D. Hawkins 1973. Acoustic properties of the cod swimbladder. Journal of Experimental Biology, 58: 797–820.

Sand, O. and H. E. Karlsen 1986. Detection of infrasound by the Atlantic cod. J. Exp. Biol. 125; 197-204.

Sand, O., P. S. Enger, H.E. Karlsen, F. Knudsen, and T. Kvernstuen 2000. Avoidance responses to infrasound in downstream migrating European silver eels, Anguilla anguilla. Environ. Biol. Fishes. 57(3):327-336.

Schiff, K. C., M. J. Allen, E. Y. Zeng, and S. M. Bay 2000. Southern California. Marine Pollution Bulletin 41:76-93.

Scholik, A. R. and H. Y. Yan 2001. Effects of underwater noise on auditory sensitivity of a cyprinidfish. Hearing Research 152: 17–24.

Scholik, A. R. and H. Y. Yan 2001. The effects of underwater noise on auditory sensitivity of fish. Proc. I.O.A Vol 23 Part 4.

Scholik, A. R., and H. Y. Yan 2002. The effects of noise on the auditory sensitivity of the bluegill sunfish, *Lepomis macrochirus*. Comp. Biochem. Phys. A 133, 43-52.

Schwarz, A. L. 1985. The behaviour of fishes in their acoustic environment. Environmental Biology of Fishes 13(1):3-15.

Schwing, F. B., S. J. Bograd, C. A. Collins, G. Gaxiola-Castro, J. García, R. Goericke, J. Goméz-Valdéz, A. Huyer, K. D. Hyrenbach, P. M. Korso, B. E. Lavaniegos, R. J. Lynn, A. W. Mantyla, M. D. Ohman, W. T. Peterson, R. L. Smith, W. J. Sydeman. E. Venrick, and P. A. Wheeler. 2002. The state of the California Current, 2001-2002: Will the California Current System keep its cool, or is El Niño Looming? CalCOFI Reports 43:31-68.

Scripps Institution of Oceanography (SIO) 2005. draft Environmental Assessment of a Planned Low-Energy Marine Seismic Survey by the Scripps Institution of Oceanography on the Louisville Ridge in the Southwestern Pacific Ocean. LGL Canada. Report TA4133-1.

Settle, L. R., J. J. Govoni, M. D. Greene, and M. A. West 2002. Investigation of impacts of underwater explosions on larval and early juvenile fishes. Part 1: The effects of underwater explosions on larval fish with implications for the Wilmington Harbor Project. Report to U.S. Army Corps of Engineers, Wilmington, NC. 64 p.

Sevaldsen, E. M. and P. H. Kvadsheim 2004. Active sonar and the marine environment. Pages 272-279 in Porter, M.B., M. Siderius, and W.A. Kuperman (editors), High Frequency Ocean Acoustics. Conference Proceedings 728, American Institute of Physics 0-7354-0210-8/04.

Skalski, J. R., W.H. Pearson, and C. I. Malme 1992. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes spp*.). Can. J. Fish. Aquat. Sci. 49: 1357.1365.

Slotte, A., K. Kansen, J. Dalen, and E. Ona 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. Fisheries Research 67: 143-150.

Smith, M. E., A. S. Kane, and A. N. Popper 2004a. Noise-induced stress response and hearing loss in goldfish (*Carassius auritus*). J. Exp. Biol. 2004 Sep: 207 (Pt 20): 3591-602.

Smith, M. E., A. S. Kane, and A. N. Popper 2004b. Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water? J. Exp. Biol.: 3591-602.

Song, J., A. Mathieu, R. F. Soper, and A. N. Popper 2006. Structure of the inner ear of bluefin tuna *Thunnus thynnus*. Journal of Fish Biology 68: 1767–1781.

Sonny D., F. R. Knudsen, P. S. Enger, T Kvernsuen, and O. Sand 2006. Reactions of cyprinids to infrasound in a lake and at the cooling water inlet of a nuclear power plant Journal of Fish Biology, 69(3): 735-748.

SPAWAR Systems Center San Diego (SPAWAR) 2006. Ex-oriskany Artificial Reef Project Ecological Risk Assessment. Final Report. Prepared for: Program Executive Office Ships (PMS 333) Prepared by: Marine Environmental Support Office SPAWAR Systems Center, San Diego. January 2006.

Stuhmiller, J. H., Y. Y. Phillips, and D. R. Richmong 1990. "The Physics and Mechanisms of Primary Blast Injury," in Textbook of Military Medicine. Part I. Warfare, Weapons, and the Casualty, Vol. 5:241-270, R. Zatchuck, D. P. Jenkins, R. F. Bellamy, and C. M. Quick (eds.), TMM Publications, Washington D.C.

Sverdrup, A., E. Kjellsby, P. G. Krüger, R. Fløysand, F. R. Knudsen, P. S. Enger, G. Serck-Hanssen, and K. B. Helle 1994. Effects of experimental seismic shock on vasoactivity of arteries, integrity of the vascular endothelium and on primary stress hormones of the Atlantic salmon. J. Fish Biol. 45: 973-995.

Swisdak Jr., M. M. and P. E. Montaro 1992. "Airblast and Fragmentation Hazards Produced by Underwater Explosions", NSWCDD/TR-92/196, Naval Surface Warfare Center (Code R15), Silver Spring, MD, p. 35.

Turnpenny, A. W. H., Thatcher, K. P., and J. R. Nedwell 1994. The Effects on Fish and Other Marine Animals of High-level Underwater Sound. Report FRR 127/94, Fawley Aquatic Research Laboratories, Ltd., Southampton, UK.

United Nations 1982. United Nations Convention on the Law of the Sea. 202p. http://www.un.org/Depts/los/convention_agreements/texts/unclos/unclos_e.pdf.

U.S. Navy 2007was. Whales and Sonar. http://www.whalesandsonar.navy.mil/.

United States Air Force (USAF) 1997. Environmental Effects of Self-protection Chaff and Flares. U.S. Air Force, Headquarters Air Combat Command. Air Force Base, Langley, VA. NTIS PB98-110620.

USAF 2002. Environmental Assessment for the West Coast Combat Search and Rescue (CSAR) Beddown.BEDDOWN. United States Air Force Headquarters Air Combat Command.

University of Maryland (UM) 2007. Fish Hearing. Laboratory of Bioacoustics. http://www.life.umd.edu/biology/popperlab/background/index.htm.

University of Rhode Island (URI) 2007. Animals and Sound in the Sea. Office of Marine Programs .http://omp.gso.uri.edu/work1/animals/intro.htm

University of South Florida (USF) 2007. Marine Animal Bioacoustics. College of Marine Science. http://www.marine.usf.edu/bio/fishlab/bioacoustics.htm.

Urick, R.J., 1983. Principles of Underwater Sound. McGraw-Hill Book Company.

URS Greiner Woodward Clyde 2000. Preliminary evaluation of ecological risks related to naval activities at the Atlantic Fleet Weapons Training Facility on Vieques, Puerto Rico. Prepared for U.S. Navy Litigation Office, Washington, D.C.

Wardle, C. S., T. J. Carter, G. G. Urquhart, A. D. F. Johnstone, A. M. Ziolkowski, G. Hampton, and D. Mackie 2001. Some effects of seismic air guns on marine fish. Cont. Shelf Res. 21(8-10):1005-1027.

Wiley, M. L., J. B. Gaspin, and J. F. Goertner 1981. Effects of underwater explosions on fish with a model to predict fish kill. Ocean Science and Engineering 6(2): 223-284.

Wilson, B. and M. Dill 2002. Pacific herring respond to simulated odontocete echolocation sounds. Can. J. Fish. Aquat. Sci. 59: 542-553.

Wilson, M., R. T. Hanlon, P. L. Tyack, and P. T. Madsen 2007. Intense ultrasonic clicks from echolocating toothed whales do not elicit anti-predator responses or debilitate the squid *Loligo pealeii*. Biology Letters 3:225-227.

Wright, D. G. 1982. A discussion paper on the effects of explosives on fish and marine mammals in the waters of the Northwest Territories. Canadian Technical Report of Fisheries and Aquatic Sciences 1052:1-16.

Wright, D. G., and G. E. Hopky 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. Can. Tech. Rep. Fish. Aquat. Sci. 2107: iv + 34p.

Wright, K. J., D. M. Higgs, A. J. Belanger, and J. M. Leis 2005. Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces:Pomacentridae). Marine Biology 147: 1425-1434.

Wysocki L. E. and F. Ladich 2005. Hearing in Fish Under Noise Conditions. Association for Research in Otolaryngology. 26p.

Wysocki, L.E., J. P. Dittami, and F. Ladich 2006. Ship noise and cortisol secretion in European freshwater fishes. Biological Conservation 128:501-508.

Yagla, J. J. 1986. “Far Propagation of Blast from the 16-in Naval Gun: Gun Blast and Bow Wave Data for Iowa and New Jersey”, Technical Report 86-191, Naval Surface Weapons Center, Silver Spring, MD.

Yagla, J. J. and R. L. Stiegler 2003. “Gun Blast Noise Transmission Across the Air-Sea Interface,” EuroNoise, 19-21 May, Naples, Italy.

Yelverton, J. T., D. R. Richmond, W. Hicks, K. Saunders, and E. R. Fletcher 1975. The Relationship Between Fish Size and Their Response to Underwater Blast. Report DNA 3677T. Director, Defense Nuclear Agency. Washington, DC. 39p.

Young, G. A. 1991. Concise methods for predicting the effects of underwater explosions on marine life. NAVSWC NO 91-220. Naval Surface Warfare Center. Silver Spring, MD.

Zelick, R., D. A. Mann, and A. N. Popper 1999. Acoustic communication in fishes and frogs. p. 363-411 In: R.R. Fay and A.N. Popper (eds.), Comparative Hearing: Fish and Amphibians. Springer Handbook of Auditory Research. Springer-Verlag New York Inc.

This Page Intentionally Left Blank

Appendix F

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 OVERVIEW AND TECHNICAL APPROACH

1.1 DATA SOURCES

The Marine Resource Assessment (MRA) for the Southern California Operating Area (DoN 2005) was used as a baseline for describing the physical, biological, marine, terrestrial, and cultural features particular to this region. The MRA was supplemented during the development of this EIS/OEIS to update information since the MRA was published in 2005. This supplementation included a detailed search of multiple peer-review scientific journals, and government reports. Several search engines were used in this process including *Science Direct*®, *High Wire Press*®, *Directory of Open Access Journals,* the *Journal of the Acoustical Society of America-Online (JASA-O).* *Science Direct*® databases provide access to more than 8 million articles in over 2,000 journals focused on the physical sciences and engineering, life sciences, health sciences, and social sciences and humanities. *High Wire Press*® offers access to nearly 4.3 million articles published by approximately 1,040 journals. Topics for journals in these databases include biological, social, medical, and physical sciences and the humanities. The *Directory of Open Access Journals* includes peer-reviewed scientific and scholarly publications that are available to the public free of charge. The searches of each database included general queries in the resource areas of and potential effects to marine species (marine mammals, sea turtles, fish, and birds), socioeconomics (fisheries, tourism, boating, and diving), natural resources (oil and gas), artificial reefs, whale and dolphin watching, and cultural resources. Finally, *JASA-O* offers search capabilities for and access to articles as early as 1929. Searches for articles available from this journal included focused information on hearing capabilities and potential effects on marine species such as marine mammals, sea turtles, manatees, fish, and diving birds. In addition to search engines and science information portals, a direct review was conducted of other journals that regularly publish marine mammal related articles (e.g., Marine Mammal Science, Canadian Journal of Zoology, Journal of Acoustical Society of America, Journal of Zoology, Aquatic Mammals). References were also obtained from previous environmental documents where applicable, and from mitigation and regional monitoring reports. The original reference authors were contacted directly if necessary to clarify particular points presented in a paper or gain additional insight into the data analysis.

1.2 DATA QUALITY AND AVAILABILITY

Recent advances in marine mammal tagging and tracking have contributed to the growth of biological information including at-sea movements and diving behavior. Given the development of this new technology and difficulties in placing tags on marine mammals in the wild, the body of literature and sample size, while growing, is still relatively small. For difficult to study marine mammals such as an audiogram from a single Gervais beaked whale stranded from natural causes (Cook et al. 2006), even a sample size of one contributes new information that had not been available previously. Addition information was also solicited from acknowledged experts within academic institutions and government agencies such as Southwest Fisheries Science Center, NMFS with expertise in marine mammal biology, distribution, and acoustics.

2 SOUTHERN CALIFORNIA MARINE MAMMALS

There are 41 marine mammal species or separate stocks with possible or confirmed occurrence in the SOCAL Range Complex. As shown in Table 2-1, there are 34 cetacean species (whales, dolphins, and porpoises), six pinnipeds (sea lions, fur seals and true seals) and one sea otter species.

2.1 SPECIES SUMMARIES AND LIFE HISTORY

The California Current passes through the SOCAL Range Complex, creating a mixing of temperate and tropical waters, and making this area one of the most productive ocean systems in the world (DoN 2002a). Because of this productive environment, there is a rich marine mammal fauna, as evidenced in abundance and species diversity (Leatherwood et al. 1988; Bonnell and Dailey 1993). In addition to many marine mammal species that live here year-round and use the region's coasts and islands for breeding and hauling out, there is a community of seasonal residents and migrants. The narrow continental shelf along the Pacific coast and the presence of the cold California Current sweeping down from Alaska allows cold-water marine mammal species to reach nearshore waters as far south as Baja California. The SCB is the major geological region occurring within the SOCAL Range Complex and can be described as a complex combination of islands, ridges, and basins that exhibit wide ranges in water temperature. San Diego Bay, a naturally-formed, crescent-shaped embayment is located along the southern end of the SCB (Largier 1995; DoN 2000); the bay provides habitat for a number of oceanic and estuarine species as the ebb and flood of tides within the Bay circulate and mix ocean and Bay waters, creating for distinct circulation zones within San Diego Bay (see Chapter 2 for further detail regarding these zones) (Largier et al. 1996; DoN 2000).

Forty-one marine mammal species or populations/stocks have confirmed or possible occurrence in the study area off southern California, including 34 cetacean (whales, dolphins, and porpoises), six pinniped (seals, sea lions, and fur seals), and one fissiped species (the sea otter) (Table 2-1). Information on marine mammal occurrence at the Point Mugu Sea Range (just to the north of the SOCAL Range Complex) is analyzed in Koski et al. (1998). Temperate and warm-water toothed whales often change their distribution and abundance as oceanographic conditions vary both seasonally (Forney and Barlow 1998) and interannually (Forney 2000). Forney and Barlow (1998) noted significant north/south shifts in distribution for Dall's porpoises, common dolphins, and Pacific white-sided dolphins, and they identified significant inshore/offshore differences for northern right whale dolphins and humpback whales. Several authors have noted the impact of the El Niño events of 1982/1983 and 1997/1998 on marine mammal occurrence patterns and population dynamics in the waters off California (Wells et al. 1990; Forney and Barlow 1998; Benson et al. 2002).

This Page Intentionally Left Blank

Table 2-1. Summary of the Abundance, ESA/MMPA Status, Population Trend, Seasonal Occurrence of Marine Mammal Species Found In Southern California Waters.

Common Name Species Name	Abundance (CV)	Stock	Southern California Abundance	ESA/ MMPA Status	Annual Population Trend	Occurrence	Warm Season May-Sep	Cold Season Nov-Apr
ESA Listed Species								
Blue whale *Balaenoptera musculus*	1,744 (0.28)	Eastern North Pacific	842 (0.20)	E, D, S	May be increasing	Seasonal; Arrive Apr-May; more common late summer to fall	YES	NO
Fin whale *Balaenoptera physalus*	2,099 (0.18)	California, Oregon, & Washington	359 (0.40)	E, D, S	May be increasing	Year round species; small population	YES MORE	YES LESS
Humpback whale *Megaptera novaeangliae*	1,391 (0.22)	California, Oregon, & Washington	36 (051)	E, D, S	Increasing 6-7%	Seasonal; More sightings around the northern Channel Islands	YES	NO
North Pacific right whale *Eubalaena japonica*	Unknown	Eastern North Pacific	Unknown	E, D, S	Unknown	Very rare: Rare throughout the Pacific; only 12 sightings in California since 1900	RARE	RARE
Sei whale *Balaenoptera borealis*	56 (0.61)	Eastern North Pacific	0 (7 Bryde's or Sei Whales)[3]	E, D, S	May be increasing	Rare; Less than three sightings within the last 30 years	UNK	UNK
Sperm whale *Physeter macrocephalus*	1,934 (0.31)	California, Oregon, & Washington	607 (0.57)	E, D, S	Unknown	Common year round; More likely in waters > 1000 m, most often > 2000 m	YES MORE	YES LESS
Guadalupe fur seal *Arctocephalus townsendi*	7,408	Mexico		T, D, S	Increasing 13.7%	Rare; Occasional visitor to northern Channel Islands; mainly breeds on Guadalupe Is., Mexico, May-Jul	UNK	UNK
Steller sea lion *Eumetopias jubatus*	6,555	California, Oregon, & Washington		T, D	Decreasing	Very rare; Summer distribution north of 36°N; last seen in northern Channel Islands in 1998	NO	NO
Southern Sea Otter *Enhydra lutris*	2,359	California	~29 (from ground surveys)	T, D (Only north of Pt. Conception)	Increasing	Main distribution just north of the SOCAL OPAREAs; translocated population of approximately 29 animals at San Nicolas Island is an experimental population and is not considered endangered	YES	YES

Common Name Species Name	Abundance (CV)	Stock	Southern California Abundance	ESA & MMPA Status	Annual Population Trend	Occurrence	Warm Season May-Oct	Cold Season Nov-Apr
Mysticetes								
Bryde's whale *Balaenoptera edeni*	12 (2.0)	Eastern Tropical Pacific	0 (7 Bryde's or Sei Whales)[3]		Unknown	Rare; Only one confirmed sighting in California	UNK	UNK
Gray whale *Eschrichtius robustus*	26,635 (0.10)	Eastern North Pacific	Population migrate through SOCAL		Increasing ~ 2.5%	Transient during seasonal migrations		
Minke whale *Balaenoptera acutorostrata*	823 (0.56)	California, Oregon, & Washington	226 (1.02)		No Trends	Less common in summer; small numbers around northern Channel Islands	NO	YES
Odontocetes								
Baird's beaked whale *Berardius bairdii*	1,005 (0.37)	California, Oregon, & Washington	127 (1.14)		Unknown	Rare	UNK	UNK
Bottlenose dolphin coastal *Tursiops truncatus*	323 (012)	California Coastal	323 (0.12)		Stable	Limited, small population within one km of shore	YES	YES
Bottlenose dolphin offshore *Tursiops truncatus*	2,026 (0.54)	California Offshore	1,831 (0.47)		No Trend	Common	YES	YES
Cuvier's beaked whale *Ziphius cavirostris*	4,342 (0.58)	California, Oregon, & Washington	911 (0.68)		Unknown	Uncommon; seaward of 1000 m; only limited sightings in winter	YES	UNK
Dall's porpoise *Phocoenoides dalli*	85,955 (0.45)	California, Oregon, & Washington	727 (0.99)		Unknown	Common; year round cool water species; more abundant Nov-Apr	NO	YES
Dwarf sperm whale *Kogia sima*	Unknown	California, Oregon, & Washington	0		Unknown	Possible visitor; seaward of 500-1000 m; limited sightings over entire SCB	UNK	YES LESS
False killer whale *Pseudorca crassidens*	Unknown Rare	Eastern Tropical Pacific	Unknown		Unknown	Uncommon; warm water species; although stranding records from the Channel Islands	UNK	UNK
Killer whale offshore *Orcinus orca*	1,340 (0.31)	Eastern North Pacific	30 (0.73)		Unknown	Uncommon; occurs infrequently; more likely in winter	NO	YES

Common Name Species Name	Abundance (CV)	Stock	Southern California Abundance	ESA & MMPA Status	Annual Population Trend	Occurrence	Warm Season May-Oct	Cold Season Nov-Apr
Killer whale transient *Orcinus orca*	346	Eastern North Pacific	Unknown		Unknown	Uncommon; occurs infrequently; more likely in winter	NO	YES
Long-beaked common dolphin *Delphinus capensis*	21,902 (0.50)	California	17,530 (0.57)	S	Varies by oceanographic conditions	Common; more inshore distribution	YES	YES
Mesoplodont beaked whales[4] *Mesoplodon spp.*	1,177 (0.40)	California, Oregon, & Washington	132 (0.96)		Unknown	Rare; seaward of 500-1000 m; limited sightings	UNK	UNK
Northern right whale dolphin *Lissodelphis borealis*	11,097 (0.26)	California, Oregon, & Washington	1,172 (0.52)		No Trend	Common; cool water species; more abundant Nov-Apr		
Pacific white-sided dolphin *Lagenorhynchus obliguidens*	23,817 (0.36)	California, Oregon, & Washington	2,196 (0.71)		No Trend	Common; year round cool water species; more abundant Nov-Apr	YES LESS	YES MORE
Pantropical spotted dolphin *Stenella attenuate*	Unknown	Eastern Tropical Pacific	Unknown		Unknown	Rare	UNK	UNK
Pygmy sperm whale *Kogia breviceps*	247 (1.06)	California, Oregon, & Washington	0		Unknown	Rare; seaward of 500-1000 m; limited sightings over entire SCB	UNK	UNK
Risso's Dolphin *Grampus griseus*	11,910 (0.24)	California, Oregon, & Washington	3,418 (0.31)		No Trend	Common; present in summer, but higher densities Nov-Apr	YES LESS	YES MORE
Rough-toothed dolphin *Steno bredanensis*	Unknown	Tropical and warm temperate	Unknown		Unknown	Rare; more tropical offshore species	RARE	RARE
Short-beaked common dolphin *Delphinus delphis*	352,069 (0.18)	California, Oregon, & Washington	165,400 (0.19)		Varies by oceanographic conditions	Common; one of the most abundant SOCAL dolphins; higher summer densities	YES MORE	YES LESS
Short-finned pilot whale *Globicephala macrorhynchus*	350 (0.48)	California, Oregon, & Washington	118 (1.04)		Unknown	Uncommon; more common before 1982	UNK	UNK

Common Name Species Name	Abundance[1] (CV)	Stock[1]	Southern California Abundance	ESA & MMPA Status	Annual Population Trend	Occurrence	Warm Season May-Oct	Cold Season Nov-Apr
Spinner dolphin *Stenella longirostris*	2,805 (0.66)	Tropical and warm temperate	Unknown		Unknown	Rare	RARE	RARE
Striped dolphin *Stenella coeruleoalba*	18,976 (0.28)	California, Oregon, & Washington	12,529 (0.28)		No Trend	Occasional visitor; cool water oceanic species	NO	RARE
Pinniped								
Harbor seal *Phoca vitulina*	34,233	California	5,271 (All age classes from aerial counts)[5]		Stabilizing	Common; Channel Islands haul-outs including SCI	YES	YES
Northern elephant seal *Mirounga angustirostris*	101,000	California Breeding	SNI 9,794 pups in 2000. SCI up to 16 through 2000 [6]		Increasing < 8,3%	Common; Channel Island haul-outs of different age classes; including SCI Dec-Mar and Apr-Aug; spend 8-10 months at sea	YES	YES
California sea lion *Zalophus californianus*	237,000	U.S. Stock	All pupping occurs in Southern California		Increasing 6.1%	Common; most common pinniped, Channel Islands breeding sites in summer	YES	YES
Northern fur seal *Callorhinus ursinus*	9,424	San Miguel Island	San Miguel Is. is within Southern California but is outside of the SOCAL Range Complex		Increasing 8.6%	Common; small population that breeds on San Miguel Is. May-Oct	YES MORE	YES LESS

[1]Stock or population abundance estimates and correlation of variance (CV) status under the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA), and the population trend are from NMFS 2006 Pacific Stock Assessment Reports (SAR) (Carretta et al., 2007; Angliss and Outlaw, 2007; Barlow and Forney, 2007), **E**=Endangered under the ESA; **D** = Depleted under the MMPA; and **S**=Strategic Stock under the MMPA. Due to lack of information, several beaked whale species have been grouped together under Mesoplodont by the National Marine Fisheries Service.

[2] Sources used to define trend are Carretta et al. (2007), Angliss and Outlaw (2007) and NMFS (2006e)

[3] Seven whales were identified as either Bryde's or Sei whales but could not be identified to the species level

4 Mesoplodont whales includes five species of *Mesoplodon* spp. that are not easily identifiable in the field.

[5] Lowry and Carretta (2003)[6] Lowry (2002)

Southern California abundance is from Point Conception to the US-Mexican border

2.1.1 Federally Designated Threatened and Endangered Species

There are nine marine mammal species within Southern California marine waters listed as endangered under the Endangered Species Act (ESA) with confirmed or historic occurrence in the study area. These include the blue whale, fin whale, humpback whale, North Pacific right whale, sei whale, sperm whale, Guadalupe fur seal, Steller sea lion, and southern sea otter.

2.1.1.1 Listed Marine Mammal Species in the Action Area But Excluded

Killer whale, Southern Resident Stock-(*Orcinus orca*) The Southern Resident stock of killer whale is not likely to be present within Southern California. Of the three stocks of killer whales that may be found in the action area, Eastern North Pacific (ENP) Southern Residents, ENP Offshores, and ENP transients, only the ENP Southern Resident stock is listed as endangered under the ESA. This stock is most commonly seen in the inland waters of Washington state and southern Vancouver Island; however, individuals from this stock have been observed in Monterey Bay, California in January, 2000 and March, 2003, near the Farallon Islands in February 2005 and off Point Reyes in January 2006 (Pacific Fishery Management Council (PFMC) and NMFS 2006). Although one killer whale from the non-ESA listed ENP Transient Stock was observed taken in the California/Oregon drift gillnet fishery in 1995 (Carretta et al. 2006), no ENP resident killer whales have been observed taken in any California-based fisheries. Based on the above known information, there is a very low likelihood of Southern Resident killer whales being present in the action area, so this species will not be considered in greater detail in the remainder this analysis.

North Pacific right whale-(*Eubalaena japonica*) The likelihood of a North Pacific right whale being present in the action area is extremely low. It may be the most endangered of the large whale species (Perry et al. 1999), and currently, there is no reliable population estimate, although the population in the eastern North Pacific Ocean is considered to be very small, perhaps in the tens to low hundreds of animals. Despite many years of systematic aerial and ship-based surveys for marine mammals off the western coast of the U.S., only seven documented sightings of right whales were made from 1990 through 2000 (Waite et al. 2003). Based on this information, it is highly unlikely for this species to be present in the action area, so consequently, this species will not be considered in greater detail in the remainder of this analysis.

Steller sea lion (***Eumetopias jubatus***) Eastern Distinct Population Segment- Steller sea lions are also not expected to be present in the action area. Steller sea lions range along the North Pacific Rim from northern Japan to California (Loughlin et al. 1984), with centers of abundance and distribution in the Gulf of Alaska and Aleutian Islands, respectively. In U.S. waters, there are two separate stocks of Steller sea lions: an eastern U.S. stock, which includes animals east of Cape Suckling, Alaska (144oW longitude), and a western U.S. stock, which includes animals at and west of Cape Suckling (Loughlin 1997). The closest rookery to the action area is Año Nuevo Island, which declined by 85% between 1970 and 1987 (LeBoeuf et al. 1991). Pup counts at this location have declined steadily at approximately 5% annually since 1990 (Angliss and Lodge 2004). Steller sea lions are rarely sighted in Southern California waters and have not been documented interacting with southern California fisheries in over a decade. The last documented interaction with California-based fisheries was in northern California, in 1994, with the California/Oregon drift gillnet fishery (NMFS 2000). The last sighting of a Steller sea lion (a sub adult male) on the Channel Islands was in 1998 (Thorson et al. 1998). For the reasons listed above, Steller sea lions are not likely to be present in the action area, consequently, this species will not be considered in greater detail in the remainder of this analysis.

2.1.1.2 Listed Marine Mammal Species in the Action Area and Included

The ESA-listed blue whale, fin whale, humpback whale, and sperm whale are expected to regularly occur in Southern California and each species is described below. The sei whale is a rare and infrequently sighted species, but is also included in this analysis as a conservative conservation approach. Information on at sea density estimates and dive depth distribution provided for each species are used in the acoustic exposure analysis.

Blue whale (*Balaenoptera musculus*) Eastern North Pacific Stock

Listing Status—In the North Pacific, the IWC began management of commercial whaling for blue whales in 1969; blue whales were fully protected from commercial whaling in 1976 (Allen 1980). Blue whales were listed as endangered under the ESA in 1973, therefore the California/Oregon/Washington Stock is, considered depleted and strategic under the MMPA They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the Marine Mammal Protection Act of 1972. Blue whales are listed as endangered on the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). Critical habitat has not been designated for blue whales.

Population Status- The blue whale was severely depleted by commercial whaling in the twentieth century (NMFS 1998). In the North Pacific, pre-exploitation population size is speculated to be approximately 4,900 blue whales and the current population estimate is a minimum of 3,300 blue whales (Wade and Gerrodette 1993, NMFS 2006e). Blue whale population structure in the North Pacific remains uncertain, but two stocks are recognized within U.S. waters: the Hawaiian and the eastern North Pacific (NMFS 2006e). There is no clear information on the population trend of blue whales off California. Population estimate for this stock of blue whales is 1,744 (CV =0.28) individuals (Carretta et al. 2007).

A clear population trend for blue whales is difficult to detect under current survey methods. An increasing trend between 1979/80 and 1991 and between 1991 and 1996 was suggested by available survey data, but it was not statistically significant (Carretta et al. 2006). The abundance of blue whales along the California coast has clearly been increasing during the past two decades (Calambokidis et al. 1990; Barlow 1994; Calambokidis 1995). The magnitude of this increase is considered too large to be explained by population growth alone, and it is therefore assumed that a shift in distribution may have occurred (NMFS 1998). However, the scarcity of blue whales in areas of former abundance (e.g., Gulf of Alaska near the Aleutian Islands) suggests that the increasing trend does not apply to the species' entire range in the eastern North Pacific (Calambokidis et al. 1990). Although the population in the North Pacific is expected to have grown since being given protected status in 1966, the possibility of continued unauthorized takes by Soviet whaling vessels after blue whales were protected in 1966 (Yablokov 1994) and the existence of incidental ship strikes and gillnet mortality makes this uncertain.

Distribution—The blue whale has a worldwide distribution in circumpolar and temperate waters. Blue whales undertake seasonal migrations and were historically hunted on their summer, feeding areas. It is assumed that blue whale distribution is governed largely by food requirements and that populations are seasonally migratory. Poleward movements in spring allow the whales to take advantage of high zooplankton production in summer. Movement toward the subtropics in the fall allows blue whales to reduce their energy expenditure while fasting, avoid ice entrapment in some areas, and engage in reproductive activities in warmer waters of lower latitudes (~30º N or S). For example, blue whales were taken off the west coast of Baja California as early as the mid-19th century (Scammon 1874). The timing varied, but whalers located few blue whales in wintering areas from December to February. Observations made after whaling was banned revealed a similar pattern: blue whales spend most of the summer foraging at higher latitudes (where the waters are more productive (Sears 1990; Calambokidis et al. 1990; Calambokidis 1995).

The eastern North Pacific stock feeds in waters from California to Alaska in summer and fall, and migrates south to waters from Mexico to Costa Rica in winter (NMFS 2006e). They are fairly widespread and unpredictable in their areas of concentration from August to November. Some of the whales that spend the summer and fall (August-October) off the California coast migrate to Mexican waters, where they have been re-identified by photographs in spring (March-April) (Calambokidis et al. 1990). The population that uses coastal waters of California is present there primarily from June to November, with a peak in blue whale calling intensity observed in September (Burtenshaw et al. 2004). Foraging areas include the edges of continental shelves and upwelling regions (Reilly and Thayer 1990; Schoenherr 1991). Feeding grounds have been identified in coastal upwelling zones off the coast of California (Croll et al. 1998; Fiedler et al.. 1998; Burtenshaw et al. 2004), Baja California (Reilly and Thayer 1990). Blue whales are found around the Northern Channel Islands, Santa Rosa and San Miguel Islands, from summer through the fall where currents provide dense layers of euphausiids for them to feed on. This population is thought to inhabit waters off Central America from December to May (Calambokidis 1995). During the cold-water months, very few blue whales are present in waters off California (Forney and Barlow 1998; Larkman and Veit 1998; U.S. Navy 1998). These seasonal movement patterns are thought to coincide with productivity, particularly abundance of euphausiids which are the main food source of blue whales.

Blue whales are not expected to be in the SOCAL Range Complex from December through May (Calambokidis 1995; Burtenshaw et al. 2004). Ingebrigtsen (1929) reported that blue whales appeared off the Baja California coast “from the north” in October and traveled southward along the shore, returning in April, May, and June. Recently, some blue whales have been seen along the west coast of Baja California between March and July (Gendron and Zavala-Hernandez 1995). They are first observed in Monterey Bay, around the Channel Islands, and in the Gulf of the Farallons in June and July (Calambokidis et al. 1990; Calambokidis 1995). In addition, the strongest seasonal acoustic signal off of San Nicolas Island in California, from June through January, is due to blue whales singing (Burtenshaw et al. 2004), which appears primarily as a broad peak near 20 Hz in the spectral data (McDonald et al. 2006). Blue whales are commonly seen around the Channel Islands during the late spring and summer and primarily occur in the northeastern portion of the SOCAL OPAREAs. Calambokidis (1995) concluded that such changes in distribution reflect a shift in feeding from the more offshore euphausiid, *Euphasia pacifica*, to the primarily neritic euphausiid, *Thysanoessa spinifera*. Recent studies in the coastal waters of California have found blue whales feed primarily on the latter (Schoenherr 1991; Kieckhefer et al. 1995; Fiedler et al. 1998).

A few blue whales were observed in or near the SOCAL Range Complex in early to mid spring (U.S. Navy 1998), but were most common during July–September (Hill and Barlow 1992; Mangels and Gerrodette 1994; Teranishi et al. 1997; Larkman and Veit 1998; U.S. Navy 1998). During the SWFSC/NMFS surveys in 1998–1999, blue whales arrived in late May and were common into August, with one whale seen as late as November (Carretta et al. 2000). In other years, blue whales were common in waters west of San Clemente Island as late as mid-October (e.g., in 1995) (Spikes and Clark 1996; Clark and Fristrup 1997; Clark et al. 1998).

Photographic studies have proven that blue whales remain in waters off California throughout the summer, apparently to feed (Calambokidis 1995; Larkman and Veit 1998). Over 100 blue whales were present in the Santa Barbara Channel in 1992 and 1994 (Calambokidis 1995).Concentrations of blue whales have been seen elsewhere off southern California in some years.

At Sea Density Estimates—The most recent vessel survey took place from August to December 2005 during CSCAPE. Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0041222 for both warm and cold water seasons (Barlow 2007; Table 2-2).

Reproduction/Breeding—The eastern North Pacific stock feeds in waters from California to Alaska in summer and fall, migrates south to the waters of Mexico to Costa Rica in winter (NMFS 2006e) for breeding and to give birth (Mate et al.1999).

Diving Behavior—Blue whales spend more than 94 percent of their time below the water's surface (Lagerquist et al. 2000). Croll et al. (2001) determined that blue whales dived to an average of 462 ft. and for 7.8 minutes (min) when foraging and to 222 ft. and for 4.9 min when not foraging. Data from southern California and Mexico showed that whales dived to >100 m for foraging; once at depth, vertical lunge-feeding often occurred (lunging after prey). Lunge-feeding at depth is energetically expensive and likely limits the deeper diving capability of blue whales. Foraging dives are deeper than traveling dives; traveling dives were generally to ~ 30m. Typical dive shape is somewhat V-shaped, although the bottom of the V is wide to account for the vertical lunges at bottom of dive. Blue whales also have shallower foraging dives. Calambokidis et al. (2003) deployed tags on blue whales and collected data on dives as deep as about 984 ft. Lunge-feeding at depth is energetically expensive and likely limits the deeper diving capability of blue whales. Foraging dives are deeper than traveling dives; traveling dives were generally to ~ 30m. Typical dive shape is somewhat V-shaped, although the bottom of the V is wide to account for the vertical lunges at bottom of dive. Blue whales also have shallower foraging dives. Best information for percentage of time at depth is from Lagerquist et al (2000) collected on blue whales off central California: 78% in 0-16 m, 9% in 17-32 m, 13% in >32 m.

Acoustics—Blue whales produce calls with the lowest frequency and highest source levels of all cetaceans.). Blue whale vocalizations are long, patterned low-frequency sounds with durations up to 36 sec (Richardson et al. 1995) repeated every 1 to 2 min (Mellinger and Clark 2003). The frequency range of their vocalizations is 12 to 400 hertz (Hz), with dominant energy in the infrasonic range at 12 to 25 Hz (Ketten 1998; Mellinger and Clark 2003). Source levels are up to 188 decibels (dB) re 1 µPa-m (Ketten 1998; McDonald et al, 2001). During the Magellan II Sea Test (at-sea exercises designed to test systems for antisubmarine warfare), off the coast of California in 1994, blue whale vocalization source levels at 17 Hz were estimated in the range of 195 dB re 1 µPa-m (Aburto et al. 1997). Širović et al. (2007) reported that blue whales produced vocalizations with a source level of 189 ± 3 dB re:1 Pa-1 m over a range of 25–29 Hz and could be detected up to 200 km away. A comparison of recordings between November 2003 and November 1964 and 1965, reveals a strong blue whale presence near San Nicolas Island (McDonald et al. 2006). A long-term shift in the frequency of the blue whale calling is seen; in 2003 the spectral energy peak was 16 Hz, whereas in 1964-65 the energy peak was near 22.5 Hz, illustrating a more than 30% shift in call frequency over four decades (McDonald et al. 2006).

Vocalizations of blue whales appear to vary among geographic areas (Rivers 1997), with clear differences in call structure suggestive of separate populations for the western and eastern regions of the North Pacific (Stafford et al. 2001). Stafford et al. (2005) recorded the highest calling rates when blue whale prey was closest to the surface during its vertical migration. Wiggins et al. (2005) reported the same trend of reduced vocalization during daytime foraging and then an increase in vocalizations at dusk as prey move up into the water column and disperse. Blue whales make seasonal migrations to areas of high productivity to feed and vocalize less in the feeding grounds than during the migration (Burtenshaw et al. 2004). Oleson et al. (2007) reported higher calling rates in shallow diving (<100 ft) whales while deeper diving whales (> 165 ft) were likely feeding and calling less.

As with other mysticete sounds, the function of vocalizations produced by blue whales is unknown. Hypothesized functions include: (1) maintenance of inter-individual distance, (2) species and individual recognition, (3) contextual information transmission (e.g. feeding, alarm, courtship), (4) maintenance of social organization (e.g. contact calls between females and offspring), (5) location of topographic features, and (6) location of prey resources (Thompson et al. 1992). Responses to conspecific sounds have been demonstrated in a number of mysticetes (Edds-Walton 1997), and there is no reason to believe that blue whales do not communicate similarly. While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing. Although no recent studies have directly measured the sound sensitivity in blue whales, we assume that blue whales are able to receive sound signals in roughly the same frequencies as the signals they produce.

Impacts of human activity—Historic Whaling**-** Blue whales were occasionally hunted by the sailing-vessel whalers of the 19th century (Scammon 1874). The introduction of steam power in the second half of that century made it possible for boats to overtake large, fast-swimming blue whales and other rorquals. From the turn of the century until the mid-1960s, blue whales from various stocks were intensely hunted in all the world's oceans. Blue whales were protected in portions of the Southern Hemisphere beginning in 1939, but were not fully protected in the Antarctic until 1965. In 1955, they were given complete protection in the North Atlantic under the International Convention for the Regulation of Whaling; this protection was extended to the Antarctic in 1965 and the North Pacific in 1966 (Gambell 1979; Best 1993). The protected status of North Atlantic blue whales was not recognized by Iceland until 1960 (Sigurjonsson 1988). Only a few illegal kills of blue whales have been documented in the Northern Hemisphere, including three at Canadian east-coast whaling stations during 1966-69 (Mitchell 1974), some at shore stations in Spain during the late 1950s to early 1970s (Aguilar and Lens 1981; Sanpera and Aguilar 1992), and at least two by "pirate" whalers in the eastern North Atlantic in 1978 (Best 1992). Some illegal whaling by the USSR also occurred in the North Pacific (Yablokov 1994); it is likely that blue whales were among the species taken by these operations, but the extent of the catches is not known. Since gaining complete legal protection from commercial whaling in 1966, some populations have shown signs of recovery, while others have not been adequately monitored to determine their status (NMFS 1998). Removal of this significant threat has allowed increased recruitment in the population, and therefore, the blue whale population in the eastern North Pacific is expected to have grown.

Fisheries Interactions—Because little evidence of entanglement in fishing gear exists, and large whales such as the blue whale may often die later and drift far enough not to strand on land after such incidents, it is difficult to estimate the numbers of blue whales killed and injured by gear entanglements. In addition, the injury or mortality of large whales due to interactions or entanglements in fisheries may go unobserved because large whales swim away with a portion of the net or gear. Fishers have reported that large whales tend to swim through their nets without entangling and causing little damage to nets (Barlow et al. 1997).

Ship Strikes-Because little evidence of ship strikes exists, and large whales such as the blue whale may often die later and drift far enough not to strand on land after such incidents, it is difficult to estimate the numbers of blue whales killed and injured by ship strikes. In addition, a boat owner may be unaware of the strike when it happens. Ship strikes were implicated in the deaths of blue whales in 1980, 1986, 1987, 1993, and 2002 (Carretta et al. 2006). Additional mortality from ship strikes probably goes unreported because the whales do not strand, or if they do, they do not always have obvious signs of trauma (Carretta et al. 2006). However, several blue whales have been photographed in California with large gashes in their dorsal surface that appear to be from ship strikes (Carretta et al. 2006). According to the California Marine Mammal Stranding Network Database (2006), six blue whales were struck by ships off of California from 1982-2005. The average number of blue whale mortalities in California attributed to ship strikes was 0.2 whales per year for 1998-2002 (Carretta et al. 2006). In addition, there were 9 unidentified whales and one unidentified balaenopterid struck by ships in California from 1982-2005

(California Marine Mammal Stranding Network Database 2006). Of these 10 animals, five were reported by the Navy as being struck offshore of the Channel Islands (e.g., San Nicholas and San Clemente Islands).

Some whale watching focused on blue whales has developed in recent years off the coast of California, notably in the Santa Barbara Channel, where the species occur with regularity in July and August. Major shipping lanes pass through, or near, whale watching areas, and underwater noise by commercial ship traffic may have a much greater impact than that produced by whale watching. However, little is known about whether, or how, vessel noise affects blue whales.

Fin whale (Balaenoptera physalus) California/Oregon/Washington Stock

Listing—In the North Pacific, the IWC began management of commercial whaling for fin whales in 1969; fin whales were fully protected from commercial whaling in 1976 (Allen 1980). Fin whales were listed as endangered under the ESA in 1973. Since the fin whale is listed as endangered under the ESA, the California/Oregon/Washington Stock is, therefore, considered depleted and strategic under the MMPA. They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the Marine Mammal Protection Act of 1972. Fin whales are listed as endangered on the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). Critical habitat has not been designated for fin whales.

Population Status—In the North Pacific, the total pre-exploitation population size of fin whales is estimated at 42,000 to 45,000 whales (Ohsumi and Wada 1974). The most recent abundance estimate (early 1970s) for fin whales in the entire North Pacific basin is between 14,620 and 18,630 whales (NMFS 2006e). Fin whales have a worldwide distribution with two distinct stocks recognized in the North Pacific: the East China Sea Stock and “the rest of the North Pacific Stock” (Donovan 1991). Currently, there are considered to be three stocks in the North Pacific for management purposes: an Alaska Stock, a Hawaii Stock, and a California/Oregon/Washington Stock (Barlow et al. 1997). Currently, the best estimate for the California/Oregon/Washington Stock is 2,099 (CV = 0.18) individuals (Barlow and Forney 2007).

During the early 1970s, 8,520 to 10,970 fin whales were surveyed in the eastern half of the North Pacific (Braham 1991). Moore et al. (2000) conducted surveys for whales in the central Bering Sea in 1999 and tentatively estimated the fin whale population was about 4,951 animals (95% C.I. 2,833-8,653). If these historic estimates are statistically reliable, the population size of fin whales has not increased significantly over the past 20 years despite an international ban on whaling in the North Pacific. The strongest contrary evidence comes from investigators conducting seabird surveys around the Pribilof Islands in 1975-1978 and 1987-1989. These investigators observed more fin whales in the second survey and suggested they were more abundant in the survey area (Baretta and Hunt 1994). However, observations of increased counts of fin whales in an area do not support a conclusion that there are more fin whales until changes in distribution have been ruled out first.

Distribution—Fin whales occur in oceans of both Northern and Southern Hemispheres between 20–75° N and S latitudes (NMFS 2006e). Fin whales are distributed widely in the world’s oceans. In the northern hemisphere, most migrate seasonally from high Arctic feeding areas in summer to low latitude (~30º N or S) breeding and calving areas in winter. During the summer in the North Pacific Ocean, fin whales are distributed in the Chukchi Sea, around the Aleutian Islands, the Gulf of Alaska, and along the coast of North America to CaliforniaWorldwide, fin whales were severely depleted by commercial whaling activities. The fin whale is found in continental shelf and oceanic waters (Gregr and Trites 2001; Reeves et al. 2002). Globally, it tends to be aggregated in locations where populations of prey are most plentiful, irrespective of water depth, although those locations may shift seasonally or annually (Payne et al. 1986, 1990;

Kenney et al. 1997; Notarbartolo-di-Sciara et al. 2003). Fin whales in the North Pacific spend the summer feeding along the cold eastern boundary currents (Perry et al. 1999).

The North Pacific population summers from the Chukchi Sea to California, and winters from California southward (Gambell 1985). Aggregations of fin whales are found year-round off southern and central California (Dohl et al. 1983; Forney et al. 1995; Barlow 1997). In the NMFS 1998–1999 surveys in SCIRC, they were sighted most frequently during warm-water months (Carretta et al. 2000). The fin whale was the second most commonly-encountered baleen whale (after gray whales) during those surveys; there were 21 sightings, with most sightings on the western side of San Clemente Island. Fin whales can be found in the SOCAL OPAREAs throughout the year (Barlow 1997).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0024267 for warm water seasons and 0.0008008 for cold water season (Barlow 2007;Table 2-2).

Life history information—Fin whales become sexually mature between six to ten years of age, depending on density-dependent factors (Gambell 1985b). Reproductive activities for fin whales occur primarily in the winter. Gestation lasts about 12 months and nursing occurs for 6 to 11 months (Perry et al. 1999). The age distribution of fin whales in the North Pacific is unknown. Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggest annual natural mortality rates may range from 0.04 to 0.06 (based on studies of northeast Atlantic fin whales). The occurrence of the nematode Crassicauda boopis appears to increase the potential for kidney failure in fin whales and may be preventing some fin whale stocks from recovering from whaling (Lambertsen 1992, as cited in Perry et al. 1999). Killer whale or shark attacks may result in serious injury or death in very young and sick whales (Perry et al. 1999). NMFS has no records of fin whales being killed or injured by commercial fisheries operating in the North Pacific (Ferrero et al. 2000). Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggest annual natural mortality rates may range from 0.04 to 0.06 (based on studies of northeast Atlantic fin whales). The occurrence of the nematode. *Crassicauda boopis*, appears to increase the potential for kidney failure in fin whales and may be preventing some fin whale stocks from recovering from whaling (Lambertsen 1992, as cited in Perry et al. 1999). Killer whale or shark attacks may result in serious injury or death in very young and sick whales (Perry et al. 1999). NMFS has no records of fin whales being killed or injured by commercial fisheries operating in the North Pacific (Ferrero et al. 2000).

Reproduction/Breeding—Reproductive activities for fin whales occur primarily in low latitude areas (~30º N or S)in the winter (Reeves 1998; Carretta et al. 2007).

Diving Behavior—Fin whales typically dive for 5 to 15 min, separated by sequences of 4 to 5 blows at 10 to 20 sec intervals (Cetacean and Turtle Assessment Program 1982; Stone et al. 1992; Lafortuna et al. 2003). Kopelman and Sadove (1995) found significant differences in blow intervals, dive times, and blows per hour between surface feeding and non-surface-feeding fin whales. Croll et al. (2001) determined that fin whales dived to 321 ft (Standard Deviation [SD] = ± 106.8 ft) with a duration of 6.3 min (SD = ± 1.53 min) when foraging and to 168 ft (SD = ± 97.3 ft) with a duration of 4.2 min (SD = ± 1.67 min) when not foraging. Goldbogen et al. (2006) reported that fin whales in California made foraging dives to a maximum of 748-889 ft and dive durations of 6.2-7.0 min. Fin whale dives exceeding 492 ft and coinciding with the diel migration of krill were reported by Panigada et al. (1999). Fin whales feed on planktonic crustaceans, including *Thysanoessa* sp and *Calanus* sp, as well as schooling fish including herring, capelin and mackerel (Aguilar 2002). Depth distribution data from the Ligurian Sea in the Mediterranean are the most complete (Panigada et al. 2003), and showed differences between day and night diving; daytime dives were shallower (<100m) and night dives were deeper (>400m), likely taking advantage of nocturnal prey migrations into shallower depths; this data may be atypical of fin whales elsewhere in areas where they do not feed on vertically-migrating prey.

Goldbogen et al. (2006) studied fin whales in southern California and found that 60% of total time was spent diving, with the other 40% near surface (<50m); dives were to >225 m and were characterized by rapid gliding ascent, foraging lunges near the bottom of dive, and rapid ascent with flukes. Dives were somewhat V-shaped although the bottom of the V is wide. Based on information from Goldbogen et al. (2006), percentage of time at depth levels is estimated as 44% at <50m, 23% at 50-225 m (covering the ascent and descent times) and 33% at >225 m.

Acoustics—Underwater sounds produced by fin whales are one of the most studied Balaenoptera sounds. Fin whales produce calls with the lowest frequency and highest source levels of all cetaceans. Infrasonic (10-200 Hz), pattern sounds have been documented for fin whales (Watkins et al. 1987; Clark and Fristrup 1997; McDonald and Fox 1999). ; Charif et al. 2002). Charif et al. (2002) estimated source levels between 159-184 dB *re*:1 µPa-1 m for fin whales vocalizations recorded between Oregon and Northern California. Fin whales can also produce a variety of sounds with a frequency range up to 750 Hz. The long, patterned 15 to 30 Hz vocal sequence is most typically recorded; only males are known to produce these (Croll et al. 2002). The most typical signals are long, patterned sequences of short duration (0.5-2s) infrasonic pulses in the 18-35 Hz range (Patterson and Hamilton 1964). Estimated source levels are as high as 190 dB (Patterson and Hamilton 1964; Watkins et al. 1987a; Thompson et al. 1992; McDonald et al. 1995). Širović et al. (2007) reported that fin whales produced vocalizations with a source level of 189 ± 4 dB re:1 Pa-1 m over a range of 15–28 Hz and could be detected up to 56 km away. In temperate waters intense bouts of long patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clark and Charif 1998). Short sequences of rapid pulses in the 20-70 Hz band are associated with animals in social groups (McDonald et al. 1995; Clark pers. comm.; McDonald pers. comm.). Each pulse lasts on the order of one second and contains twenty cycles (Tyack 1999). Particularly in the breeding season, fin whales produce series of pulses in a regularly repeating pattern. These bouts of pulsing may last for longer than one day (Tyack 1999). The seasonality and stereotype of the bouts of patterned sounds suggest that these sounds are male reproductive displays (Watkins et al. 1987a), while the individual counter-calling data of McDonald et al. (1995) suggest that the more variable calls are contact calls. Some authors feel there are geographic differences in the frequency, duration and repetition of the pulses (Thompson et al. 1992). As with other mysticete sounds, the function of vocalizations produced by fin whales is unknown. Hypothesized functions include: (1) maintenance of inter-individual distance, (2) species and individual recognition, (3) contextual information transmission (e.g. feeding, alarm, courtship), (4) maintenance of social organization (e.g. contact calls between females and offspring), (5) location of topographic features, and (6) location of prey resources (review by Thompson et al. 1992). Responses to conspecific sounds have been demonstrated in a number of mysticetes, and there is no reason to believe that fin whales do not communicate similarly (Edds-Walton 1997). The low-frequency sounds produced by fin whales have the potential to travel over long distances, and it is possible that long-distance communication occurs in fin whales (Payne and Webb 1971; Edds-Walton 1997). Also, there is speculation that the sounds may function for long-range echolocation of large-scale geographic targets such as seamounts, which might be used for orientation and navigation (Tyack 1999).

The most typical fin whale sound is a 20 Hz infrasonic pulse (actually an FM sweep from about 23 to 18 Hz) with durations of about 1 sec and can reach source levels of 184 to 186 dB re 1 µPa-m (maximum up to 200) (Richardson et al. 1995; Charif et al. 2002). Croll et al. (2002) suggested that these long, patterned vocalizations might function as male breeding displays, much like those that male humpback whales sing. The source depth, or depth of calling fin whales, has been reported to be about 162 ft (Watkins et al. 1987).

Although no studies have directly measured the hearing sensitivity of fin whales, we assume that fin whales are able to receive sound signals in roughly the same frequencies as the signals they produce. This suggests fin whales, like other baleen whales are more likely to have their best hearing capacities at low frequencies, including infrasonic frequencies, rather than at mid- to high-frequencies (Ketten 1997).

Impacts of human activity—As early as the mid-seventeenth century, the Japanese were capturing fin, blue, and other large whales using a fairly primitive open-water netting technique (Tønnessen and Johnsen 1982, Cherfas 1989). In 1864, explosive harpoons and steam-powered catcher boats were introduced in Norway, allowing the large-scale exploitation of previously unobtainable whale species. The North Pacific and Antarctic whaling operations soon added this >modern' equipment to their arsenal. After blue whales were depleted in most areas, the smaller fin whale became the focus of whaling operations and more than 700,000 fin whales were landed in the twentieth century. The incidental take of fin whales in fisheries is extremely rare. In the California/Oregon drift gillnet fishery, observers recorded the entanglement and mortality of one fin whale, in 1999, off southern California (NMFS 2000). Based on a worst-case scenario, NMFS estimates that a maximum of six fin whales (based on calculations that adjusted the fin whale observed entangled and killed in 1999 by the number of sets per year) in a given year could be captured by the California-Oregon drift gillnet fleet and killed (NMFS 2000). Anecdotal observations from fishermen, suggest that large whales swim through their nets rather than get caught in them (NMFS 2000). Because of their size and strength, fin whales probably swim through fishing nets which might explain why these whales are rarely reported as having become entangled in fishing gear.

Humpback whale (*Megaptera novaeangliae*) Eastern North Pacific Stock

Listing Status—The IWC first protected humpback whales in the North Pacific in 1966. They are also protected under CITES. In the U.S., humpback whales were listed as endangered under the ESA in 1973 and are therefore classified as depleted and strategic stock under the MMPA. Critical habitat has not been designated for this species in waters off California, Oregon, and Washington.

Population Status—Humpback whales live in all major ocean basins from equatorial to sub-polar latitudes migrating from tropical breeding areas to polar or sub-polar feeding areas (Jefferson et al. 1993, NMFS 2006e). Three Pacific stocks of humpback whales are recognized in the Pacific Ocean and include the western North Pacific stock, central North Pacific stock, and eastern North Pacific stock Calambokidis et al. 1997; Baker et al. 1998). The Eastern North Pacific humpback whale stock is the one most likely to be encountered within Southern California. In the entire North Pacific Ocean prior to 1905, it is estimated that there were 15,000 humpback whales basin-wide (Rice 1978). In 1966, after heavy commercial exploitation, humpback abundance was estimated at 1,000 to 1,200 whales (Rice 1978), although it is unclear if estimates were for the entire North Pacific or just the eastern North Pacific. There are no reliable estimates for current humpback whale abundance in the entire North Pacific (NMFS 2006e). The most recent estimate of population size for the Eastern North Pacific Stock is 1,391 (CV = 0.22; Carretta et al. 2007).

Distribution—The Eastern North Pacific Stock inhabits waters from Costa Rica (Steiger et al. 1991) to southern British Columbia (Calambokidis et al. 1993). This Stock is most abundant in coastal waters off California during spring and summer, and off Mexico during autumn and winter. Although humpback whales typically travel over deep, oceanic waters during migration, their feeding and breeding habitats are mostly in shallow, coastal waters over continental shelves (Clapham and Mead 1999). Shallow banks or ledges with high sea-floor relief characterize feeding grounds (Payne et al. 1990; Hamazaki 2002). North Pacific humpback whales are distributed primarily in four more-or-less distinct wintering areas: the Ryukyu and Ogasawara (Bonin) Islands (south of Japan), Hawai'i, the Revillagigedo Islands off Mexico, and along the coast of mainland Mexico (Calambokidis et al. 2001). There is known to be some interchange of whales among different wintering grounds, and some matches between Hawaii and Japan, and between Hawaii and Mexico have been found (Salden et al. 1999; Calambokidis et al. 2000; 2001). During summer months, North Pacific humpback whales feed in a nearly continuous band from southern California to the Aleutian Islands, Kamchatka Peninsula, and the Bering and Chukchi seas (Calambokidis et al., 2001). Humpback whales are mainly found in the Southern Califorina from December through June (Calambokidis et al. 2001). During late summer, more humpback whales are sighted north of the Channel Islands, and limited occurrence expected south of the northern Channel Islands (San Miguel, Santa Rosa, Santa Cruz) (Carretta et al. 2000). Humpback whales summer throughout the central and western portions of the Gulf of Alaska, including Prince William Sound, around Kodiak Island (including Shelikof Strait and the Barren Islands), and along the southern coastline of the Alaska Peninsula. The northern Bering Sea, Bering Strait, and the southern Chukchi Sea along the Chukchi Peninsula, appear to form the northern extreme of the humpback whale's range (Nikulin 1946, Berzin and Rovnin 1966).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0001613 for warm water season and 0.0000984 for cold water season (Barlow, 2007; Table 2-2).

Life History—Humpbacks primarily feed on small schooling fish and krill (Caldwell and Caldwell 1983). While in California waters, humpback prey includes euphausiids and small schooling fish like anchovies, sardines, and mackerel (Wynne and Folkens, 1992). It is believed that minimal feeding occurs in wintering grounds, such as the Hawaiian Islands (Balcomb 1987; Salden 1989).

Reproduction/Breeding—Humpback whales migrate south from California to the waters off Mexico and Costa Rica to breed and to give birth (Calambokidis et al. 2004).

Diving Behavior—Humpback whale diving behavior depends on the time of year (Clapham and Mead 1999). In summer, most dives last less than 5 min; those exceeding 10 min are atypical. In winter (December through March), dives average 10 to 15 min; dives of greater than 30 min have been recorded (Clapham and Mead 1999). Although humpback whales have been recorded to dive as deep as about 1,638 ft (Dietz et al. 2002), on the feeding grounds they spend the majority of their time in the upper 400 ft of the water column (Dolphin 1987; Dietz et al. 2002). Humpback whales on the wintering grounds do dive deeply; Baird et al. (2000) recorded dives to 577 ft.

Like other large mysticetes, they are a "lunge feeder" taking advantage of dense prey patches and engulfing as much food as possible in a single gulp. They also blow nets, or curtains, of bubbles around or below prey patches to concentrate the prey in one area, then lunge with mouths open through the middle. Dives appear to be closely correlated with the depths of prey patches, which vary from location to location. In the north Pacific, most dives were of fairly short duration (<4 min) with the deepest dive to 148 m (southeast Alaska; Dolphin 1987), while whales observed feeding on Stellwagen Bank in the North Atlantic dove to <40 m (Hain et al. 1995). Depth distribution data collected at a feeding area in Greenland resulted in the following best estimation of depth distribution: 37% of time at <4 m, 25% at 4-20 m, 7% at 21-35m, 4% at 36-50 m, 6% at 51-100 m, 7% at 101-150 m, 8% at 151-200 m, 6% at 201-300 m, and <1% at >300 m (Dietz et al. 2002).

Acoustics—Humpback whales are known to produce three classes of vocalizations: (1) "songs" in the late fall, winter, and spring by solitary males; (2) sounds made within groups on the wintering (calving) grounds; and (3) social sounds made on the feeding grounds (Richardson et al. 1995). The best-known types of sounds produced by humpback whales are songs, which are thought to be breeding displays used only by adult males (Helweg et al. 1992). Singing is most common on breeding grounds during the winter and spring months, but is occasionally heard outside breeding areas and out of season (Matilla et al. 1987; Clark and Clapham 2004). There is geographical variation in humpback whale song, with different populations singing different songs, and all members of a population using the same basic song. However, the song evolves over the course of a breeding season, but remains nearly unchanged from the end of one season to the start of the next (Payne et al. 1983). Social calls are from 50 Hz to over 10 kilohertz (kHz), with the highest energy below 3 kHz (Silber 1986). Female vocalizations appear to be simple; Simão and Moreira (2005) noted little complexity. The male song, however, is complex and changes between seasons. Components of the song range from under 20 Hz to 4 kHz and occasionally 8 kHz, with source levels of 144 to 174 dB re 1 µPa m, with a mean of 155 dB re 1 µPa-m (Thompson et al. 1979; Payne and Payne 1985, Frazer and Mercado 2000). Au et al. (2001) recorded high-frequency harmonics (out to 13.5 kHz) and source level (between 171 and 189 dB re 1 µPa-m) of humpback whale songs. Au et al. (2006) took recordings of whales off Hawaii and found high frequency harmonics of songs extending beyond 24 kHz, which may indicate that they can hear at least as high as this frequency. Songs have also been recorded on feeding grounds (Mattila et al. 1987; Clark and Clapham 2004). "Feeding calls," unlike song and social sounds are highly stereotyped series of narrow-band trumpeting calls. They are 20 Hz to 2 kHz, less than 1 second in duration, and have source levels of 175 to 192 dB re 1 µPa-m (U.S. Navy 2006a).

The main energy of humpback whale songs lies between 0.2 and 3.0 kHz, with frequency peaks at 4.7 kHz. Feeding calls, unlike song and social sounds, are highly stereotyped series of narrow-band trumpeting calls. They are 20 Hz to 2 kHz, less than 1 sec in duration, and have source levels of 175 to 192 dB re 1 µPa-m. The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent et al. 1985).

No tests on humpback whale hearing have been made. Houser et al. (2001) constructed a humpback audiogram using a mathematical model based on the internal structure of the ear. The predicted audiogram indicates sensitivity to frequencies from 700 Hz to 10 kHz, with maximum relative sensitivity between 2 and 6 kHz. Recent information on the songs of humpback whales suggests that their hearing, if animals hear the sounds they make, may extend to frequencies of at least 24 kHz (Au et al. 2006). Maybaum (1989) reported that humpback whales showed a mild response to a hand held sonar marine mammal detection and location device (frequency of 3.3 kHz at 219 dB re 1µPa @ 1 meter or frequency sweep of 3.1-3.6 kHz) although this system is significantly different from the Navy's hull mounted sonars. In addition, the system had some low frequency components (below 1 kHz) which may be an artifact of the acoustic equipment. This may have affected the response of the whales to both the control and sonar playbacks.

Impacts of human activity- Historic whaling—Commercial whaling, the single most significant impact on humpback whales ceased in the North Atlantic in 1955 and in all other oceans in 1966. The humpback whale was the most heavily exploited by Soviet whaling fleets after World War II.

Fisheries Interactions-Entanglement in fishing gear poses a threat to individual humpback whales throughout the Pacific. Reports of entangled humpbacks whales found swimming, floating, or stranded with fishing gear attached, have been documented in the North Pacific. A number of fisheries based out of west coasts ports may incidentally take the ENP stock of humpback whale, and documented interactions are summarized in the U.S. Pacific Marine Mammal Stock Assessments: 2006 (Carretta et al. 2007). The estimated impact of fisheries on the ENP humpback whale stock is likely underestimated, since the serious injury or mortality of large whales due to entanglement in gear, may go unobserved because whales swim away with a portion of the net, line, buoys, or pots. According to Carretta et al. (2007) and the California

Marine Mammal Stranding Network Database (U.S Department of Commerce 2006), 12 humpback whales and two unidentified whales have been reported as entangled in fishing gear (all crab pot gear, except for one of the unidentified whales) since 1997.

Ship Strikes-Humpback whales, especially calves and juveniles, are highly vulnerable to ship strikes and other interactions with non-fishing vessels. Younger whales spend more time at the surface, are less visible, and closer to shore (Herman et al. 1980; Mobley et al. 1999), thereby making them more susceptible to collisions. Humpback whale distribution overlaps significantly with the transit routes of large commercial vessels, including cruise ships, large tug and barge transport vessels, and oil tankers.

Ship strikes were implicated in the deaths of at least two humpback whales in 1993, one in 1995, and one in 2000 (Carretta et al. 2006). During 1999-2003, there were an additional 5 injuries and two mortalities of unidentified whales, attributed to ship strikes. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not have obvious signs of trauma. Several humpback whales have been photographed in California with large gashes in their dorsal surface that appear to be from ship strikes (Carretta et al. 2006). According to the California Marine Mammal Stranding Network Database (2006), one humpback whale was struck by a ship off of California from 1982-2005. The average number of humpback whale deaths by ship strikes for 1999-2003 is at least 0.2 per year (Carretta et al. 2006). In addition, there were 9 unidentified whales and one unidentified balaenopterid struck by ships in California from 1982-2005 (California Marine Mammal Stranding Network Database 2006). Of these 10 animals, 5 were reported by the Navy as being struck offshore of the Channel Islands (e.g., San Nicholas and San Clemente Islands).

Whale watching boats and boats from which scientific research is being conducted specifically direct their activities toward whales and may have direct or indirect impacts on humpback whales. The growth of the whale-watching industry has not increased as rapidly for the ENP stock of humpback whales, as it has for the Central North Pacific stock (wintering grounds in Hawaii and summering grounds in Alaska), but whale-watching activities do occur throughout the ENP stock's range. There is concern regarding the impacts of close vessel approaches to large whales, since harassment may occur, preferred habitats may be abandoned, and fitness and survivability may be compromised if disturbance levels are too high. While a 1996 study in Hawaii measured the acoustic noise of different whale-watching boats (Au and Green 2000) and determined that the sound levels were unlikely to produce grave effects on the humpback whale auditory system, the potential direct and indirect effects of harassment due to vessels cannot be discounted. Several investigators have suggested shipping noise may have caused humpback whales to avoid or leave feeding or nursery areas (Jurasz and Jurasz 1979; Dean et al. 1985), while others have suggested that humpback whales may become habituated to vessel traffic and its associated noise. Still other researchers suggest that humpback whales may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle et al. 1993; Wiley et al. 1995).

Other Threats-Similar to fin whales, humpbacks are potentially affected by a resumption of commercial whaling, loss of habitat, loss of prey (for a variety of reasons including climate variability), underwater noise, and pollutants. Generally, very little is known about the effects of organochlorine pesticides, heavy metals, and PCB's and other toxins in baleen whales, although the impacts may be less than higher trophic level odontocetes due to baleen whales' lower levels of bioaccumulation from prey.

Anthropogenic noise may also affect humpback whales, as humpback whales seem to respond to moving sound sources, such as whale-watching vessels, fishing vessels, recreational vessels, and low-flying aircraft (Beach and Weinrich 1989; Clapham et al. 1993; Atkins and Swartz 1989).

Their responses to noise are variable and have been correlated with the size, composition, and behavior of the whales when the noises occurred (Herman et al. 1980; Watkins et al. 1981; Krieger and Wing 1986).

Sei whale (*Balaenoptera borealis*) Eastern North Pacific Stock

Listing Status—Sei whales did not have meaningful protection at the international level until 1970, when catch quotas for the North Pacific began to be set on a species basis (rather than on the basis of total production, with six sei whales considered equivalent to one “blue whale unit”). Prior to that time, the kill was limited only to the extent that whalers hunted selectively for the larger species with greater return on effort (Allen 1980). The sei whale was given complete protection from commercial whaling in the North Pacific in 1976. In the late 1970's, some “pirate” whaling for sei whales took place in the eastern North Atlantic (Best 1992). There is no direct evidence of illegal whaling for this species in the North Pacific although the acknowledged misreporting of whaling data by Soviet authorities (Yablokov 1994) means that catch data are not wholly reliable. In the U.S., humpback whales were listed as endangered under the ESA in 1973 and are therefore classified as depleted and strategic stock under the MMPA. It is also classified as “endangered” by the IUCN (Baillie and Groombridge 1996) and is listed in CITES Appendix I. Critical habitat has not been designated for this species for the eastern North Pacific stock.

Population Status—The IWC groups all of sei whales in the entire North Pacific Ocean into one stock (Donovan 1991). However, some mark-recapture, catch distribution, and morphological research, indicated that more than one stock exists; one between 175°W and 155°W longitude, and another east of 155° W longitude (Masaki 1976; Masaki 1977). In the U.S. Pacific EEZ only the Eastern North Pacific Stock is recognized. Worldwide, sei whales were severely depleted by commercial whaling activities. In the North Pacific, the pre-exploitation population estimate for sei whales is 42,000 whales and the most current population estimate for sei whales in the entire North Pacific (from 1977) is 9,110 (NMFS, 2006z).

Application of various models to whaling catch and effort data suggests that the total population of adult sei whales in the North Pacific declined from about 42,000 to 8,600 between 1963 and 1974 (Tillman 1977). Since 500-600 sei whales per year were killed off Japan from 1910 to the late 1950s, the stock size presumably was already, by 1963, below its carrying capacity level (Tillman 1977). The most current population estimate for sei whales in the entire North Pacific (from 1977) is 9,110 (NMFS, 2006z). The current estimate for sei whales in the Eastern North Pacific stock is 56 (CV=0.61) individuals (Carretta et al. 2007).

Distribution—Sei whales live in temperate regions of all oceans in the Northern and Southern Hemispheres and are not usually associated with coastal features (NMFS, 2006z). Sei whales are highly mobile, and there is no indication that any population remains in the same area year-round, i.e., is resident. Pole-ward summer feeding migrations occur, and sei whales generally winter in warm temperate or subtropical waters. The species is cosmopolitan, but with a generally anti-tropical distribution centered in the temperate zones. During the winter, sei whales are found from 20°- 23° N and during the summer from 35°-50° N (Masaki 1976; Masaki 1977).

Sei whales are most often found in deep, oceanic waters of the cool temperate zone. They appear to prefer regions of steep bathymetric relief, such as the continental shelf break, canyons, or basins situated between banks and ledges (Kenney and Winn 1987; Schilling et al. 1992; Gregr and Trites 2001; Best and Lockyer 2002). On feeding grounds, the distribution is largely associated with oceanic frontal systems (Horwood 1987). In the North Pacific, sei whales are found feeding particularly along the cold eastern currents (Perry et al. 1999).

Historically, sei whales occurred in the California Current off central California (37ºN–39ºN), and they may have ranged as far south as the area west of the Channel Islands (32º47’N) (Rice 1977). A few early sightings were made in May and June, but they were encountered there primarily during July–September, and had left California waters by mid-October. Their offshore distribution along the continental slope probably explains, at least in part, the infrequency of observations in shelf waters between northern California and Washington.

Three sightings were made north of the SOCAL Range Complex in the PMSR during the warm-water months (June–September); there were two sightings north of Point Conception and one sighting south of the western tip of Santa Cruz Island (U.S. Navy 1998). Recently, only one confirmed sighting of sei whales and five possible sightings (identified as either sei or Bryde's whales) were made in California waters during extensive ship and aerial surveys during 1991–1993 (Mangels and Gerrodette 1994; Barlow, 1995; Forney et al. 1995). The confirmed sighting was more than 200 nm (370 km) off northern California. Sei whales were not seen during vessel surveys conducted off southern California in 1996, 2001 or 2005 (Appler et al. 2004; Barlow 2003; Forney 2007) nor during aerial surveys conducted in 1991-92 or 1998-99 (Carretta and Forney 1993; Carretta et al. 2000). Sei whales are found in the SOCAL Range Complex from May through October (U.S. Navy, 1998).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0000081 for warm water seasons and 0.0000050 for cold water season (Barlow 2007;Table 2-2).

Reproduction/Breeding—No breeding areas have been determined but calving is thought to occur from September to March (Rice 1977).

Diving Behavior—There are no reported diving depths or durations for Sei whales. In lieu of depth data, minke whale depth distribution percentages will be extrapolated to sei whales for use in the acoustic exposure modeling.

Acoustics—Sei whale vocalizations have been recorded only on a few occasions. They consist of paired sequences (0.5 to 0.8 sec, separated by 0.4 to 1.0 sec) of 7 to 20 short (4 milliseconds [msec]) frequency modulated sweeps between 1.5 and 3.5 kHz (Richardson et al. 1995). Sei whales in the Antarctic produced broadband "growls" and "whooshes" at frequency of 433 ±192 kHz and source level of 156 ±3.6 dB re 1 µPa at 1 m (Mc Donald et al., 2005). While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

Impact of human activity-Historic Whaling—Several hundred sei whales in the North Pacific were taken each year by whalers based at shore stations in Japan and Korea between 1910 and the start of World War II (Committee for Whaling Statistics 1942). From 1910 to 1975, approximately 74,215 sei whales were caught in the entire North Pacific Ocean (Perry et al. 1999). The species was taken less regularly and in much smaller numbers by pelagic whalers elsewhere in the North Pacific during this period (Committee for Whaling Statistics 1942). Small numbers were taken sporadically at shore stations in British Columbia from the early 1900s until the 1950s, when their importance began to increase (Pike and MacAskie 1969). More than 2,000 were killed in British Columbia waters between 1962 and 1967, when the last whaling station in western Canada closed (Pike and MacAskie 1969). Small numbers were taken by shore whalers in Washington (Scheffer and Slipp 1948) and California (Clapham et al. 1997) in the early twentieth century, and California shore whalers took 386 from 1957 to 1971 (Rice 1977). Heavy exploitation by pelagic whalers began in the early 1960s, with total catches throughout the North Pacific averaging 3,643 per year from 1963 to 1974 (total 43,719; annual range 1,280-6,053; Tillman 1977). The total reported kill of sei whales in the North Pacific by commercial whalers was 61,500 between 1947 and 1987 (Barlow et al. 1997).

A major area of discussion in recent years has been IWC member nations issuing permits to kill whales for scientific purposes. Since the moratorium on commercial whaling came into effect

Japan, Norway, and Iceland have issued scientific permits as part of their research programs. For the last five years, only Japan has issued permits to harvest sei whales although Iceland asked for a proposal to be reviewed by the IWC SC in 2003. The Government of Japan has captured minke, Bryde's, and sperm whales (*Physeter macrocephalus*) in the North Pacific (JARPN II). The Government of Japan extended the captures to include 50 sei whales from pelagic areas of the western North Pacific. Twelve takes of sei whales occurred from 1988 to 1995 in the North Atlantic off Iceland and West Greenland although the IWC has set a catch limit of 0 for all stocks in 1985.

Fisheries Interactions-Sei whales, because of their offshore distribution and relative scarcity in U.S. Atlantic and Pacific waters, probably have a lower incidence of entrapment and entanglement than fin whales. Data on entanglement and entrapment in non-U.S. waters are not reported systematically. Heyning and Lewis (1990) made a crude estimate of about 73 rorquals killed/year in the southern California offshore drift gillnet fishery during the 1980's. Some of these may have been fin whales and some of them sei whales. Some balaenopterids, particularly fin whales, may also be taken in the drift gillnet fisheries for sharks and swordfish along the Pacific coast of Baja California, Mexico (Barlow et al. 1997). Heyning and Lewis (1990) suggested that most whales killed by offshore fishing gear do not drift far enough to strand on beaches or to be detected floating in the nearshore corridor where most whale-watching and other types of boat traffic occur. Thus, the small amount of documentation should not be interpreted to mean that entanglement in fishing gear is an insignificant cause of mortality. Observer coverage in the Pacific offshore fisheries has been too low for any confident assessment of species-specific entanglement rates (Barlow et al. 1997). Sei whales, similar to other large whales, may break through or carry away fishing gear. Whales carrying gear may die later, become debilitated or seriously injured, or have normal functions impaired, but with no evidence recorded.

Ship Strikes—The decomposing carcass of a sei whale was found on the bow of a container ship in Boston harbor, suggesting that sei whales, like fin whales, are killed at least occasionally by ship strikes (Waring et al. 1997). Sei whales are observed from whale-watching vessels in eastern North America only occasionally (Edds et al. 1984) or in years when exceptional foraging conditions arise (Weinrich et al. 1986; Schilling et al. 1992). There is no comparable evidence available for evaluating the possibility that sei whales experience significant disturbance from vessel traffic. There were 9 unidentified whales and one unidentified balaenopterid struck by ships in California from 1982-2005 (California Marine Mammal Stranding Network Database 2006). Of these 10 animals, 5 were reported by the Navy as being struck offshore of the Channel Islands (e.g., San Nicholas and San Clemente Islands).

Other Threats-No major habitat concerns have been identified for sei whales in either the North Atlantic or the North Pacific. However, fishery-caused reductions in prey resources could have influenced sei whale abundance. The sei whale's strong preference for copepods and euphausiids (i.e., low trophic level organisms), at least in the North Atlantic, may make it less susceptible to the bioaccumulation of organochlorine and metal contaminants than, for example, fin, humpback, and minke whales, all of which seem to feed more regularly on fish and euphausiids (O'Shea and Brownell 1995). Since sei whales off California often feed on pelagic fish as well as invertebrates (Rice 1977), they might accumulate contaminants to a greater degree than do sei whales in the North Atlantic. There is no evidence that levels of organochlorines, organotins, or heavy metals in baleen whales generally (including fin and sei whales) are high enough to cause toxic or other damaging effects (O'Shea and Brownell 1995). It should be emphasized, however, that very little is known about the possible long-term and trans-generational effects of exposure to pollutants.

Sperm whale (Physeter macrocephalus) California/Oregon/Washington Stock

Listing Status—Sperm whales have been protected from commercial harvest by the IWC since 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). Sperm whales were listed as endangered under the ESA in 1973. Since the sperm whale is listed as endangered under the ESA, the California/Oregon/Washington Stock is, therefore, considered depleted and strategic under the MMPA. They are also protected by the Convention on International Trade in Endangered Species of wild flora and they are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the Marine Mammal Protection Act of 1972. Critical habitat has not been designated for sperm whales.

Population Status—Current estimates for population abundance, status, and trends for the Alaska stock of sperm whales are not available (Hill and DeMaster 1999). Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987 (Hill and DeMaster 1999). However, this number may be negatively biased by as much as 60% because of under-reporting by Soviet whalers (Brownell et al. 1998). In particular, the Bering Sea population of sperm whales (consisting mostly of males) was severely depleted (Perry et al. 1999). Catches in the North Pacific continued to climb until 1968, when 16,357 sperm whales were harvested. Catches declined after 1968, in part through limits imposed by the IWC (Rice 1989). Reliable estimates of current and historical sperm whale abundance across each ocean basin are not available (NMFS 2006e). Five stocks of sperm whales are recognized in U.S. waters: the North Atlantic stock, the northern Gulf of Mexico stock, the Hawaiian stock, the California/Oregon/Washington stock, and the North Pacific stock (NMFS 2006e). Sperm whales are widely distributed across the entire North Pacific Ocean and into the southern Bering Sea in summer, but the majority are thought to occur south of 40°N in winter. Estimates of pre-whaling abundance in the North Pacific are considered somewhat unreliable, but may have totaled 1,260,000 sperm whales. Whaling harvests between 1800 and the 1980s took at least 436,000 sperm whales from the entire North Pacific Ocean (NMFS 2006e).

Several authors have proposed population structures that recognize at least three sperm whales populations in the North Pacific for management purposes (Kasuya 1991, Bannister and Mitchell 1980). At the same time, the IWC's Scientific Committee designated two sperm whale stocks in the North Pacific: a western and eastern stock or population (Donovan 1991). The line separating these populations has been debated since their acceptance by the IWC's Scientific Committee. For stock assessment purposes, NMFS recognizes three discrete population centers of sperm whales in the Pacific: (1) Alaska, (2) California/Oregon/Washington, and (3) Hawai'I (Carretta et al., 2007). California, Oregon, and Washington and those sampled offshore to the Hawaiian Islands (Mesnick et al. 1999; Carretta et al. 2007).

The available data suggest that sperm whale abundance has been relatively stable in California waters since 1979 (Barlow 1994), but there is uncertainty about both the population size and the annual mortality rates. Population is estimate to be 1,233 (CV=0.41) for the California/Oregon/Washington Stock (Carretta et al. 2007). Sperm whale abundance in the eastern temperate North Pacific Ocean is estimated to be 32,100 and 26,300 by acoustic and visual detection methods, respectively (Barlow and Taylor 2005).

Preliminary genetic analyses reveal significant differences between sperm whales off the coast of California, Oregon, and Washington and those sampled offshore to the Hawaiian Islands (Mesnick et al. 1999; Carretta et al. 2007). The NOAA stock assessment report divides sperm whales within the U.S. Pacific EEZ into three discrete, noncontiguous areas: (1) water around the Hawaiian Islands, (2) California, Oregon, and Washington waters, and (3) Alaskan waters (Carretta et al. 2007).

Distribution—Sperm whales occur throughout all ocean basins from equatorial to polar waters, including the entire North Atlantic, North Pacific, northern Indian Ocean, and the southern oceans. Sperm whales are found throughout the North Pacific and are distributed broadly from tropical and temperate waters to the Bering Sea as far north as Cape Navarin. Mature, female, and immature sperm whales of both sexes are found in more temperate and tropical waters from the equator to around 45˚N throughout the year. These groups of adult females and immature sperm whales are rarely found at latitudes higher than 50˚N and 50˚S (Reeves and Whitehead 1997). Sexually mature males join these groups throughout the winter. During the summer, mature male sperm whales are thought to move north into the Aleutian Islands, Gulf of Alaska, and the Bering Sea. Sperm whales are rarely found in waters less than 300 meters in depth. They are often concentrated around oceanic islands in areas of upwelling, and along the outer continental shelf and mid-ocean waters. Sperm whales show a strong preference for deep waters (Rice 1989), especially areas with high sea-floor relief. Sperm whale distribution is associated with waters over the continental shelf edge, over the continental slope, and into deeper waters (Hain et al., 1985; Kenney and Winn 1987; Waring and Finn 1995; Gannier 2000; Gregr and Trites 2001; Waring et al. 2001). However, in some areas, such as off New England, on the southwestern and eastern Scotian Shelf, and in the northern Gulf of California, adult males are reported to quite consistently use waters with bottom depths <100 m and as shallow as 40 m (Whitehead et al. 1992; Scott and Sadove 1997; Croll et al. 1999; Garrigue and Greaves 2001; Waring et al. 2002).

The geographic distribution of the California/Oregon/Washington stock of sperm whales varies seasonally. Sperm whales are found year-round in California waters, but peak in abundance from April through mid-June and from the end of August to mid-November (NMFS 2006e). The sperm whale was reported to be rare over the continental shelf of the Southern California Bight, but abundant directly offshore of the Southern California Bight (Bonnell and Dailey 1993). During the 1991 and 1993 NMFS ship-based surveys, sperm whales were more abundant farther offshore and farther south than they were in the Southern California Bight. There are widely scattered sightings of sperm whales in deep waters of the SOCAL Range Complex in the warm-water period, and few sightings in the cold-water period. No sperm whales were sighted during the 1998–1999 NMFS aerial surveys of the SCIRC (Carretta et al. 2000). Vessel surveys conducted in 2001 and 2005 both yielded sightings of sperm whales (Forney 2007; Appler et al. 2004). However, sperm whales are found in the SOCAL Range Complex throughout the year (Carretta et al. 2000).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0014313 for warm water season and 0.0008731 for cold water season (Barlow 2007; Table 2-2).

Life history information—Female sperm whales become sexually mature at about 9 years of age (Kasuya 1991). Male sperm whales take between 9 and 20 years to become sexually mature, but will require another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991). Adult females give birth after about 15 months gestation and nurse their calves for 2 to 3 years. The calving interval is estimated to be about four to six years (Kasuya 1991). The age distribution of the sperm whale population is unknown, but sperm whales are believed to live at least 60 years (Rice 1978). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (IWC 1980).

Reproduction/Breeding—Calving generally occurs in the summer at lower latitudes and the tropics (DoN 2005).

Diving Behavior—Sperm whales forage during deep dives that routinely exceed a depth of 1,314 ft and 30 min duration (Watkins et al. 2002). Sperm whales are capable of diving to depths of over 6,564 ft with durations of over 60 min (Watkins et al., 1993). Sperm whales spend up to 83 percent of daylight hours underwater (Jaquet et al. 2000; Amano and Yoshioka 2003). Males do not spend extensive periods of time at the surface (Jaquet et al. 2000). In contrast, females spend prolonged periods of time at the surface (1 to 5 hours daily) without foraging (Whitehead and Weilgart 1991; Amano and Yoshioka 2003). The average swimming speed is estimated to be 0.7 m/sec (Watkins et al. 2002). Dive descents averaged 11 min at a rate of 1.52 m/sec, and ascents averaged 11.8 min at a rate of 1.4 m/sec (Watkins et al. 2002).

Amano and Yoshioka (2003) attached a tag to a female sperm whale near Japan in an area where water depth was 1000-1500m. For dives with active bottom periods, the total mean dive sequence was 45.9 min (mean surface time plus dive duration). Mean post dive surface time divided by total time (8.5/45.9), plus time at surface between deep dive sequences, yields a percentage of time at the surface (<10 m) of 31%. Mean bottom time divided by total time (17.5/45.9) and adjusted to include the % of time at the surface between dives, yields a percentage of time at the bottom of the dive (in this case >800 m as the mean maximum depth was 840 m) of 34%. Total time in the water column descending or ascending equals duration of dive minus bottom time (37.4-17.5) or ~20 minutes. Assuming a fairly equal descent and ascent rate (as shown in the table) and a fairly consistent descent/ascent rate over depth, we assume 10 minutes each for descent and ascent and equal amounts of time in each depth gradient in either direction. Therefore, 0-200 m = 2.5 minutes one direction (which correlates well with the descent/ascent rates provided) and therefore 5 minutes for both directions; and for 201-400 m, 401-600 m and 601-800 m. Therefore, the depth distribution for sperm whales based on information in the Amano paper is: 31% in <10 m, 8% in 10-200 m, 9% in 201-400 m, 9% in 401-600 m, 9% in 601-800 m and 34% in >800 m. The percentages derived above from data in Amano and Yoshioka (2003) are in fairly close agreement with those derived from Table 1 in Watwood et al. (2006) for sperm whales in the Ligurian Sea, Atlantic Ocean and Gulf of Mexico.

Acoustics—Sperm whales produce short-duration (generally less than 3 sec), broadband clicks from about 0.1 to 30 kHz (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995; Thode et al. 2002). These clicks range in frequency from 100 Hz to 30 kHz, with dominant energy in two bands (2 to 4 kHz and 10 to 16 kHz).). The source levels can be up to 236 dB re 1 µPa-m (Møhl et al., 2003). Thode et al. (2002) suggested that the acoustic directivity (angular beam pattern) from sperm whales must range between 10 and 30 dB in the 5 to 20 kHz region. The clicks of neonate sperm whales are very different from usual clicks of adults in that they are of low directionality, long duration, and low-frequency (centroid frequency between 300 and 1,700 Hz) with estimated source levels between 140 and 162 dB re 1 µPa-m (Madsen et al. 2003). Clicks are heard most frequently when sperm whales are engaged in diving/foraging behavior (Whitehead and Weilgart 1991; Miller et al. 2004; Zimmer et al. 2005). These may be echolocation clicks used in feeding, contact calls (for communication), and orientation during dives. When sperm whales are socializing, they tend to repeat series of clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill 1977). Codas are shared between individuals of a social unit and are considered to be primarily for intragroup communication (Weilgart and Whitehead 1997; Rendell and Whitehead 2004). Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins and Schevill 1975; Watkins et al. 1985). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995).

The anatomy of the sperm whale's ear indicates that it hears high-frequency sounds (Ketten 1992). Anatomical studies also suggest that the sperm whale has some high-frequency hearing, but at a lower maximum frequency than many other odontocetes (Ketten, 1992). The sperm whale may also possess better low-frequency hearing than some other odontocetes, although not as extraordinarily low as many baleen whales (Ketten, 1992). The only data on the hearing range of sperm whales are evoked potentials from a stranded neonate (Carder and Ridgway 1991). These data suggest that neonatal sperm whales respond to sounds from 2.5-60 kHz with the highest sensitivity to frequencies between 5 and 20 kHz (Ridgway and Carder, 2001).

Impacts of human activity—In U.S. waters in the Pacific, sperm whales are known to have been incidentally taken only in drift gillnet operations, which killed or seriously injured an average of 9 sperm whales per year from 1991-1995 (Barlow et al. 1997). Of the eight sperm whales observed taken by the California/Oregon drift gillnet fishery, three were released alive and uninjured (37.5 percent), one was released injured (12.5 percent), and four were killed (50 percent) (NMFS 2000). Therefore, approximately 63 percent of captured sperm whales could be killed accidentally or injured (based on the mortality and injury rate of sperm whales observed taken by the U.S. fleet from 1990-2000). Based on past fishery performance, sperm whales are not observed taken in every year; they were observed taken in four out of the last ten years (NMFS 2000). During the three years the Pacific Coast Take Reduction Plan has been in place, a sperm whale was observed taken only once (in a set that did not comply with the Take Reduction Plan; NMFS 2000).

Interactions between longline fisheries and sperm whales in the Gulf of Alaska have been reported over the past decade (Rice 1989, Hill and DeMaster 1999). Observers aboard Alaskan sablefish and halibut longline vessels have documented sperm whales feeding on longline-caught fish in the Gulf of Alaska (Hill and Mitchell 1998) and in the South Atlantic (Ashford and Martin 1996). During 1997, the first entanglement of a sperm whale in Alaska’s longline fishery was recorded, although the animal was not seriously injured (Hill and DeMaster 1998). The available evidence does not indicate sperm whales are being killed or seriously injured as a result of these interactions, although the nature and extent of interactions between sperm whales and long-line gear is not yet clear. Ashford and Martin (1996) suggested that sperm whales pluck, rather than bite, the fish from the long-line.

In 2000, the Japanese Whaling Association announced that it planned to kill 10 sperm whales and 50 Bryde’s whales in the Pacific Ocean for research purposes, which would be the first time sperm whales would be taken since the international ban on commercial whaling took effect in 1987. Despite protests from the U.S. government and members of the IWC, the Japanese government harvested 5 sperm whales and 43 Bryde’s whales in the last six months of 2000. According to the Japanese Institute of Cetacean Research (Institute of Cetacean Research undated), another 5 sperm whales were killed for research in 2002 – 2003. The consequences of these deaths on the status and trend of sperm whales remains uncertain; however, the renewal of a program that intentional targets and kills sperm whales before we can be certain the population has recovered from earlier harvests places this species at risk in the foreseeable future.

Guadalupe fur seal (*Arctocephalus townsendi*) Guadalupe Island, Mexico Stock

Listing Status—In the U.S., Guadalupe fur seals were listed as threatened under the ESA in 1985 and consequently, are listed as depleted and a strategic stock under the MMPA. The population is considered a single stock because all are recent descendents from one breeding colony at Isla Guadalupe, Mexico. The state of California lists the Guadalupe fur seal as a fully protected mammal in the Fish and Game Code of California (Chapter 8, Section 4700, d), and it is also listed as a threatened species in the Fish and Game Commission California Code of Regulations (Title 14, Section 670.5, b, 6, H). The Guadalupe fur seal is also protected under CITES and fully protected under Mexican law. Guadalupe Island was declared a pinniped sanctuary by the Mexican government in 1975. Critical habitat has not been designated for this species in the U.S.

Population Status—Commercial sealing during the 19th century reduced the once-abundant Guadalupe fur seal to near extinction in 1894. None were seen until a fisherman found slightly more than two dozen at Guadalupe Island in 1926. The size of the population prior to the commercial harvests of the 19th century is not known, but estimates range from 20,000 to 100,000 animals (NMFS 2006e). The Guadalupe fur seal population has increased at an average annual rate of 13.7% from 1954 to 1993 (Gallo-Reynoso, 1994; Carretta et al. 2007), and it may be expanding its range (Gallo-Reynoso 1994; Le Boeuf and Bonnell 1980; Maravilla-Chavez and Lowry 1999). The most recent population estimate of Guadalupe fur seals was 7,408 (Carretta et al. 2007).

Distribution—Prior to commercial sealing during the 19th century, this species ranged from Monterey Bay, California, to the Revillagigedo Islands, Mexico (NMFS 2006e). The only breeding colony of Guadalupe fur seals is at Isla Guadalupe, Mexico, approximately 10 km south of the Southern California Range Complex. Between 1969 and 1989, 48 sightings of Guadalupe fur seals were made on the southern Channel Islands, including one territorial male that was seen from 1981 to 1990 and a second bull established a territory from 1989 to 1991 (Reeves et al. 1992). Previous to 1985, there were only two sightings of Guadalupe fur seals from central and northern California (Monterey in 1977 and Princeton Harbor in 1984; Weber and Roletto 1987). Guadalupe fur seals pup and breed, mainly at Isla Guadalupe, Mexico. In 1997, a second rookery was discovered at Isla Benito del Este, Baja California, and a pup was born at San Miguel Island, California (Melin and DeLong 1999). The population is considered to be a single stock because all individuals are recent descendants from one breeding colony at Isla Guadalupe, Mexico. When ashore during the breeding season, Guadalupe fur seals favor rocky habitats near the water's edge and caves at windier sections of coastlines (Reeves et al. 2002). A few Guadalupe fur seals (1-2 per year) are haul-out at San Miguel Island in the Channel Islands, but do not breed or pup there (S. Melin, NMML-NMFS, Personal Communication). Distribution at sea is unknown (Reeves et al. 1992), but Guadalupe fur seals may migrate at least 600 km from the rookery sites, based on pelagic observations of individuals in the Southern California Bight (Seagars 1984). Occasional sighting have been made in offshore waters in or near the Point Mugu Sea Range as well as on the Channel Islands (Koski et al. 1998). At San Nicolas Island, male Guadalupe fur seals have occasionally established territories among breeding California sea lions. The Guadalupe fur seal is expected to be rare, except perhaps for a small area around Guadalupe Island. Researchers suspect that water temperature and prey availability would affect fur seal movements to the north of Guadalupe Island (Le Boeuf and Crocker 2005). With cooler water seals would stay further south of the SOCAL EIS/OEIS area to feed, and occur further north with warmer water temperatures as it affects prey movement. There was a warming of the Eastern North Pacific (ETP) as part of the Pacific Decadal Oscillation from the mid 1970s to the mid 1990s but the ETP may currently be in a cooling trend (Le Boeuf and Crocker 2005). From 1982 to 2005, 12 Guadalupe fur seals have stranded in California, ranging from San Diego to Santa Barbara counties (California Marine Mammal Stranding Network Database 2007).

At-sea sightings of Guadalupe fur seals are very limited in the SOCAL Range Complex, and expected density information can not meaningfully be calculated using existing survey protocols. Sightings Guadalupe fur seals hauling out on California shores are also infrequent. A single adult female regularly hauls out on San Miguel Island each breeding season (S. Melin, NMFS-Marine Mammal Laboratory 2007) but no other Guadalupe fur seals have hauled out there since the mid 1990's (Melin and DeLong 1999). Thirty-one juvenile Guadalupe fur seals have stranded in Southern California during the period of 1975 to 2006 with 2-5 strandings per year during El Niño events (D. Greig, The Mariine Mammal Center 2007).

At Sea Density Estimates—To determine the density of Guadalupe fur seals in the southern California area, the entire population size was divided by the area. While it is more likely that males would be found in the southern California Bight, the SOCAL Range Complex extends to just north of Isla Guadalupe, so all age and sex classes were included in the overall density. Therefore, density for Guadalupe fur seals is 0.007/km^2 (7,408/1,034,289 km^2), which is applicable for September-May only. Pinniped densities were averaged to warm and cold water seasons by summing monthly densities and dividing by six months. The warm water density for guadalupe fur seals was 0.004 and the cold water density was 0.007 (Gallo-Reynoso 1994; Table 2-2), which are applicable to southern California.

Life history—Researchers know little about the whereabouts of Guadalupe fur seals during the non-breeding season, from September through May, but they are presumably solitary when at sea. Females give birth from early June through July, with a peak in late June. They mate about a week after giving birth, and then begin a series of foraging trips lasting two to six days. They come ashore for four to six days between foraging trips to nurse their pups. Lactating females may travel a thousand miles or more from the breeding colony to forage.

Reproduction/Breeding—All breeding and pupping occurs from approximately June through late July on Isla Guadalupe and Isla Benito del Este in Baja Mexico (Gallo 1994) which are south of the SOCAL Range Complex.

Diving Behavior—There is little information on feeding habitats of the Guadalupe fur seal, but it is likely that they feed on deep-water cephalapods and small schooling fish like their relative the northern fur seal (Seagars 1984). Digestive tracts of stranded animals in central and northern California contained primarily squid (*Loligo opalescens* and *Onychoteuthis borealojaponica*) with a few otoliths of lampfish (*Lampanyctus*) and Pacific sanddab (*Citharichthys sordidus*) (Hanni et al. 1997). They appear to feed mainly at night, at depths of about 20 m (65 ft), with dives lasting approximately 2 ½ minutes (Reeves et al. 2002). Gallo-Reynoso (1994) instrumented one female with a time-depth recorder and analyzed scat. Most dives occurred from dusk to dawn, with mean dive depth 16.8 m and maximum dive depth 82 m. The mean bottom time (1.4 min) represented 54% of the mean dive duration (2.6 min). Dives occurred in bouts, separated by extended periods at the surface or transiting to other foraging areas. Approximately 14% of time was spent transiting from the island to foraging areas. Analysis of scat showed that fur seals feed on vertically migrating squid found in relatively shallow depths. Additional dive information was obtained by Lander et al. (2000) on a rehabilitated fur seal outfitted with a satellite-linked time-depth recorder. During migration north from a release site at Point Piedras Blancas, California, to Isla Guadalupe, mean dive depth was 15.7 m, but the majority of time was spent <4 m; nearly all of the migration time was spent <20 m. Once the seal arrived at Isla Guadalupe, the majority of dives occurred from dusk through dawn. Most dives were shallow (<20 m), and mean dive depth was 13.9 m. Based on this limited dataset, the following are estimates for depth distribution: daytime: 90% at 0-4m; 10% at 4-82 m; nighttime: 75% at <4 m; 25% at 4-82 m.

Acoustics—In-air sounds of Guadalupe fur seals include barks, roars, and coughs; few details are known (Peterson et al. 1968). There is no published information on the hearing range of the Guadalupe fur seal although it is most likely similar to other fur seals species. The underwater hearing range of the northern fur seal ranges from 0.5 Hz to 40 kHz (Moore and Schusterman 1987; Babushina et al., 1991) and the threshold is 50 to 60 dB re 1 µPa (Moore and Schusterman 1987). The best underwater hearing occurs between 4 and 17 to 28 kHz (Moore and Schusterman 1987; Babushina et al., 1991). The maximum sensitivity in air is at 3 to 5 kHz (Babushina et al. 1991), after which there is an anomalous hearing loss at around 4 or 5 kHz (Moore and Schusterman 1987; Babushina 1999).

Impacts of human activity-Hunting—Sealing on the California coast was first recorded in 1805 and Native Americans left the remains of Guadalupe fur seals in their middens (Bonner 1994).

The species was evidently exterminated from southern California waters by 1825. Commercial sealing continued, although with declining returns, in Mexican waters through 1894. Incomplete sealing records suggest that perhaps as many as 52,000 fur seals were killed on Mexican islands between 1806 and 1890, mostly before 1848; from 1877 to 1984, only some 6,600 fur seals were harvested (Reeves et al. 1992). Due to its full protection in Mexico and in the U.S., it is presumed that Guadalupe fur seals are not presently hunted, although it is not known if Guadalupe fur seals are illegally killed.

Fisheries Interactions—Drift and set gillnet fisheries may cause incidental mortality of Guadalupe fur seals in Mexico and the United States. In the United States, there have been no reports of incidental mortalities or injuries of Guadalupe fur seals in commercial fisheries. No information is available for human-caused mortalities or injuries in Mexico; however, similar drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico, and may take animals from the population. NMFS has documented strandings of Guadalupe fur seals in California. Although most of these animals likely died of natural causes, some mortalities likely can be attributed to interactions with commercial fisheries and marine debris. NMFS documented an increasing number of stranded Guadalupe fur seals on California's Channel Islands and along the central California coast. Juvenile female Guadalupe fur seals have stranded in central and northern California with net abrasions around the neck, fish hooks and monofilament line, and polyfilament string (Hanni et al. 1997).

Sea otter (*Enhydra lutris nereis*) California Stock

Listing Status—The sea otter falls under the regulatory oversight of the USFWS, while all other species of marine mammals occurring within Southern California fall under the regulatory oversight of NMFS. The southern sea otter is listed as threatened under the ESA and the California Stock is, therefore, considered depleted under the MMPA. If restrictions on the use of gill and trammel nets in areas inhabited by southern sea otters were lifted, the southern sea otter population would be designated as a strategic stock as defined by the MMPA (USFWS, 1995 in Carretta et al., 2007).

Population Status—Until recent years, the northern population had increased to well over 100,000 individuals, while the southern or California population had grown more slowly, apparently because of a lower rate of pup survival (Riedman et al. 1994). Except during 1976–1983, the southern population increased steadily between 1983-1994 at a rate of five to seven percent since it received protection in 1911.

Distribution—Historically, sea otters occupied a large range throughout the northern Pacific Coastal region, extending from Russia and Alaska to Mexico (Kenyon 1969). Harvests of sea otters in the 18th and 19th centuries nearly exterminated the species (Orr and Helm 1989). The southern sea otter's primary range is restricted to the coastal area of central California, from Point Año Nuevo to south of Point Conception (Orr and Helm 1989; USFWS 1996, 2005), plus a small translocated population around San Nicolas Island that diminished to about 17 by 1995, which was not considered viable because the population size was too small (Ralls et al. 1995; USFWS 1996). As the population has increased, its range has also expanded.

At Sea Density Estimates—To determine the density of sea otters in the SOCAL area, the entire experimental population size (maximum of 27) was divided by geographic area (90 km^2, which represents the ~2 km perimeter around San Nicolas Island). Density for sea otters is 0.30/km^2, which is applicable year round. The warm and cold water densities for sea otters are both 0.30/km^2. These densities are applicable only to 0.06% of sonar area 1, and 0% of all other sonar areas.

Life History—Sea otters prefer rocky shorelines with kelp beds and waters about 66 ft (20 m) deep (USFWS 1996). Few sea otters venture beyond 5,200 ft (1,600 m) from shore, and most remain within 1,600 ft (500 m) (Estes and Jameson 1988). They require a high intake of energy to satisfy their metabolic requirements. Most sea otters in California tend to be active at night and rest in the middle of the day (Ralls and Siniff, 1990), but there is extensive variation in the activity of individuals both among and within age and sex classes (Ralls et al. 1995).

Sea otters are rarely sighted in the SOCAL Range Complex. Only a limited number of sea otter sightings have been reported near SCI (only three sightings) (Leatherwood et al. 1978). All of those were ~3 mi (5 km) from SCI during the NMFS/SWFSC 1998–1999 surveys (Carretta et al. 2000). Since this species is not expected to be present; therefore, density information can not meaningfully be calculated and this sea otters are not included in subsequent underwater effects modeling.

Reproduction/Breeding—Sea otters breed through out their range and have two peaks in pupping (January to March and October; USFWS 2003).

Diving Behavior—Sea otters feed on or near the bottom in shallow waters, often in kelp beds. Major prey items are benthic invertebrates such as abalones, sea urchins, and rock crabs. Sea otters also eat other types of shellfish, cephalopods, and sluggish near-bottom fishes. The diet varies with the physical and biological characteristics of the habitats in which they live (reviews by Riedman and Estes 1990; Estes and Bodkin 2002). Sea otters exhibit individual differences not only in prey choice, but also in choice and method of tool use, area in which they tend to forage, and water depth (Riedman and Estes 1990; Estes et al. 2003b). In rocky-bottom habitats, sea otters generally forage for large-bodied prey offering the greatest caloric reward. In softbottom habitats, prey is smaller and more difficult to find; sea otters feed on a variety of burrowing invertebrates. Sea otters in California typically forage in waters with a bottom depth less than 25 m though individuals have been sighted foraging in waters with a bottom depth as great as 36 m (Riedman and Estes 1990; Ralls et al. 1995). The record dive depth occurred in the Aleutian Islands, where a sea otter drowned in a king crab pot set at a bottom depth of approximately 100 m (Riedman and Estes 1990). Mean dive duration exceeds 125 sec (Ralls et al. 1995).

Sea otters spend about one-quarter to one-third of their time foraging to meet metabolic needs. They dive to the bottom to collect crabs, clams, urchins, and mussels, and return to the surface to open and consume prey. Tinker et al. (2007) collected dive and forage data via time-depth recorders on otters in California. Their data indicate that 36-52% of time was spent at the surface between dives, depending on the size and type of prey being consumed. Sea otters usually dive to less than 30 m for food (Lance et al. 2004). Using this information, the following are estimated time at depth for sea otters: 50% at <1 m, 50% at 1-30 m.

Acoustics and Hearing—Sea otter vocalizations are considered to be most suitable for short range communication among individuals (McShane et al. 1995). Airborne sounds include screams; whines or whistles; hisses; deep-throated snarls or growls; soft cooing sounds; grunts; and barks (Kenyon 1975; McShane et al. 1995). The high-pitched, piercing scream of a pup can be heard from distances of greater than 1 km (McShane et al. 1995). In-air mother-pup contact vocalizations have most of their energy at 3 to 5 kHz, but there are higher harmonics (McShane et al. 1995; Richardson et al. 1995). There is no hearing data available for this species (Ketten 1998).

2.1.2 Non-Endangered and Non-Threatened Species

Other marine mammal species occurring within Southern California are described below. All of these species, while protected under the MMPA, are not listed as endangered under the ESA, and nor considered depleted or strategic under the MMPA

2.1.2.1 Baleen Whales (Sub-Order Mysticeti)

Bryde's whale (*Balaenoptera edeni*) Eastern Tropical Pacific

Population Status—The best estimate of the entire eastern tropical Pacific population size is 11,163 (CV=0.20) individuals, with only an estimated 12 (CV = 2.0) individuals in California, Oregon and Washington waters (Carretta et al. 2007).

Distribution—Bryde's whale is found in tropical and subtropical waters, generally not moving poleward of 40° in either hemisphere (Jefferson et al. 1993). Long migrations are not typical of Bryde's whales, though limited shifts in distribution toward and away from the equator, in winter and summer, respectively, have been observed (Cummings 1985). Bryde's whales are year-round residents of the inshore waters on the west coast of Baja California south to at least as far as the Islas Tres Marias, at 21°N (Rice 1977). The species is rarely seen near the SOCAL Range Complex. None were sighted in the San Clemente Island Range Complex (SCIRC) during past surveys (U.S. Navy 1998; Carretta et al. 2000). Only one Bryde's whale has ever been positively identified in surveys of California coastal waters (Barlow 1994). Only one Bryde's whale has ever been positively identified in surveys of California coastal waters (Barlow 1994b). It is possible that Bryde's whales could be sighted in the southernmost portion of the SOCAL Range Complex, but it is not known how many of the eastern tropical Pacific population could occur in California waters. One estimate is 12 (CV=2.0) individuals (Carretta et al. 2007), another is 160 (Tershy et al. 1990). Bryde's whales are more likely to be found in non-territorial waters but are occasionally sighted in nearshore areas. There was only one sighting of Bryde's whales in SOCAL Range Complex (Barlow 1994), therefore, the seasonal occurrence of the Bryde's whale can not be determined. Occurrence off southern California is unknown, and they were not seen during vessel surveys conducted off southern California in 1996, 2001 or 2005 (Appler et al. 2004; Barlow, 2003; Forney, 2007) nor during aerial surveys conducted in 1991-92 or 1998-99 (Carretta and Forney 1993; Carretta et al. 2000).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0000081 for warm and cold water seasons (Table 2-2).

Reproduction/Breeding—Breeding and calving occur in warm temperate and tropical areas.

Diving Behavior—Bryde's whales are lunge-feeders, feeding on fish and krill (Nemoto and Kawamura 1977). Cummings (1985) reported that Bryde's whales might dive as long as 20 min.

Bryde's whales feed on pelagic schooling fish, small crustaceans including euphausiids and copepods and cephalopods (Kato, 2002). Feeding appears to be regionally different. Off South Africa, the inshore form feeds on epipelagic fish while the offshore form feeds on mesopelagic fish and euphausiids (Best, 1977; Bannister, 2002). Stomach content analysis from whales in the southern Pacific and Indian oceans indicated that most feeding apparently occurred at dawn and dusk, and were primarily euphausiids (Kawamura, 1980). There have been no depth distribution data collected on Bryde's whales. In lieu of depth data, minke whale depth distribution percentages will be extrapolated to Bryde's whales.

Acoustics—Bryde's whales produce low frequency tonal and swept calls similar to those of other rorquals (Oleson et al. 2003). Calls vary regionally, yet all but one of the call types have a fundamental frequency below 60 Hz; they last from 0.25 sec to several seconds; and they are produced in extended sequences (Oleson et al. 2003). Heimlich et al. (2005) recently described five tone types. While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

Gray whale (*Eschrichtius robustus*) Eastern North Pacific

Population Status—The Eastern North Pacific stock was believed to consist of 26,635 (CV=0.10) individuals in 2002 (Anglis and Outlaw, 2007. This estimate is similar to previous estimates in 1997–1998 (26,635; CV=0.101; Hobbs and Rugh [1999]), 1993–1994 (23,109; CV=0.054; Laake et al. [1994]) and 1995–1996 (22,263; CV=0.093; Hobbs et al. [1996]).

Distribution—The gray whale makes a well-defined seasonal north-south migration (Fig. 10). Most of the population summers in the shallow waters of the northern Bering Sea, the Chukchi Sea, and the western Beaufort Sea (Rice and Wolman 1971), whereas some individuals also summer along the Pacific coast from Vancouver Island to central California (Rice and Wolman 1971; Darling 1984; Nerini 1984). In October and November, the whales begin to migrate southeast through Unimak Pass and follow the shoreline south to breeding grounds on the west coast of Baja California and the southeastern Gulf of California (Braham 1984; Rugh 1984). The average gray whale migrates 7,500–10,000 km at a rate of 147 km/d (Rugh et al. 2001; Jones and Swartz 2002). Although some calves are born along the coast of California, most are born in the shallow, protected waters on the Pacific coast of Baja California from Morro de Santo Domingo (28°N) south to Isla Creciente (24°N) (Urban et al. 2003). The main calving sites are Laguna Guerrero Negro, Laguna Ojo de Liebre, Laguna San Ignacio, and Estero Soledad (Rice et al. 1981).

Almost all of the population passes through the SOCAL Range Complex during both the northward and the southward migration. Gray whales are common there only during cold-water months; none were sighted in the warm season (May–October) in the 1998–1999 NMFS surveys of the SCIRC (Carretta et al. 2000). Southbound and northbound migrations through the SOCAL Range Complex occur, for the most part, at predictable times. The southbound migration begins in the third week of December, peaks in January, and extends through February (Gilmore 1960; Leatherwood 1974). The northbound migration generally begins in mid-February, peaks in March, and lasts at least through May. Gray whales do not spend much time feeding in the Range Complex. Northbound mothers and calves travel more slowly than other whales, and tend to be seen later in the season. Not all gray whales make the full migration south to wintering areas; a "resident" Pacific Feeding Aggregation estimated at ~300 whales remains offshore northern California to southeast Alaska (Calambokidis et al. 2004b).

A mean group size of 2.9 gray whales was reported for both coastal (16 groups) and non-coastal (15 groups) areas in the SCIRC (Carretta *et al*. 2000). The largest group reported was nine animals. The largest group reported by U.S. Navy (1998) was 27 animals. There is no apparent difference in group sizes between day and night (Donahue et al. 1995).

Gray whales are typically absent from August to November (Rice et al. 1981), although there have been a few summer sightings in southern California waters (Patten and Samaras 1977). The nearshore route follows the shoreline between Point Conception and Point Vicente but includes a more direct line from Santa Barbara to Ventura and across Santa Monica Bay. Around Point Vicente or Point Fermin, some whales veer south towards Santa Catalina Island and return to the nearshore route near Newport Beach. Others join the inshore route that includes the northern chain of the Channel Islands along Santa Cruz Island and the Anacapas and east along the Santa Cruz Basin to Santa Barbara Island and the Osborn Bank. From here, gray whales migrate east directly to Santa Catalina Island and then to Point Loma or Punta Descanso, or southeast to San Clemente Island and on to the area near Punta Banda. A significant portion of the eastern North Pacific Stock passes by San Clemente Island and its associated offshore waters (Carretta et al. 2000). The offshore route follows the undersea ridge from Santa Rosa Island to the mainland shore of Baja California and includes San Nicolas Island and Tanner and Cortes banks (Bonnell and Dailey 1993). Gray whales are not expected to be in the SOCAL Range Complex from August through November (Rice et al. 1981).

At Sea Density Estimates—Carretta et al. (2000) calculated a density of 0.051 for gray whales from aerial surveys conducted near San Clemente Island, which is applicable for January through April.*Life history*—When foraging, gray whales typically dive to 50 to 60 m for 5 to 8 min. In the breeding lagoons, dives are usually less than 6 min (Jones and Swartz 2002), although dives as long as 26 min have been recorded (Harvey and Mate 1984). When migrating, gray whales may remain submerged near the surface for 7 to 10 min and travel 500 m or more before resurfacing to breathe. The maximum known dive depth is 170 m (Jones and Swartz 2002). Migrating gray whales sometimes exhibit a unique "snorkeling" behavior in which they surface cautiously, exposing only the area around the blow hole, exhale quietly without a visible blow, and sink silently beneath the surface (Jones and Swartz 2002). A mean group size of 2.9 gray whales was reported for both coastal (16 groups) and non-coastal (15 groups) areas in the SCIRC (Carretta et al. 2000). The largest group reported was nine animals. The largest group reported by U.S. Navy (1998) was 27 animals. There is no apparent difference in group sizes between day and night (Donahue *et al*. 1995).

Reproduction/Breeding—Although some calves are born along the coast of Southern California, most are born in the shallow, protected waters on the Pacific coast of Baja California (Urban et al. 2003).

Diving Behavior—When foraging, gray whales typically dive to 50 to 60 m for 5 to 8 min. In the breeding lagoons, dives are usually less than 6 min (Jones and Swartz, 2002), although dives as long as 26 min have been recorded (Harvey and Mate 1984). When migrating, gray whales may remain submerged near the surface for 7 to 10 min and travel 500 m or more before resurfacing to breathe. The maximum known dive depth is 170 m (Jones and Swartz 2002). Migrating gray whales sometimes exhibit a unique "snorkeling" behavior in which they surface cautiously, exposing only the area around the blow hole, exhale quietly without a visible blow, and sink silently beneath the surface (Jones and Swartz 2002).

Mate and Urban Ramirez (2003) noted that 30 of 36 locations for a migratory gray whale with a satellite tag were in water <100m deep, with the deeper water locations all in the southern California Bight within the Channel Islands. Whales in that study maintained consistent speed indicating directed movement. There has been only one study yielding a gray whale dive profile, and all information was collected from a single animal that was foraging off the west coast of Vancouver Island (Malcolm and Duffus, 2000; Malcolm et al.,1995/96). They noted that the majority of time was spent near the surface on interventilation dives (<3 m depth) and near the bottom (extremely nearshore in a protected bay with mean dive depth of 18 m, range 14-22 m depth). There was very little time spent in the water column between surface and bottom. Foraging depth on summer feeding grounds is generally between 50-60 m (Jones and Swartz, 2002). Based on this very limited information, the following is a rough estimate of depth distribution for gray whales: 50% at <4 m (surface and interventilation dives), 50% at 4-18 m.

Acoustics—Au (2000) reviewed the characteristics of gray whale vocalizations. Gray whales produce broadband signals ranging from 100 Hz to 4 kHz (and up to 12 kHz) (Dahlheim et al. 1984; Jones and Swartz 2002). The most common sounds on the breeding and feeding grounds are knocks (Jones and Swartz 2002), which are broadband pulses from about 100 Hz to 2 kHz and most energy at 327 to 825 Hz (Richardson et al. 1995). The source level for knocks is approximately 142 dB re 1 µPa-m (Cummings et al. 1968). During migration, individuals most often produce low-frequency moans (Crane and Lashkari 1996). The structure of the gray whale ear is evolved for low-frequency hearing (Ketten, 1992). The ability of gray whales to hear frequencies below 2 kHz has been demonstrated in playback studies (Cummings and Thompson 1971; Dahlheim and Ljungblad 1990; Moore and Clarke 2002) and in their responsiveness to underwater noise associated with oil and gas activities (Malme *et al*. 1986; Moore and Clarke 2002). Gray whale responses to noise include changes in swimming speed and direction to move away from the sound source; abrupt behavioral changes from feeding to avoidance, with a resumption of feeding after exposure; changes in calling rates and call structure; and changes in surface behavior, usually from traveling to milling (e.g., Moore and Clarke 2002).

Minke whale (*Balaenoptera acutorostrata*) California/Oregon/Washington Stock

Population Status—The population abundance for offshore California, Oregon, and Washington stock is estimated to be 823 (CV=0.56) individuals (Barlow and Forney 2007).

Distribution—In the Northeast Pacific Ocean, minke whales range from the Chukchi Sea south to Baja California (Leatherwood et al. 1987). They occur year-round off California (Dohl et al. 1983; Barlow 1995; Forney et al. 1995). The minke whales found in waters off California, Oregon, and Washington appear to be resident in that area, and to have home ranges, whereas those farther north are migratory. The minke whale generally occupies waters over the continental shelf, including inshore bays and estuaries (Mitchell and Kozicki 1975; Ivashin and Vitrogov, 1981; Murphy, 1995; Mignucci-Giannoni, 1998; Calambokidis et al. 2004). However, based on whaling catches and surveys worldwide, there is also a deep-ocean component to the minke whale’s distribution (Slijper et al. 1964; Horwood 1990; Mitchell 1991; Mellinger et al. 2000; Roden and Mullin 2000).

Minke whale abundance in the Southern California Bight fluctuates dramatically through the year, with warm-water months being the period of greatest abundance (Dohl et al. 1981). Because of the apparent fluctuations in abundance, Bonnell and Dailey (1993) believed that some minke whales migrated northward through the Southern California Bight in spring and returned southward through the same area in autumn. Leatherwood et al. (1987) suggested that minke whales may remain in the area throughout the year, and that the scarcity of sightings during autumn and winter may be attributable to behavioral and environmental considerations. The lack of sightings in autumn and winter may also be attributable to movements into offshore areas where there has been less survey effort. The surveys conducted in the SCIRC in 1998–1999 recorded minke whales during the cold-water but not the warm-water period (Carretta et al. 2000), whereas the densities calculated for the Point Mugu EIS/OEIS showed no preference for cold or warm water (U.S. Navy 1998). The summer distribution of minke whales was described by Bonnell and Dailey (1993). They are seen commonly along the shelves associated with the southern coasts of the Channel Islands and offshore features south of there. Ship-based surveys during the summers of 1991 and 1993 seem to confirm the importance of the Southern California Bight for minke whales. Three of the eight sightings made during those two extensive surveys were in or adjacent to the Southern California Bight despite relatively little survey effort in that area. Few minke whales are present in the nearshore and continental slope parts of the Southern California Bight during winter, but they appear to be present in offshore waters. The few sightings in winter sometimes include newborn or small calves, suggesting that the Southern California Bight is part of, or at least near, the calving grounds of this Stock (Bonnell and Dailey 1993). In the Southern California, during both the warm-water and cold-water periods, the minke whale appears to be concentrated nearshore and over the continental shelf and slope. Data from acoustic surveys indicate that minke whales also occur further offshore on the westernmost fringe of the SOCAL Range Complex (Barlow et al. 2004). Minke whales are found in the SOCAL Range Complex throughout the year but in higher numbers June through December (Bonnell and Dailey 1993).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0010313 for warm and cold water seasons (Table 2-2).

Reproduction/Breeding—Stewart and Leatherwood (1985) suggested that mating occurs in winter or early spring although it had never been observed.

Diving Behavior—Stern (1992) described a general surfacing pattern of minke whales consisting of about four surfacings, interspersed by short-duration dives averaging 38 sec. After the fourth surfacing, there was a longer duration dive ranging from approximately 2 to 6 min. Minke whales are “gulpers,” like the other rorquals (Pivorunas 1979). Hoelzel et al. (1989) reported on different feeding strategies used by minke whales. In the North Pacific, major food items include krill, Japanese anchovy, Pacific saury, and walleye Pollock (Perrin and Brownell 2002).

The only depth distribution data for this species are reported from a study on daily energy expenditure conducted off northern Norway and Svalbard (Blix and Folkow 1995). The limited depth information available (from Figure 2 in Blix and Folkow 1995) is representative of a 75-min diving sequence where the whale was apparently searching for capelin, then foraging, then searching for another school of capelin. Search dives were mostly to ~20 m, while foraging dives were to 65 m. Based on this very limited depth information, rough estimates for % of time at depth are as follows: 53% at <20 m and 47% at 20-65 m.

Acoustics—Recordings in the presence of minke whales have included both high-and low-frequency sounds (Beamish and Mitchell 1973; Winn and Perkins 1976; Mellinger et al. 2000). Mellinger et al. (2000) described two basic forms of pulse trains that were attributed to minke whales: a “speed up” pulse train with energy in the 200 to 400 Hz band, with individual pulses lasting 40 to 60 msec, and a less-common “slow-down” pulse train characterized by a decelerating series of pulses with energy in the 250 to 350 Hz band. Recorded vocalizations from minke whales have dominant frequencies of 60 Hz to greater than 12,000 Hz, depending on vocalization type (Richardson et al. 1995). Recorded source levels, depending on vocalization type, range from 151 to 175 dB re 1 µPa-m (Ketten 1998). Gedamke et al. (2001) recorded a complex and stereotyped sound sequence (“star-wars vocalization”) in the Southern Hemisphere that spanned a frequency range of 50 Hz to 9.4 kHz. Broadband source levels between 150 and 165 dB re 1 µPa-m were calculated. “Boings,” recently confirmed to be produced by minke whales and suggested to be a breeding call, consist of a brief pulse at 1.3 kHz, followed by an amplitude-modulated call with greatest energy at 1.4 kHz, with slight frequency modulation over a duration of 2.5 sec (Anonymous 2002; Rankin and Barlow 2003). While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

2.1.2.2 Toothed whales (Sub-Order Odontoceti)

Baird’s beaked whale (*Berardius bairdii*) California/Oregon/Washington Stock

Population Status—Population size for the California/Oregon/Washington Stock is estimated to be 1,005 (CV=0.37) individuals (Carretta et al. 2007).

Distribution—Baird’s beaked whales appear to occur mainly in deep waters over the continental slope, oceanic seamounts, and areas with submarine escarpments (Ohsumi 1983; Kasuya and Ohsumi 1984; Willis and Baird 1998; Kasuya 2002). They may be seen close to shore where deep water approaches the coast (Jefferson et al. 1993) and in shallow waters in the central Okhotsk Sea (Kasuya 2002). Recent information suggests that some beaked whales (Blaineville’s and Cuvier’s beaked whales, and northern bottlenose whales) show site fidelity and can be sighted in the area over many years (Hooker et al. 2002; Wimmer and Whitehead 2005; McSweeney et al. 2007).

Baird's beaked whales are infrequently encountered along the continental slope and throughout deep waters of the eastern North Pacific (Forney et al. 1994; Barlow et al. 1997). No sightings were made during the 1998–1999 NMFS surveys offshore of San Clemente (Carretta et al. 2000). All Baird's beaked whales found in the SOCAL Range Complex are expected to be found in non-territorial waters. There are few sightings of Baird's beaked whales in the SOCAL Range Complex, sightings occurred in both the cold and warm seasons (U.S. Navy 1998).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0001434 for warm and cold water seasons (Table 2-2).

Reproduction/Breeding—Mating generally occurs in October and November but little else is known of their reproductive behavior (Balcomb 1989).

Diving Behavior—Analysis of stomach contents from captured and stranded individuals suggests that beaked whales are deep-diving animals, feeding by suction (Heyning and Mead 1996). The Baird's beaked whale, feeds mainly on benthic fishes and cephalopods, but occasionally on pelagic fish such as mackerel, sardine, and saury (Kasuya 2002; Walker et al. 2002; Ohizumi et al. 2003). Baird et al. (2006) reported on the diving behavior of four Blaineville's beaked whales (a similar species) off the west coast of Hawaii. The four beaked whales foraged in deep ocean areas (2,270-9,855ft) with a maximum dive to 4,619 ft. Dives ranged from at least 13 min (lost dive recorder during the dive) to a maximum of 68 min (Baird et al. 2006).

In lieu of other information, the depth distribution for northern bottlenose whales, *Hyperoodon ampullatus,* will be extrapolated to Baird's. There has been one study on northern bottlenose whales, which provides some guidance as to depth distribution (Hooker and Baird 1999). Most (62-70%, average = 66%) of the time was spent diving (deeper than 40 m), and most dives were somewhat V-shaped. Both shallow dives (<400 m) and deep dives (>800 m) were recorded, and whales spent 24-30% (therefore, average of 27%) of dives at 85% maximum depth indicating they feed near the bottom. Using these data points, we estimate 34% of time at 0-40 m, 39% at 41-800 m, 27% at >800 m for *H. ampullatus* and extrapolate this to *B. berardius*.

Acoustics—MacLeod (1999) suggested that beaked whales use frequencies of between 300 Hz and 129 kHz for echolocation, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. Both whistles and clicks have been recorded from Baird's beaked whales in the eastern North Pacific Ocean (Dawson et al. 1998). Whistles had fundamental frequencies between 4 and 8 kHz, with 2 to 3 strong harmonics within the recording bandwidth (Dawson et al. 1998). Pulsed sounds (clicks) had a dominant frequency around 23 kHz, with a second frequency peak around 42 kHz (Dawson et al. 1998). The clicks were most often emitted in irregular series of very few clicks; this acoustic behavior appears unlike that of many species that do echolocate (Dawson et al. 1998). Cuvier's beaked whales echolocation clicks were recorded at frequencies from 20 to 70 kHz (Zimmer et al. 2005).

Cook et al. (2006) reported that the Gervais beaked whale (Mesoplodon europeus) could hear in the range of 5 to 80 kHz although no measurements were attempted above 80 kHz). The Gervais beaked whale was most sensitive from 40 to 80 kHz (Cook et al. 2006).

Bottlenose dolphin, Coastal (*Tursiops truncatus*) California Coastal Stock

Population Status—There are two distinct populations of bottlenose dolphins within Southern California, a coastal population found within 0.5 nm (0.9 km) of shore and a larger offshore population (Hansen 1990). Population size for the California Coastal Stock of the bottlenose dolphin is estimated to be 323 (CV=0.13) individuals (Carretta et al. 2007).

Distribution—The coastal population of bottlenose dolphins inhabits waters from Point Loma to San Pedro (Dohl et al. 1981; Hansen 1990). Occasionally, during warm-water incursions such as during the 1982–1983 El Niño event, their range extends as far north as Monterey Bay (Wells et al. 1990). Bottlenose dolphins in the Southern California Bight appear to be highly mobile within a relatively narrow coastal zone (Defran et al. 1999), and exhibit no seasonal site fidelity to the region (Defran and Weller, 1999). Sightings of coastal bottlenose dolphins are common along the coast east of the SCIRC (Barlow et al. 1997). Bottlenose dolphins are found in the SOCAL Range Complex throughout the year (Defran and Weller 1999).

At Sea Density Estimates—At sea densities of the California coastal stock of bottlenose dolphins was not calculated.

Reproduction/Breeding—Newborn calves are seen through out the year and reproduction may be influenced by productivity and food abundance (Urian et al. 1996).

Diving Behavior—Pacific coast bottlenose dolphins feed primarily on surf perches (Family Embiotocidae) and croakers (Family Sciaendae) (Norris and Prescott 1961; Walker 1981; Schwartz et al. 1992; Hanson and Defran 1993), and also consume squid (Loligo opalescens) (Schwartz et al., 1992). Navy bottlenose dolphins have been trained to reach maximum diving depths of about 984 ft (Ridgway et al. 1969). Reeves et al. (2002) noted that the presence of deep-sea fish in the stomachs of some offshore individual bottlenose dolphins suggests that they dive to depths of more than 1,638 ft. Dive durations up to 15 min have been recorded for trained individuals (Ridgway et al. 1969). Typical dives, however, are more shallow and of a much shorter duration. Bottlenose dolphins utilize the entire water column by feeding on prey that concentrate near the surface, midwater areas and benthic areas (Hastie et al. 2005).

Acoustics—Sounds emitted by bottlenose dolphins have been classified into two broad categories: pulsed sounds (including clicks and burst-pulses) and narrow-band continuous sounds (whistles), which usually are frequency modulated (FM). Generally, whistles range in frequency from 0.8 to 24 kHz but can also go much higher (Richardson et al. 1995). Clicks and whistles have a dominant frequency range of 110 to 130 kHz and a source level of 218 to 228 dB re 1 μPa-m (peak to peak levels; Au, 1993) and 3.5 to 14.5 kHz with a source level of 125 to 173 dB re 1 μPa-m, respectively (Ketten, 1998).

The bottlenose dolphin has a functional high-frequency hearing limit of 160 kHz (Au 1993) and can hear sounds at frequencies as low as 40 to 125 Hz (Turl 1993). Inner ear anatomy of this species has been described (Ketten 1992). Electrophysiological experiments suggest that the bottlenose dolphin brain has a dual analysis system: one specialized for ultrasonic clicks and the other for lower-frequency sounds, such as whistles (Ridgway 2000). The audiogram of the bottlenose dolphin shows that the lowest thresholds occurred near 50 kHz at a level around 45 dB re 1 μPa (Nachtigall et al. 2000; Finneran and Houser 2006; Houser and Finneran 2007). Below the maximum sensitivity, thresholds increased continuously up to a level of 137 dB at 75 Hz. Above 50 kHz, thresholds increased slowly up to a level of 55 dB at 100 kHz, then increased rapidly above this to about 135 dB at 150 kHz. Scientists have reported a range of best sensitivity between 25 and 70 kHz, with peaks in sensitivity occurring at 25 and 50 kHz at levels of 47 and 46 dB re 1 μPa (Nachtigall et al. 2000).

Temporary threshold shifts (TTS) in hearing have been experimentally induced and behavioral responses observed in captive bottlenose dolphins (Ridgway et al. 1997; Schlundt et al. 2000; 2006; Nachtigall et al. 2003; Finneran et al. 2002; 2005; 2007b). Ridgway et al. (1997) observed changes in behavior at the following minimum levels for 1 sec tones: 186 dB at 3 kHz, 181 dB at 20 kHz, and 178 dB at 75 kHz (all re 1 μPa). TTS levels were 194 to 201 dB at 3 kHz, 193 to 196 dB at 20 kHz, and 192 to 194 dB at 75 kHz (all re 1 μPa). Schlundt et al. (2000) exposed bottlenose dolphins to intense tones (0.4, 3, 10, 20, and 75 kHz); the animals demonstrated altered behavior at source levels of 178 to 193 dB re 1 μPa, with TTS after exposures generally between 192 and 201 dB re 1 μPa-m (though one dolphin exhibited TTS after exposure at 182 dB re 1 μPa). Nachtigall et al. (2003) determined threshold for a 7.5 kHz pure tone stimulus. No shifts were observed at 165 or 171 dB re 1 μPa, but when the sound level reached 179 dB re 1 μPa, the animal showed the first sign of TTS. Recovery apparently occurred rapidly, with full recovery apparently within 45 min following sound exposure. TTS measured between 8 and 16 kHz (negligible or absent at higher frequencies) after 30 min of sound exposure (4 to 11 kHz) at 160 dB re 1 μPa (Nachtigall et al. 2004). Further details of TTS in bottlenose dolphins are described in section 3.10.

Bottlenose dolphin, Offshore (Tursiops truncatus) California/Oregon/Washington Offshore Stock

Population Status—Population size for the California/Oregon/Washington bottlenose dolphin stock is estimated to be 2,026 (CV=0.54) individuals (Barlow and Forney 2007).

Distribution—Offshore bottlenose dolphins are thought to have a continuous distribution in California (Mangels and Gerrodette 1994). They have been found in the Southern California Bight and in waters as far north as ~41ºN (Barlow et al. 1997). During most of the year, a relatively large population of bottlenose dolphins occurs in offshore waters of the Southern California Bight centered around Santa Catalina Island and, to a lesser degree, the eastern coast of San Clemente Island. The population may disperse more broadly in summer than in winter (Dohl et al. 1981). Offshore bottlenose dolphins are found in the SOCAL Range Complex throughout the year (Carretta et al. 2007).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0123205 for warm water season and 0.0184808 for cold water season (Table 2-2).

Reproduction/Breeding—Newborn calves are seen through out the year and reproduction may be influenced by productivity and food abundance (Urian et al. 1996).

Diving Behavior—Offshore bottlenose dolphins in the Bahamas dove to depths below 450 m and for over 5 min during the night but dives were shallow (<50m) during the day (Klatsky et al. 2007). In contrast, the dives of offshore bottlenose dolphins off the east coast of Australia were mostly within 5 m of the surface (approximately 67% of dives) with the deepest dives to only 150 meters (Corkeron and Martin 2004). A comparison of hemoglobin concentration and hematocrit, important to oxygen storage for diving, between Atlantic coastal and offshore bottlenose dolphins shows higher levels of both in offshore dolphins (Hersh and Duffield 1990). The increase in hemoglobin and hematocrit suggest greater oxygen storage capacity in the offshore dolphin which may allow it to dive longer in the deep offshore areas that they inhabit.

Based on data presented in Klatsky et al. (2007), the following depth distribution has been estimated for offshore bottlenose dolphins: Daytime: 96% at <50 m, 4% at >50 m; nightime: 51% at <50 m, 8% at 50-100 m, 19% at 101-250 m, 13% at 251-450 m and 9% at >450 m. Data on time spent at the surface were not published, therefore, it was included in the least shallow depth category published.

Acoustics—The acoustic abilities of offshore bottlenose dolphins is assume to be similar to the coastal population of bottlenose dolphins described in the previous discussion.

Cuvier's beaked whale (*Ziphius cavirostris*) California/Oregon/Washington Stock

Population Status—Population size for the California/Oregon/Washington Cuvier's beaked whale stock is estimated to be 4,342 (CV=0.58) individuals (Barlow and Forney 2007).

Distribution—Little is known about the habitat preferences of any beaked whale. Based on current knowledge, beaked whales normally inhabit deep ocean waters (>2,000 m) or continental slopes (200–2,000 m), and only rarely stray over the continental shelf (Pitman 2002). Cuvier's beaked whale generally is sighted in waters >200 m deep, and is frequently recorded at depths >1,000 m (Gannier 2000; MacLeod et al. 2004). They are commonly sighted around seamounts, escarpments, and canyons. MacLeod et al. (2004) reported that Cuvier's beaked whales occur in deeper waters than Blainville's beaked whales in the Bahamas. Recent data from Ferguson et al. (2006) demonstrated that beaked whales can be found in habitats ranging from continental slopes to abyssal plains. In Hawaii Cuvier's beaked whales showed a high degree of site fidelity in a study spanning 21 years and showed that there was a offshore population and an island associated population (McSweeney et al. 2007). The site fidelity in the island associated population was hypothesized to take advange of the influence of islands on oceanographic conditions that may increase productivity (McSweeney et al. 2007).

The distribution and abundance of beaked whales in the SOCAL Range Complex are not well known because they are difficult to identify; many of the beaked whales sighted have not been identified to species. Based on those that were identified, Cuvier's beaked whale appears to be the most abundant beaked whale in the area, representing almost 80% of the identified beaked whale sightings (Barlow and Gerrodette 1996). While they are sighted only during the cold-water season, it is unknown if Cuvier's beaked whales are found in the SOCAL Range Complex year-round or shift distribution.

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0036883 for warm and cold water seasons (Table 2-2).

Reproductive/Breeding—Little is known of beaked whale reproductive behavior.

Diving Behavior—Cuvier's beaked whales are generally sighted in waters with a bottom depth greater than about 650 ft and are frequently recorded at depths of 3,282 ft or more (Gannier 2000; MacLeod et al. 2004). They are commonly sighted around seamounts, escarpments, and canyons. In the eastern tropical Pacific Ocean, the mean bottom depth for Cuvier's beaked whales is approximately 11,154 ft, with a maximum depth of over 16,732 ft. (Ferguson 2005). Recent studies by Baird et al. (2006) show that Cuvier's beaked whales dive deeply (maximum of 4,757 ft) and for long periods (maximum dive duration of 68.7 min) but also spent time at shallow depths. Tyack et al. (2006b) has also reported deep diving for Cuvier's beaked whales with mean depth of 3,510 ft and mean duration of 58 min. Gouge marks were observed on mud volcanoes on the seafloor at 5,580–6,564, and Woodside et al. (2006) speculated that they were caused by Cuvier's beaked whales foraging on benthic prey.

Total time at surface (0-2 m) was calculated by subtracting the mean length of deep foraging dives and two shallow duration dives from the total dive cycle (121.4 - 58.0 – 30.4 = 33 min). Total (DFD) time at deepest depth was taken from the vocal phase duration time, as echolocation clicks generally commenced when animals were deepest, and was 32.8 min. The amount of time spent descending and ascending on DFDs was calculated by subtracting the mean Vocal phase duration time from the mean total DFD (58.0 - 32.8 = 25.2 min) and then dividing by five (# of 200 m depth categories between surface and 1070 m) which equals ~five min per 200 m. The five-minute value was applied to each 200 m depth category from 400-1070 m; for the 2-220 m category, the mean length of shallow duration dives was added to the time for descent/ascent (30.4 + 5 = 35.4 min). Therefore, the depth distribution for Cuvier's beaked whales based on best available information from Tyack et al. (2006b) is: 27% at <2 m, 29% at 2-220 m, 4% at 221-400 m, 4% at 401-600 m, 4% at 601-800 m, 5% at 801-1070 m and 27% in >1070 m.

Acoustics—MacLeod (1999) suggested that beaked whales use frequencies of between 300 Hz and 129 kHz for echolocation, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. Blaineville's beaked whales echolocation clicks were recorded at frequencies from 20 to 40 kHz (Johnson et al. 2004) and Cuvier's beaked whales at frequencies from 20 to 70 kHz (Zimmer et al. 2005). Soto et al. (2006) reported changes in vocalizations during diving on close approaches of large cargo ships which may have masked their vocalizations. Cuvier's beaked whales only echolocated below 200 m (Tyack et al. 2006a). Echolocation clicks are produced in trains (interclick intervals near 0.4 s and individual clicks are frequency modulated pulses with durations of 200-300 µsec, the center frequency was around 40 kHz with no energy below 20 kHz (Tyack et al. 2006a).

Cook et al. (2006) reported that the Gervais beaked whale (Mesoplodon europeus) could hear in the range of 5 to 80 kHz although no measurements were attempted above 80 kHz.

Dall's porpoise (*Phocoenoides dalli*) California/Oregon/Washington stock

Population Status—Population size for the Washington/Oregon/California Dall's porpoise stock is estimated to be 85,955 (CV=0.45) individuals (Barlow and Forney 2007). No specific data are available regarding trends in population size in California or adjacent waters.

Distribution—Dall's porpoise's range in the eastern North Pacific extends from Alaska south to Baja California (Morejohn 1979). It is probably the most abundant small cetacean in the North Pacific Ocean. Its abundance changes seasonally, probably in relation to water temperature. It is considered to be a cold-water species, and is rarely seen in areas where water temperatures exceed 17°C (Leatherwood et al. 1982). Its distribution shifts southward and nearshore in autumn, especially near the northern Channel Islands, and northward and offshore in late spring (Dohl et al. 1981; Leatherwood et al. 1987; Barlow et al. 1997; Forney and Barlow 1998). Dall's porpoises are found in the SOCAL Range Complex throughout the year (Forney and Barlow 1998).

Although feeding aggregations of up to 200 have been sighted (Leatherwood et al. 1987), recent sightings in and near the Southern California Bight have been of groups averaging 3.1–3.4 (Barlow 1995; Forney et al. 1995; Carretta et al. 2000). During the 1998–1999 NMFS surveys of the SCIRC, the mean size of 8 groups was 3.4 (Carretta et al. 2000).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0016877 for warm water season and 0.0081008 for cold water season (Table 2-2).

Reproduction/Breeding—Calving occurs in the north Pacific from early June through late July (Ferrero and Walker 1999).

Diving Behavior—Dall's porpoises feed primarily on small fish and squid (Houck and Jefferson 1999). Dall's porpoises in some areas appear to feed preferentially at night on vertically migrating fish and squid associated with the DSL (Houck and Jefferson 1999). Hanson and Baird (1998) provided the first data on diving behavior for this species, an individual tagged for 41 min dove to a mean depth of 33.4 m (S.D. = + 23.9 m) for a mean duration of 1.29 min (S.D. = + 0.84 min).

Total time at the surface was 10.27 min (time between dives minus the dive durations). Dives within 10 m totaled 2.11 min, dives to >60 m totaled 0.4 min, and dives with bottom time between 41 and 60 m totaled 1.83 min. The remaining time can be assumed to be spent diving between 11 and 40 m.

Based on this information, the depth distribution can be estimated as 39% at <1 m, 8% at 1-10 m, 45% at 11-40 m, and 8% at >40 m.

Acoustics—Only short duration pulsed sounds have been recorded for Dall's porpoise (Houck and Jefferson 1999); this species apparently does not whistle often (Richardson et al. 1995). Dall's porpoises produce short-duration (50 to 1,500 µs), high-frequency, narrow band clicks, with peak energies between 120 and 160 kHz (Jefferson 1988). There are no published data on hearing ability of this species.

Dwarf and Pygmy sperm whale (Kogia spp) California/Oregon/Washington Stock

Population Status—The two species *Kogia*, dwarf and pygmy sperm whales whales are distributed widely in the world's oceans, but they are poorly known (Caldwell and Caldwell 1989). Their small size, non-gregarious nature, and cryptic behavior make dwarf sperm and pygmy whales whales difficult to observe. The two species are also difficult to distinguish when sighted at sea, and are often jointly categorized as *Kogia* spp. Dwarf sperm whales within the U.S. Pacific EEZ are each divided into two discrete, non-contiguous areas: (1) Hawaiian waters, and (2) waters off California, Oregon, and Washington (Carretta et al. 2007). The best available estimate of abundance for the California/Oregon/Washington stock of the dwarf sperm whale is unknown (Carretta et al. 2007). Both Kogia species have a worldwide distribution in tropical and temperate waters (Jefferson et al. 1993). There is insufficient information available to estimate population size of the dwarf sperm whale off the Pacific coast of the U.S (Carretta et al. 2007).

Distribution—Dwarf and pygmy sperm whales are sighted primarily along the continental shelf edge and over deeper waters off the shelf (Hansen et al. 1994; Davis et al. 1998). However, along the U.S. west coast, sightings of the whales have been rare, although that is likely a reflection of their pelagic distribution and small size rather than their true abundance (Carretta et al. 2002). Several studies have suggested that pygmy sperm whales live mostly beyond the continental shelf edge, whereas dwarf sperm whales tend to occur closer to shore, often over the continental shelf (Rice 1998; Wang et al. 2002; MacLeod et al. 2004). Barros et al. (1998), on the other hand, suggested that dwarf sperm whales might be more pelagic and dive deeper than pygmy sperm whales.

Another suggestion is that the pygmy sperm whale is more temperate, and the dwarf sperm whale more tropical, based at least partially on live sightings at sea from a large database from the eastern tropical Pacific Ocean (Wade and Gerrodette 1993). There, the pygmy sperm whale was not seen in truly tropical waters south of the southern tip of Baja California, but the dwarf sperm whale was common in those waters. This idea is also supported by the distribution of strandings in South American waters (Muñioz-Hincapié et al. 1998). Also, in the western tropical Indian Ocean, the dwarf sperm whale was much more common than the pygmy sperm whale, which is consistent with this hypothesis (Balance and Pitman 1998). There have been few sightings of Dwarf sperm whales in the SOCAL Range Complex; therefore, seasonal occurrence can not be determined (Wade and Gerrodette 1993). Both species of Kogia generally occur in waters along the continental shelf break and over the continental slope (e.g., Baumgartner et al. 2001; McAlpine 2002; Baird 2005). The primary occurrence for Kogia is seaward of the shelf break in and in deep water with a mean depth of 4,675 ft (Baird 2005). This takes into account their preference for deep waters. There is a rare occurrence for Kogia inshore of the area of primary occurrence. Occurrence is expected to be the same throughout the year. Dwarf sperm whales showed a high degree of site fidelity, determined from photo identification over several years, in area of west of the island of Hawaii (Baird et al. 2006).

At Sea Density Estimates—There were no sightings of *Kogia* during vessel surveys conducted in 2005 (Forney, 2007) and one sighting off central California in 2001 (Appler et al. 2004). Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0013785 for warm and cold water seasons (Table 2-1).

Reproduction/Breeding—There is no information on the breeding behavior in this area.

Diving Behavior—*Kogia* feed on cephalopods and, less often, on deep-sea fishes and shrimps (Caldwell and Caldwell 1989; Baird et al. 1996; Willis and Baird 1998; Wang et al. 2002). Willis and Baird (1998) reported that Kogia make dives of up to 25 min. Median dive times of around 11 min have been documented for *Kogia* (Barlow 1999). A satellite-tagged pygmy sperm whale released off Florida was found to make long nighttime dives, presumably indicating foraging on squid in the deep scattering layer (Scott et al. 2001). Most sightings of Kogia are brief; these whales are often difficult to approach and they actively avoid aircraft and vessels (Würsig et al. 1998).

Prey preference, based on stomach content analysis from Atlantic Canada (McAlpine et al. 1997) and New Zealand (Beatson 2007), appears to be mid and deep water cephalopods, crustaceans and fish. There is some evidence that they may use suction feeding and feed at or near the bottom. They may also take advantage of prey undergoing vertical migrations to shallower waters at night (Beatson 2007). In lieu of any other information, Blainville’s beaked whale depth distribution data will be extrapolated to pygmy sperm whales as the two species appear to have similar prey preferences and are closer in size than either is to sperm or Cuvier’s beaked whales. Blainville’s undertakes shallower non-foraging dives in-between deep foraging dives. Blainville’s beaked whale depth distribution data, taken from Tyack et al. (2006b) and summarized in greater depth later in this document is: 26% at <2 m, 41% at 2-71 m, 2% at 72-200 m, 4% at 201-400 m, 4% at 401-600 m, 4% at 601-835 m and 19% at >838 m.

Acoustics—No information is available on dwarf sperm whale vocalizations or hearing capabilities. Pygmy sperm whale clicks range from 60 to 200 kHz, with a dominant frequency of 120 kHz (Richardson et al. 1995). An auditory brainstem response study indicates that pygmy sperm whales have their best hearing between 90 and 150 kHz (Ridgway and Carder 2001).

False killer whale (*Pseudorca crassidens*) Not defined for this area.

Population Status—This stock is listed as a strategic stock by NMFS because the estimated level of serious injury and mortality from the Hawaii-based tuna and swordfish long-line fishery is greater than the potential biological removal (Carretta et al. 2007). Genetic evidence suggests that the Hawaiian stock might be a reproductively isolated population from false killer whales in the eastern tropical Pacific (Chivers et al. 2003).

Distribution—False killer whales are found in tropical and temperate waters, generally between 50°S and 50°N latitude with a few records north of 50°N in the Pacific and the Atlantic (Odell and McClune 1999). Seasonal movements in the western North Pacific may be related to prey distribution (Odell and McClune 1999). Baird et al. (2005) noted considerable inter-island movements of individuals in the Hawaiian Islands.

False killer whales are commonly sighted in offshore waters from small boats and aircraft, as well as offshore from long-line fishing vessels (e.g., Mobley et al. 2000; Baird et al. 2003; Walsh and Kobayashi 2004).

At Sea Density Estimates—There are no density estimates for false killer whales in Southern California.

Reproduction/Breeding—Little is known of their reproductive behavior.

Diving Behavior—False killer whales primarily eat deep-sea cephalopods and fish (Odell and McClune 1999), but they have been known to attack other cetaceans, including dolphins

(Perryman and Foster 1980; Stacey and Baird 1991), sperm whales (Palacios and Mate 1996), and baleen whales.

Acoustics—The dominant frequencies of false killer whale whistles are 4 to 9.5 kHz; those of their clicks are 25 to 30 kHz and 95 to 130 kHz (Thomas et al. 1990; Richardson et al. 1995). The source level of clicks is 220 to 228 dB re 1 µPa-m (Ketten 1998). Best hearing sensitivity measured for a false killer whale was around 16 to 64 kHz (Thomas et al. 1988, 1990). Yuen et al. (2005) tested a stranded false killer whale using auditory evoke potentials produce an audiogram in the range of 4-44 kHz and with best sensitivity at 16-24 kHz.

Killer whale, Offshore (*Orcinus orca*) Eastern North Pacific Offshore

Population Status—Killer whales are segregated socially, genetically, and ecologically into three distinct groups: residents, transients, and offshore animals. Offshore whales do not appear to mix with the other types of killer whales (Black et al. 1997; Dahlheim et al. 1997). Most of the killer whales off California are from transient and offshore groups. Population size for all killer whales along the coasts of California, Oregon and Washington is estimated to be 1,340 (CV=0.31) individuals (Carretta et al. 2007).

Distribution—Killer whales from the Eastern North Pacific Southern Offshore Stock, range from Washington to the Southern California Bight and could occur in the SOCAL Range Complex. No killer whales were sighted during the 1998–1999 NMFS surveys offshore of San Clemente Island (Carretta et al. 2000), although killer whales could theorectically be sighted throughout the year (Black et al. 1997).

At Sea Density Estimates—Killer whales were seen off southern California during vessel surveys conducted in 2005 (Forney 2007). Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0000812 for warm and cold water seasons (Table 2-2).

Reproduction/Breeding—There is no information the reproductive behavior of killer whales in this area.

Diving Behavior—The maximum depth recorded for free-ranging killer whales diving off British Columbia is about 864 ft (Baird et al. 2005). On average, however, for seven tagged individuals, less than 1 percent of all dives examined were to depths greater than about 30 m (Baird et al. 2003). The longest duration of a recorded dive from a radio-tagged killer whale was 17 min (Dahlheim and Heyning 1999).

Transient" stocks of killer whales feed on other marine mammals, including other whales, pinnipeds (e.g., London 2006) and sea otters (e.g., Estes et al. 1998). Diving studies on killer whales have been undertaken mainly on "resident" (fish-eating) killer whales in Puget Sound and may not be applicable across all populations of killer whales. Diving is usually related to foraging, and mammal-eating killer whales may display different dive patterns. Killer whales in one study (Baird et al. 2005b) dove as deep as 264 m, and males dove more frequently and more often to depths >100 m than females, with fewer deep dives at night. Dives to deeper depths were often characterized by velocity bursts which may be associated with foraging or social activities.

Using best available data from Baird et al. (2003a), it would appear that killer whales spend ~4% of time at depths >30 m and 96% of time at depths 0-30 m.

Acoustics—The killer whale produces a wide variety of clicks and whistles, but most of its sounds are pulsed and at 1 to 6 kHz (Richardson et al. 1995). The peak to peak source levels of echolocation signals range between 195 and 224 dB re 1 µPa-m (Au et al. 2004). The source level of social vocalizations ranges between 137 to 157 dB re 1 µPa-m (Veirs 2004). Acoustic studies of resident killer whales in British Columbia have found that there are dialects, in their highly stereotyped, repetitive discrete calls, which are group-specific and shared by all group members (Ford 2002). These dialects likely are used to maintain group identity and cohesion, and may serve as indicators of relatedness that help in the avoidance of inbreeding between closely related whales (Ford 2002). Dialects also have been documented in killer whales occurring in northern Norway, and likely occur in other locales as well (Ford 2002). The killer whale has the lowest frequency of maximum sensitivity and one of the lowest high frequency hearing limits known among toothed whales (Szymanski et al. 1999). The upper limit of hearing is 100 kHz for this species. The most sensitive frequency, in both behavioral and in auditory brainstem response audiograms, has been determined to be 20 kHz (Szymanski et al. 1999).

Killer whale, Transient (*Orcinus orca*) Eastern North Pacific Transient

Population Status—The population estimate for the Eastern North Pacific Stock of transient killer whales is 346 (Carretta et al. 2007) and along the coast of California 105 killer whales have been identified by Forney et al. 2000).

Distribution—Little is known about the movements and range of the Eastern Pacific Transient stock (Caretta et al. 2007).

Reproduction/Breeding—There is no information the reproductive behavior of killer whales in this area.

*Diving Behavio*r—Diving behavior is assumed to be similar to that of the offshore stock but may feed on different prey items.

Acoustics—The acoustic abilities of transient killer whales is assume to be similar to the population of killer whales described in the section on the killer whale offshore stock.

Long-beaked common dolphin (*Delphinus capensis*) California

Population Status—Two species of common dolphin occur off California, the more coastal long-beaked dolphin (*D. capensis*) and the more offshore short-beaked dolphin (*D. delphis*). The long-beaked common dolphin is less abundant, and only recently has been recognized as a separate species (Heyning and Perrin 1994). Thus, much of the available information has not differentiated between the two species. Population size is estimated to be 21,902 (CV = 0.50) individuals (Carretta et al. 2007). Available data regarding trends in population size in California and adjacent waters suggest an increase in numbers of short-beaked , likely because of gradual warming of waters off California with the population shifting north (Heyning and Perrin 1994; Barlow et al. 1997; Forney 1997) but long beaked common dolphins decreased (Barlow and Forney, 2007). The long-beaked common dolphin is considered threatened or endangered under the ESA but is considered a strategic stock under theMMPA. It is considered as a strategic stock because the human caused more mortality exceeds the potential biological removal (Carreta et al., 2008; draft stock assessment report)

Distribution—Common dolphin distributions are related to bathymetry; high-relief areas known to be associated with high concentrations of anchovies (Hui 1979) are used more frequently than are low-relief areas. Short-beaked common dolphins have been sighted as far as 300 nm (556 km) from shore, and are likely present further offshore (Barlow et al. 1997, Bearzi 2005, 2006). Long-beaked common dolphins are usually found within 50 nm (92.5 km) of shore (Barlow et al. 1997, Bearzi 2005, 2006) and are generally not sighted further than 100 nm (185 km) from shore (Perrin et al. 1985; Barlow 1992 in Heyning et al. 1994).

Between the two common dolphin species, the short-beaked common dolphin is more abundant in the waters of the SOCAL Range Complex and the long-beaked common dolphin relatively less common, occurring mostly in the warm-water period. Long beaked common dolphins are found in the region throughout the year (Carretta et al. 2000), although abundance of common dolphins has been shown to change on both seasonal and inter-annual time scales in southern California (Dohl et al. 1986; Barlow 1995; Forney et al. 1995; Forney and Barlow 1998). The common dolphin is the most abundant cetacean in the SCIRC; it comprised 74.6% of the estimated number of cetaceans in cold-water months and 98.0% in warm-water months (Carretta et al. 2000). The available data show a mean group size of 353.6 animals (based on n=61 groups) offshore of San Clemente Island (Carretta et al. 2000). The largest group of common dolphins seen there was 2,700.

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0965747 for warm water season and 0.0366984 for cold water season (Table 2-2).

Reproduction/Breeding—The peak calving season occurs from spring and early summer (Forney 1994).

Diving Behavior—Stomach contents of *Delphinus* from California waters revealed 19 species of fish and two species of cephalopods; *Delphinus* feeds primarily on organisms in the vertically migrating DSL (Evans 1994). Diel fluctuations in vocal activity of this species (more vocal activity during late evening and early morning) appear to be linked to feeding on the DSL as it rises during the sametime (Goold 2000). A tagged individual tracked off San Diego conducted dives deeper than 200 m, but with most in the range of 9 to 50 m (Evans 1971; 1994).

This species is an opportunistic feeder of small mesopelagic fishes and squids found in the deep scattering layer. There have been several studies on localized feeding behavior of short-beaked common dolphins, but none specifically on long-beaked common dolphins as they have only been differentiated as a separate species since the late 1990s. There have been no studies on depth distribution of either *Delphinus* species**.** Most foraging behavior studies (many based on stomach content analysis of stranded animals) indicate that common dolphins take advantage of small schooling fish that undergo vertical migrations at night and that most feeding takes place at dusk and early evening (Pusineri et al. 2007). Perrin (2002b) indicates that common dolphins may forage to depths of 200 m but that most dives occur in less than 100 m.

Based on this limited information, depth distribution is estimated as: 100% at 0-200m.

Acoustics—Recorded Delphinus vocalizations include whistles, chirps, barks, and clicks (Ketten 1998). Clicks and whistles have dominant frequency ranges of 23 to 67 kHz and 0.5 to 18 kHz, respectively (Ketten 1998). Maximum source levels were approximately 180 dB 1 μPa-m (Fish and Turl 1976). Popov and Klishin (1998) recorded auditory brainstem responses from a short-beaked common dolphin. The audiogram was U-shaped with a steeper high-frequency branch. The audiogram bandwidth was up to 128 kHz at a level of 100 dB above the minimum threshold. The minimum thresholds were observed at frequencies of 60 to 70 kHz.

Longman's beaked whale (Indopacetus pacificus) Undefined for Southern California and Mexico

Population Status—There is no information on the population trend of Longman's beaked whale (Carretta et al. 2007).

Distribution—Longman's beaked whale sightings in the Eastern Tropical Pacific were south of 25°N Ferguson and Barlow (2001). The northernmost records in the eastern North Pacific Ocean are five sightings off Baja California, during an El Niño event (Gallo-Reynoso and Figueroa-Carranza 1995). Beaked whales may be expected to occur in the area including around seaward of the shelf break. There is a low or unknown occurrence of beaked whales on the shelf between the 162 ft isobath and the shelf break, which takes into account that deep waters come very close to the shore in this area. In some locales, beaked whales can be found in waters over the shelf, so it is possible that beaked whales have similar habitat preferences here.

Longman's beaked whale is not as rare as previously thought. However, the frequency with which it has been sighted in the eastern and western tropical Pacific oceans (MacLeod et al. 2004) suggests that it is probably not as common as the Cuvier's and Mesoplodon beaked whales (Ferguson and Barlow 2001). Recent information shows that Cuvier's and Mesoplodon beaked whales may not always inhabit deep ocean areas and may be found over the continental slope (Ferguson et al. 2006).

At Sea Density Estimates—There is no density estimate for the SOCAL Range Complex area.

Reproduction/Breeding—There is no information the reproductive behavior of Longman's beaked whales in this area.

Diving Behavior—Analysis of stomach contents from captured and stranded individuals suggests that beaked whales are deep-diving animals, feeding by suction (Heyning and Mead 1996). Another species of beaked whales, the Baird's beaked whale, feed mainly on benthic fishes and cephalopods, but occasionally on pelagic fish such as mackerel, sardine, and saury (Kasuya 2002; Walker et al. 2002; Ohizumi et al. 2003). Prolonged dives by the Baird's beaked whales for periods of up to 67 min have been reported (Kasuya, 2002), though dives of about 84 to 114 ft are typical, and dives of 45 min are not unusual (Balcomb 1989; Von Saunder and Barlow 1999).

Acoustics—MacLeod (1999) suggested that beaked whales use frequencies of between 300 Hz and 129 kHz for pulse sounds, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. Cuvier's beaked whales echolocation clicks were recorded at frequencies from 20 to 70 kHz (Zimmer et al. 2005).

There is no hearing information on Longman's beaked whale acoustics but they may be similar to other beaked whales. Cook et al. (2006) reported that the Gervais beaked whale (Mesoplodon europeus) could hear in the range of 5 to 80 kHz although no measurements were attempted above 80 kHz). The Gervais beaked whale was most sensitive from 40 to 80 kHz (Cook et al. 2006).

Mesoplodont beaked whales (Mesoplodon spp.) California/Oregon/Washington

Population Status—Mesoplodonts are difficult to distinguish in the field. They are pelagic, spending most of their time in deep water far from shore, and dive for long periods. Five species of Mesoplodon may occur off the coast of southern California: Blainville's beaked whale (*M. densirostris*), Hubb's beaked whale (*M. carlhubbsi*), Perrin's beaked whale (*M. perrini*), pygmy beaked whale (*M. peruvianus*), and ginkgo-toothed beaked whale (*M. ginkgodens*) (Mead 1981). Until better methods are developed for distinguishing the different Mesoplodon species from one another, the management unit is defined to include all Mesoplodon populations. Population size of California/Oregon/Washington Stock of Mesoplodont beaked whales is estimated to be 1,177 (CV=0.40) individuals (Barlow and Forney 2007).

Distribution—Blainville's beaked whale is the *Mesoplodon* species with the widest distribution throughout the world (Mead 1989), although it is generally limited to tropical and warmer temperate waters (Leatherwood and Reeves 1983). Occasional occurrences in cooler higher-latitude waters are presumably related to warm-water incursions (Reeves et al. 2002). In the North Pacific Ocean, the northernmost documented occurrence of this species is a stranding off central California (Reeves et al. 2002). Seasonal movements or migrations by Blainville's beaked whales are not known to occur.

Blainville's beaked whale distribution is mainly derived from stranding data. It is mainly a pelagic species, and like other beaked whales, is generally found in deep slope waters ~500–1000 m deep (Davis et al. 1998; Reeves et al. 2002). However, it may also occur in coastal areas, particularly where deep water gullies come close to shore. Most strandings involved single individuals, although groups of 3–7 were observed in tropical waters (Jefferson et al. 1993). Ritter and Brederlau (1999) estimated group size to range from 2–9 (mean 3.44).

Hubb's beaked whale occurs in temperate waters of the North Pacific (Mead 1989). Most (22 of 35) of the records are from California, including two records in Santa Barbara County (Mead, 1989). The distribution of the species appears to be correlated with the deep subarctic current (Mead et al. 1982). Hubb's beaked whales are often killed in drift gillnets off California (Reeves et al. 2002).

Perrin's beaked whale was first discovered in 2002, when genetic analysis was carried out on four whales stranded between 1975 and 1979 in California, all along <80 km of beach just north of San Diego (Dalebout et al. 2002). The whales previously were identified by Mead (1981) as Hector's beaked whale (*Mesoplodon hectori*), which before then was known only from the Southern Hemisphere. A fifth Perrin's beaked whale was identified by genetic analysis of a stranded whale near Monterey in 1997 that previously had been identified as a neonate Cuvier's beaked whale. Dalebout et al. (2002) also suggested that two sightings off the coast of California in the 1970s that were tentatively identified as Hector's beaked whales were Perrin's beaked whale.

The ginkgo-toothed beaked whale is only known from stranding records (Mead 1989). Strandings have been reported for the western and eastern North Pacific, South Pacific, and Indian oceans, and from the Galápagos Islands (Palacios 1996b). Two of the thirteen total records reported by Mead (1989) were from the eastern North Pacific, one from Del Mar, California, and one from Baja California. The species is hypothesized to occupy relatively cool areas in the temperate and tropical Pacific, where upwelling is known to occur, such as in the California and Peru Currents and the equatorial front (Palacios 1996b).

The pygmy beaked whale is the smallest Mesoplodont (Reyes et al. 1991). It is hypothesized to forage in mid-to-deep waters (Urbán-Ramírez and Aurioles-Gamboa 1992). The pygmy beaked whale is thought to occur between the latitudes 25°N and 15°S, from Baja California to Peru (Urbán-Ramírez and Aurioles-Gamboa 1992), although Pitman and Lynn (2001) noted a stranding record for the species in Chile, at latitude 29°15'S. Carretta et al. (2005) reported that is known to occur off the U.S. west coast, and Reeves et al. (2002) reported that it is also known to occur off southern California.

There have been few sightings of Mesoplodon species; therefore, seasonal occurrence in the SOCAL Range Complex can not be determined.

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0011125 for warm and cold water seasons (Table 2-2).

Reproduction/Breeding—There is no information the reproductive behavior of Mesoplodont whales in this area.

Diving Behavior—Analysis of stomach contents from captured and stranded individuals suggests that beaked whales are deep-diving animals, feeding by suction (Heyning and Mead 1996). Another species of beaked whales, the Baird's beaked whale, feeds mainly on benthic fishes and cephalopods, but occasionally on pelagic fish such as mackerel, sardine, and saury (Kasuya, 2002; Walker et al., 2002; Ohizumi et al. 2003). Baird et al. (2006) reported on the diving behavior of four Blaineville's beaked whales off the west coast of Hawaii. The four beaked whales foraged in deep ocean areas (2,270-9,855ft) with a maximum dive to 4,619 ft. Dives ranged from at least 13 min (lost dive recorder during the dive) to a maximum of 68 min (Baird et al. 2006). Tyack et al. (2006b) reported a mean depth of 2,740 ft and mean duration of 46.5 min for Baird's beaked whales.

Total time at surface (0-2 m) was calculated by subtracting the mean length of Deep Foraging Dives (DFD) and six shallow duration dives from the total dive cycle (Tyack et al. 2006b; 138.8 – 46.5 – 55.8 = 36.5 min). Total time at mean deepest depth was taken from the Vocal phase duration time, as echolocation clicks generally commenced when animals were deepest, and was 26.4 min. The amount of time spent descending and ascending on DFDs was calculated by subtracting the mean Vocal phase duration time from the mean total DFD (46.5 – 26.4 = 20.1 min) and then dividing by 12 (# of 70 m depth categories between surface and 838 m), which equals 1.7 min per 70 m. The 1.7 min value was applied to each 70 m depth category from 72-838 m; for the 2-71 m category, the mean length of shallow duration dives was added to the time for descent/ascent (55.8 + 1.7 = 57.5 min).

The depth distribution for Blainville's beaked whales (and applicable to *Mesoplodon* sp) based on best available information from Tyack et al. (2006b) is: 26% at <2 m, 41% in 2-71 m, 2% at 72-200 m, 4% at 201-400 m, 4% at 401-600 m, 4% at 601-835 m, and 19% at >835 m.

Acoustics—Rankin and Barlow (2007) reported on the vocalizations of Blaineville's beaked whales in Hawaii that included four mid frequency sounds: a frequency-modulated whistle and three frequency and amplitude modulated pulsed sounds within the range of 6 and 16 kHz. Vocalizations recorded from two juvenile Hubbs' beaked whales consisted of low and high frequency click trains ranging in frequency from 300 Hz to 80 kHz and whistles with a frequency range of 2.6 to 10.7 kHz and duration of 156 to 450 msec (Lynn and Reiss, 1992; Marten, 2000).

MacLeod (1999) suggested that beaked whales use frequencies of between 300 Hz and 129 kHz for pulse sounds, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. Cuvier's beaked whale's echolocation clicks were recorded at frequencies from 20 to 70 kHz (Zimmer et al. 2005).

There is no hearing information on these beaked whale acoustics but they may be similar to other beaked whales. Cook et al. (2006) reported that the Gervais beaked whale (*Mesoplodon europeus*) could hear in the range of 5 to 80 kHz although no measurements were attempted above 80 kHz). The Gervais beaked whale was most sensitive from 40 to 80 kHz (Cook et al. 2006).

Northern right whale dolphin (*Lissodelphis borealis*) California/Oregon/Washington Stock

Population Status—The northern right whale dolphin is not listed under the ESA, and the California/ Oregon/Washington Stock is not considered depleted or strategic. There are no available data regarding trends in population size in California or adjacent waters. Population size of the California/Oregon/Washington Stock is estimated to be 11,097 (CV=0.26) individuals (Barlow and Forney 2007).

Distribution—This species is endemic to the North Pacific Ocean, and is found primarily in temperate (8–19ºC) continental shelf and slope waters (Leatherwood and Walker 1979; Barlow et al. 1997). There is strong evidence of seasonal movements, probably related to water temperature. Peak numbers of northern right whale dolphins are seen in southern California in December and January. Northern right whale dolphins were dispersed throughout offshore waters in the SCIRC during the cold water months, with several sightings near San Clemente Island. They were rare in the continental slope waters of the SCIRC during the warm-water months (Forney 1997; Carretta et al. 2000). The mean size of 11 groups in the SCIRC was 12.4

(Carretta et al. 2000). Northern right whale dolphins are found in SOCAL Range Complex throughout the year (Carretta et al. 2000).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0056284 for warm water season and 0.0270163 for cold water season (Table 2-2).

Reproduction/Breeding—The calving season is unknown although small calves are seen in winter or early spring (Jefferson et al. 1994).

Diving Behavior—There is no information on the diving behavior of northern right whale dolphins. They feed on small fish, especially lanternfish and squid (Lipsky 2002), and are believed to take advantage of the deep scattering layer around 200 m. Based on the lack of specific information, spinner dolphin depth distribution data will be extrapolated to northern right whale dolphins. Studies on spinner dolphins in Hawaii have been carried out using active acoustics (fish-finders) (Benoit-Bird and Au 2003). These studies show an extremely close association between spinner dolphins and their prey (small, mesopelagic fishes). Mean depth of spinner dolphins was always within 10 m of the depth of the highest prey density. These studies have been carried out exclusively at night, as stomach content analysis indicates that spinners feed almost exclusively at night when the deep scattering layer moves toward the surface bringing potential prey into relatively shallower (0-400 m) waters. Prey distribution during the day is estimated at 400-700 m.

Based on these data, the following are very rough order estimates of time at depth: daytime: 100% at 0-50 m; nighttime: 100% at 0-400 m.

Acoustics—Clicks with high repetition rates and whistles have been recorded from animals at sea (Fish and Turl 1976; Leatherwood and Walker, 1979). Maximum source levels were approximately 170 dB 1 μPa-m (Fish and Turl 1976). Rankin et al. (2007) reported the mean frequency of individual echolocation clicks were 31.3 kHz (Range of 23 – 41 kHz; SD = 3.7 kHz). There is no published data on the hearing abilities of this species.

Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) California/Oregon/Washington

Population Status—The Pacific white-sided dolphin is not listed under the ESA, and the California/Oregon/Washington Stock is not considered depleted or strategic under the MMPA. No population trends have been observed in California or adjacent waters. Size of the California/Oregon/Washington Stock is estimated to be 23,817 (CV=0.36) individuals (Barlow and Forney 2007).

Distribution—There is conflicting evidence concerning seasonal shifts in distribution and numbers of Pacific white-sided dolphins in the Southern California Bight. Analyses of many years of data suggest that peak numbers probably occur in and near the SOCAL Range Complex in the cold-water months (Leatherwood et al. 1984). Most winter Pacific white-sided dolphin sightings offshore of San Clemente Island occurred in coastal waters on the western side of the island (Carretta et al. 2000).

The Pacific white-sided dolphin is most common in waters over the continental shelf and slope. Sighting records and captures in pelagic driftnets indicate that this species occurs in oceanic waters well beyond the shelf and slope (Leatherwood et al. 1984; Ferreo and Walker 1999). The Pacific white-sided dolphin occurs across temperate Pacific waters, to latitudes as low as (or lower than) 38°N, and northward to the Bering Sea and coastal areas of southeast Alaska (Leatherwood et al. 1984). Surveys suggest a seasonal north-south movement of Pacific white-sided dolphins in the eastern North Pacific, with animals found primarily off California during the colder water months and shifting northward into Oregon and Washington as water temperatures increase during late spring and summer (Green et al. 1992; Forney 1994; Carretta et al. 2007). Peak abundance in California waters occurs from November to April (Leatherwood et al. 1984). Pacific white-sided dolphins are found in the SOCAL Range Complex throughout the year (Carretta et al. 2007).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0160748 for warm and cold water seasons (Table 2-2).

Reproduction/Breeding—Calving occurs from June through August (Heise 1997)

Diving Behavior— Studies on diving by this species have not been undertaken. Pacific white-sided dolphins in the eastern North Pacific feed primarily on epipelagic fishes and cephalopods (e.g., Schwartz et al. 1992; Black 1994; Heise 1997; Brownell et al. 1999; Morton 2000). Leatherwood (1975) observed Pacific white-sided dolphins and California sea lions feeding together on anchovies off southern California. This does not appear to be a deep-diving species. Based on feeding habits, Fitch and Brownell (1968) inferred that Pacific white-sided dolphins dive to at least 120 m. The majority of foraging dives last less than 15 to 25 sec (Black 1994; Heise 1997). Pacific white-sided dolphins are generalist feeders (van Waerebeek and Wursig, 2002). Satellite tag studies of a rehabilitated related species (*Lagenorhynchus acutus*) in the Gulf of Maine indicated that nearly all time was spent in waters <100 m total depth with largely directed movement (Mate et al., 1994). Another related species, *Lagenorhynchus obscurus*, was observed feeding in two circumstances; at night to 130 m depth to take advantage of the deep scattering layer closer to the surface and during the day in shallower depths (<65 m) where they fed on schooling fish (Benoit-Bird et al. 2004).

In lieu of the lack of other data available for this species, the following are very rough estimates of time at depth: daytime - 100% at 0-65 m; night time – 100% at 0-130 m.

Acoustics—Vocalizations produced by Pacific white-sided dolphins include whistles and clicks. Whistles are in the frequency range of 2 to 20 Hz (Richardson et al., 1995). Peak frequencies of the pulse trains for echolocation fall between 50 and 80 kHz; the peak amplitude is 170 dB re 1μPa-m (Fahner et al. 2004). Tremel et al. (1998) measured the underwater hearing sensitivity of the Pacific white-sided dolphin from 75 Hz through 150 kHz. The greatest sensitivities were from 4 to 128 kHz.Below 8 Hz and above 100 kHz, this dolphin's hearing was similar to that of other toothed whales.

Pantropical spotted dolphin (*Stenella attenuata*) Undefined for Southern California

Population Status—The pantropical spotted dolphin is not listed as endangered under the ESA, and is not considered to be a strategic stock under the MMPA. There are no abundance estimates available for this species in the NOAA Stock Assessment Reports for this area of the Pacific.

Distribution—The pantropical spotted dolphin can be found throughout tropical and some subtropical oceans of the world (Perrin and Hohn 1994). In the eastern Pacific, its range is from 25ºN (Baja California, Mexico) to 17ºS (southern Peru) (Perrin and Hohn 1994). Pantropical spotted dolphins are associated with warm tropical surface water (Au and Perryman 1985; Reilly 1990; Reilly and Fiedler 1994). Au and Perryman (1985) noted that the species occurs primarily north of the Equator, off southern Mexico, and westward along 10ºN. They also noted its occurrence in seasonal tropical waters south of the Galápagos Islands.

Pantropical spotted dolphins usually occur in deeper waters, and rarely over the continental shelf or continental shelf edge (Davis et al. 1998; Waring et al. 2002). They are extremely gregarious, forming groups of hundreds or even thousands of individuals. In the Eastern Tropical Pacific (ETP), spotted and spinner dolphins are often seen together in mixed groups (Au and Perryman

1985). There have been few sightings of pantropical spotted dolphins in the SOCAL Range Complex; therefore seasonal occurrence can not be determined (Waring et al. 2002).

At Sea Density Estimates—There are no density estimates for pantropical spotted dolphns in Southern California.

Reproduction/Breeding—In the Eastern Tropical Pacific there are two calving peaks, one in spring and one in fall (Perrin and Hohn1994).

Diving Behavior—Results from various tracking and food habit studies suggest that pantropical spotted dolphins in the eastern tropical Pacific and off Hawaii feed primarily at night on epipelagic species and on mesopelagic species which rise towards the water's surface after dark (Robertson and Chivers 1997; Scott and Cattanach 1998; Baird et al. 2001). Dives during the day generally are shorter and shallower than dives at night; rates of descent and ascent are higher at night than during the day (Baird et al. 2001). Similar mean dive durations and depths have been obtained for tagged pantropical spotted dolphins in the eastern tropical Pacific and off Hawaii (Baird et al. 2001).

Acoustics—Pantropical spotted dolphin whistles have a dominant frequency range of 6.7 to 17.8 kHz (Ketten 1998). The frequency range of clicks are 40-140 kHz and source levels between 197 and 220 dB re 1 μPa-m have been recorded for pantropical spotted dolphins (Schotten et al. 2004). There are no published hearing data for pantropical spotted dolphins (Ketten 1998). Anatomy of the ear of the pantropical spotted dolphin has been studied; Ketten (1992, 1997) found that they have a Type II cochlea, like other delphinids.

Risso's dolphin (*Grampus griseus*) California/Oregon/Washington Stock

Population Status—Risso's dolphin is not listed under the ESA and the California/Oregon/Washington Stock is not considered depleted or strategic. There are no quantitative data regarding trends in population size in California or adjacent waters, although sightings have become more frequent in the past 20 years. The population estimate of the California/Oregon/Washington Stock is 11,910 (CV=0.24) individuals (Barlow and Forney 2007).

Distribution—A comprehensive study of the distribution of Risso's dolphin in the Gulf of Mexico found that they used the steeper sections of the upper continental slope in waters 1,150–3,200 ft (350–975 m) deep (Baumgartner 1997). Risso's dolphins have been sighted in waters of the SOCAL Range Complex during all seasons. However, in most years, higher numbers are present during the cold-water months than during other times of the year (Forney and Barlow 1998). Most sightings in the study area have been well offshore, but Risso's dolphins have been sighted close to the eastern shore of San Clemente Island during the cold season (Carretta et al. 2000). Risso's dolphins occur individually or in small to moderate-sized groups, normally ranging in numbers from 2 to nearly 250. The majority of groups contain fewer than 50 (Leatherwood et al. 1980; Carretta et al. 1995 and 2000), however group sizes may reach as high as 2,500. Risso's dolphins are found in the SOCAL Range Complex throughout the year (Carretta et al. 2000).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0180045 for warm water season and 0.0540134 for cold water season (Table 2-2).

Reproduction/Breeding—There is no information on the breeding behavior in this area.

Diving Behavior—There are no depth distribution data for this species. They may remain submerged on dives for up to 30 min (Kruse et al. 1999). Cephalopods are the primary prey (Clarke 1996). They are primarily squid eaters and feeding is presumed to take place at night. A study undertaken in the Gulf of Mexico demonstrated that Risso's are distributed non-uniformly with respect to depth and depth gradient (Baumgartner 1997), utilizing mainly the steep sections of upper continental slope bounded by the 350 m and 975 m isobaths. That data agrees closely with Blanco et al. (2006), who collected stomach samples from stranded Risso's dolphins in the western Mediterranean. Their results indicate that, based on prey items, Risso's feed on the middle slope at depths ranging from 600-800 m. Stomach content analysis from three animals elsewhere in the Mediterranean indicated that Risso's fed on species that showed greater vertical migrations than those ingested by striped dolphins (Ozturk et al. 2007).

In lieu of depth distribution information or information on shape of dives, the following are very rough estimates of time at depth based on habitat and prey distribution: 50% at <50 m, 15% at 51-200 m, 15% at 201-400 m, 10% at 401-600 m and 10% at >600 m.

Acoustics—Risso's dolphin vocalizations include broadband clicks, barks, buzzes, grunts, chirps, whistles, and simultaneous whistle and burst-pulse sounds (Corkeron and Van Parijs 2001). The combined whistle and burst pulse sound appears to be unique to Risso's dolphin (Corkeron and Van Parijs 2001). Corkeron and Van Parijs (2001) recorded five different whistle types, ranging in frequency from 4 to 22 kHz. Broadband clicks had a frequency range of 6 to greater than 22 kHz. Low-frequency narrowband grunt vocalizations had a frequency range of 0.4 to 0.8 kHz. A recent study established empirically that Risso's dolphins echolocate; estimated peak to peak source levels were up to 216 dB re 1 μPa-m at frequencies of 27.4-104.7 kHz (Philips et al. 2003).

The range of hearing in Risso's dolphins is 1.6-122.9 kHz with maximum sensitivity occurring between 8 and 64 kHz (Nachtigall et al. 1995).

Rough-toothed dolphin (*Steno bredanensis*) Undefined for Southern California

Population Status—The rough-toothed dolphin is not listed as endangered under the ESA or as depleted or strategic under the MMPA. There are no abundance estimates available for this species in the NOAA Stock Assessment Report for this area of the Pacific.

Distribution—Rough-toothed dolphins are typically found in tropical and warm temperate waters (Perrin and Walker, 1975 in Bonnell and Dailey 1993), rarely ranging north of 40°N or south of 35°S (Miyazaki and Perrin 1994). Rough-toothed dolphins occur in low densities throughout the ETP where surface water temperatures are generally above 25°C (Perrin and Walker 1975). Sighting and stranding records in the eastern North Pacific Ocean are rare (e.g., Ferrero et al. 1994).

Rough-toothed dolphins usually form groups of 10–20 (Reeves et al. 2002), but aggregations of hundreds can be found (Leatherwood and Reeves 1983). In the ETP, they have been found in mixed groups with spotted, spinner, and bottlenose dolphins (Perrin and Walker 1975). Reeves et al. (2002) suggested that they are deep divers, and can dive for up to 15 min. They usually inhabit deep waters (Davis et al. 1998), where they prey on fish and cephalopods (Reeves et al., 2002). There have been few sightings of rough-toothed dolphins in the SOCAL Range Complex; therefore seasonal occurrence can not be determined (Ferrero et al. 1994).

At Sea Density Estimates—There are no density estimates for rough-tooth dolphins in Southern California.

Reproduction/Breeding—There is no information on the breeding behavior in this area.

Diving Behavior—Rough-toothed dolphins are deep divers and can stay under for up to 15 min (Reeves et al. 2002). They usually inhabit deep waters (Davis et al. 1998), where they prey on fish and cephalopods (Reeves et al., 2002). Rough-toothed dolphins may stay submerged for up to 15 min and are known to dive as deep as 230 ft, but can probably dive much deeper (Miyazaki and Perrin 1994).

Acoustics—The vocal repertoire of the rough-toothed dolphin includes broad-band clicks, barks, and whistles (Yu et al. 2003). Echolocation clicks of rough-toothed dolphins are in the frequency range of 0.1 to 200 kHz, with a peak of about 25 kHz (Miyazaki and Perrin 1994; Yu et al. 2003). Whistles show a wide frequency range: 0.3 to >24 kHz (Yu et al. 2003). There is no published information on hearing ability of this species.

Short-beaked common dolphin (*Delphinus delphis*) California/Oregon/Washington Stock

Population Status—The short-beaked common dolphin is the most abundant cetacean off California (Dohl et al. 1981; Forney et al. 1995; Carretta et al. 2007). The single current management unit for the short-beaked common dolphin in this area is a California/Oregon/Washington Stock with a population estimate of 352,069 (CV = 0.18) individuals (Carretta et al. 2007). The abundance of common dolphins varies seasonally but may be increasing in California with a northward shift in the population (Heyning and Perrin 1994; Barlow et al. 1997; Forney 1997). The short beaked common dolphin is not listed as endangered under the ESA or as depleted or strategic under the MMPA.

Distribution—Along the U.S. west coast, the short-beaked common dolphins' distribution overlaps with that of the long-beaked common dolphin. The short-beaked common dolphin is distributed between the coast and at least 556 km from shore (Carretta et al. 2007). Short-beaked common dolphin abundance off California has increased dramatically since the late 1970s, along with a concomitant decrease in abundance in the ETP, suggesting a large-scale shift in the distribution of this species in the eastern North Pacific (Forney et al. 1995; Forney and Barlow 1998). The northward extent of short-beaked common dolphin distribution appears to vary interannually and with changing oceanographic conditions (Forney and Barlow 1998). Short beaked common dolphins are found in the SOCAL Range Complex throughout the year (Forney and Barlow 1998).

Stomach contents of *Delphinus* from California waters revealed 19 species of fish and 2 species of cephalopods; *Delphinus* feeds primarily on organisms in the vertically migrating DSL (Evans 1994). Diel fluctuations in vocal activity of this species (more vocal activity during late evening and early morning) appear to be linked to feeding on the DSL as it rises during the same time (Goold 2000).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.8299606 for warm water season and 0.3153850 for cold water season (Table 2-2).*Reproduction/Breeding*—The peak calving season occurs from spring and early summer (Forney 1994).

Diving Behavior—Limited direct measurements but dives to >200 meters possible, but most in the range of 9-50 m based on a study on one tagged individual tracked off San Diego (Evans 1971, 1994). Common dolphins feed on small schooling fish as well as squid and crustaceans, and varies by habitat and location. They appear to take advantage of the deep scattering layer at dusk and during early night-time hours, when the layer migrates closer to the water surface, as several prey species identified from stomach contents are known to vertically migrate (e.g., Ohizumi et al., 1998; Pusineri et al., 2007). Perrin (2002b) reports foraging dives to 200 m, but there have been no detailed studies of diving behavior.

Based on this limited information, depth distribution is estimated as: 100% at 0-200m.

Acoustics—Recorded Delphinus vocalizations include whistles, chirps, barks, and clicks (Ketten 1998). Clicks and whistles have dominant frequency ranges of 23 to 67 kHz and 0.5 to 18 kHz, respectively (Ketten 1998). Maximum source levels of clicks were approximately 180 dB 1 μPa-m (Fish and Turl 1976). Oswald et al. (2003) found that short-beaked common dolphins in the ETP have whistles with a mean frequency range of 6.3 kHz, mean maximum frequency of 13.6 kHz, and mean duration of 0.8 sec. Popov and Klishin (1998) recorded auditory brainstem responses from a common dolphin. The audiogram was U-shaped with a steeper high-frequency branch. The audiogram bandwidth was up to 128 kHz at a level of 100 dB above the minimum threshold. The minimum thresholds were observed at frequencies of 60 to 70 kHz.

Short-finned pilot whale (*Globicephala macrorhynchus*) California/Oregon/Washington Stock

Population Status—The short-finned pilot whale is not listed under the ESA. However, the California/Oregon/Washington Stock is considered strategic under the MMPA because the average human-caused mortality may not be sustainable (Barlow et al. 1997). Population size for the California/Oregon/Washington Stock is 350 (CV=0.48) individuals (Barlow and Forney 2007).

Distribution—The range of the short-finned pilot whale in the eastern North Pacific extends from the tropics to the Gulf of Alaska. However, sightings north of Point Conception are uncommon (Forney, 1994). Prior to the 1982–1983 El Niño event, short-finned pilot whales were commonly seen off southern California, with an apparently resident population around Santa Catalina Island (Dohl et al. 1981). After the El Niño event, they virtually disappeared from the region, and few sightings were made from 1984 to 1992. The reason for the decrease in numbers is unknown (Heyning et al. 1994b), but the El Niño event apparently disrupted their distribution pattern, and they have not returned as residents to waters off southern California (Forney 1994). Short finned pilot whales are found in the SOCAL Range Complex throughout the year (Forney 1994).

Pilot whales are deep divers; the maximum dive depth measured is 971 m (Baird personal communication). Pilot whales feed primarily on squid, but also take fish (Bernard and Reilly 1999). Pilot whales are not generally known to prey on other marine mammals; however, records from the ETP suggest that the short-finned pilot whale does occasionally chase, attack, and may eat dolphins during fishery operations (Perryman and Foster 1980), and they have been observed harassing sperm whales in the Gulf of Mexico (Weller et al. 1996).

At Sea Density Estimates—Pro-rated densities incorporating vessel survey results from 1986-2005 resulted in densities of 0.0003315 for warm and cold water seasons (Table 2-2).

Reproduction/Breeding—Calving and breeding primarily occurs in the summer (Jefferson et al. 1993).

Diving Behavior—Pilot whales are deep divers; the maximum dive depth measured is about 3,186 ft (Baird et al. 2002). Short-finned pilot whales feed on squid and fish. Stomach content analysis of pilot whales in the southern California Bight consisted entirely of cephalopod remains (Sinclair 1992). The most common prey item identified by Sinclair (1992) was *Loligo opalescens*, which has been documented in spawning concentrations at depths of 20-55 m. Stomach content analysis from the closely related long-finned pilot whale (*Globicephala melas*) from the U.S mid-Atlantic coast demonstrated preference for cephalopods as well as a relatively high diversity of prey species taken (Gannon et al. 1997). Stomach content analysis from *G. melas* off New Zealand did not show the same diversity of prey (Beatson et al. 2007a) which indicates that pilot whales may differ significantly in prey selection based on geographic location. Pilot whales feed primarily on squid, but also take fish (Bernard and Reilly 1999). Pilot whales are not generally known to prey on other marine mammals; however, records from the eastern tropical Pacific suggest that the short-finned pilot whale does occasionally chase, attack, and may eat dolphins during fishery operations (Perryman and Foster 1980), and they have been observed harassing sperm whales in the Gulf of Mexico (Weller et al. 1996). A diving study on *G. melas* also showed marked differences in daytime and nighttime diving in studies in the Ligurian Sea (Baird et al. 2002), but there was no information on percentage of time at various depth categories. A study following two rehabilitated and released long-finned pilot whales provides a breakdown of percentage of time at depth distribution for two whales (Nawojchik et al. 2003), although this data may be skewed due to the unique situation. Heide-Jorgensen et al. (2002) studied diving behavior of long-finned pilot whales near the Faroe Islands in the north Atlantic. Most diving activity occurred at depth of less than 36 m and >90% of dives were within 12-17 m.

Based on this information, the following are estimates of time at depth for both species of pilot whale: 60% at <7 m, 36% at 7-17 m and 4% at 18-828 m.

Acoustics—Short-finned pilot whale whistles and clicks have a dominant frequency range of 2 to 14 kHz and a source level of 180 dB re 1 μPa-m for whistles (Fish and Turl 1976; Ketten 1998). There are no published hearing data available for this species.

Spinner dolphin (Stenella longirostris) Not defined for Southern California

Population Status—Spinner dolphins are not found in California but inhabit the warm waters of Central America, therefore, they are a possible summer visitor to southern California waters. The spinner dolphin is not listed as endangered under the ESA, and is not considered to be depleted or strategic under the MMPA.

Distribution—The spinner dolphin is found in tropical and subtropical waters worldwide. Limits are near 40°N and 40°s (Jefferson et al. 1993). There have been few sightings of spinner dolphins in the SOCAL Range Complex; therefore, seasonal occurrence can not be determined (Forney 1994).

At Sea Density Estimates—There are no at sea density estimates for spinner dolphins in the SOCAL Range Complex.

Reproductive/Breeding—There is no information on the breeding behavior in this area.

Diving Behavior—Spinner dolphins feed primarily on small mesopelagic fishes, squids, and sergestid shrimps and they dive to at least 654 to 984 ft (Perrin and Gilpatrick 1994). Foraging takes place primarily at night when the mesopelagic prey migrates vertically towards the surface and also horizontally towards the shore (Benoit-Bird et al. 2001; Benoit-Bird and Au 2004; Dollar et al. 2003).

Acoustics—There is little information on the acoustic abilities of the spinner dolphin. They produce whistles in the range of 1 to 22.5 kHz with the dominant frequency being 6.8 to 17.9 kHz (Richardson et al. 1995; Nedwell et al. 2004). They also display pulse burst sounds in the range of 5 to 60 kHz. Their echolocation clicks range up to at least 65 kHz (Richardson et al. 1995). There is no information on their hearing.

Striped dolphin (Stenella coeruleoalba) California/Oregon/Washington Stock

Population Status—The striped dolphin is not listed as endangered under the ESA, and the California/Oregon/Washington Stock is not considered to be depleted or strategic under the MMPA. The best estimate of the size of the California/Oregon/Washington Stock is 18,976 (CV=0.28) individuals (Barlow and Forney 2007).

Distribution—Striped dolphins have a cosmopolitan distribution in tropical to warm temperate waters (Perrin *et al.* 1994a). Their preferred habitat seems to be deep water (Davis et al. 1998) along the edge and seaward of the continental shelf, particularly in areas influenced by warm currents (Waring et al. 2002). This species is well documented in both the western and eastern Pacific off the coasts of Japan and North America (Perrin et al. 1994); the northern limits are the Sea of Japan, Hokkaido, Washington state, and along roughly 40°N across the western and central Pacific (Reeves et al. 2002). In and near the SOCAL Range Complex, striped dolphins are found mostly offshore, and are much more common in the warm-water period. Striped dolphins are found in the SOCAL Range Complex throughout the year (Waring et al. 2002).

Striped dolphins are gregarious (groups of 20 or more are common) and active at the surface (Whitehead et al. 1998). Wade and Gerrodette (1993) noted a mean group size of 61 in the ETP, and Smith and Whitehead (1999) reported a mean group size of 50 in the Galápagos.

Reproduction/Breeding—There is no information on the breeding behavior in this area.

Diving Behavior—Striped dolphins often feed in pelagic or benthopelagic zones along the continental slope or just beyond oceanic waters. A majority of the prey possess luminescent organs, suggesting that striped dolphins may be feeding at great depths, possibly diving to about 109 to 383 fathoms to reach potential prey (Archer and Perrin 1999). Striped dolphins may feed at night, in order to take advantage of the deep scattering layer's diurnal vertical movements. Small, mid-water fishes (in particular, myctophids or lanternfish) and squids are the dominant prey (Perrin *et al*. 1994).

Acoustics—Striped dolphin whistles range from 6 to at least 24 kHz, with dominant frequencies ranging from 8 to 12.5 kHz (Richardson et al. 1995). The striped dolphin's range of most sensitive hearing (defined as the frequency range with sensitivities within 10 dB of maximum sensitivity) was determined to be 29 to 123 kHz using standard psycho-acoustic techniques; maximum sensitivity occurred at 64 kHz (Kastelein et al. 2003). Hearing ability became less sensitive below 32 kHz and above 120 kHz (Kastelein et al. 2003).

2.1.2.3 Pinnipeds

Northern Elephant Seal (*Mirounga angustirostris*) California Breeding Stock

Population Status—The California Breeding stock has recovered from near extinction in the early 1900s to an estimated 101,000 (Carretta et al. 2004).

Distribution—Northern elephant seals molt, breed, and give birth primarily on offshore islands off Baja California and California. Rookeries are found as far north as the South Farallon Islands and Point Reyes (Barlow et al. 1993). The California population is demographically isolated from the Baja California population, and is considered a separate stock, although genetically the two populations are indistinguishable (Barlow *et al*. 1997). About two thirds of the California population hauls out on San Miguel Island, about 32% on San Nicolas Island, and the remaining seals use Santa Rosa (1%), Santa Cruz, Anacapa, Santa Barbara, and San Clemente islands (Bonnell and Dailey 1993; U.S. Navy 1998; Carretta et al. 2000).

Life History-Northern elephant seals haul out on land to give birth and breed from December through March, and pups remain hauled out through April. After spending time at sea to feed (post-breeding migration), they generally return to the same areas to molt (Odell 1974; Stewart and Yochem 1984; Stewart 1989; Stewart and DeLong 1995). However, they do not necessarily return to the same beach. Adult males tend to haul out to molt between June and August (peaking in July), whereas females and juveniles haul out to most between March and May (peaking in April). Different age classes of northern elephant seals are found in the SOCAL Range Complex throughout the year (Carretta et al. 2000). For much of the year, northern elephant seals feed mostly in deep, offshore waters, and their foraging range extends thousands of kilometers offshore from the breeding range into the eastern and central North Pacific (Stewart and DeLong 1995; Stewart 1997; Le Boeuf et al. 2000). Adult males and females segregate while foraging and migrating; females mostly range west to about 173°W, between the latitudes of 40°N and 45°N, whereas males range further north into the Gulf of Alaska and along the Aleutian Islands, to between 47°N and 58°N (Stewart and Huber 1993; Stewart and DeLong 1995; Le Boeuf *et al*. 2000).

Reproduction/Breeding—Northern elephant seals haul out on land to give birth and breed from December through March, and pups remain hauled out through April.

Diving Behavior—Both sexes routinely dive deep (up to 4,500 ft) (Le Boeuf et al. 2000); dives average 15–25 min, depending on time of year, and surface intervals between dives are 2–3 min. The deepest dives recorded for both sexes are over 5,000 ft (e.g., Le Boeuf et al. 2000; Schreer *et al*. 2001). Females remain submerged about 86–92 percent of the time and males about 88–90 percent (Le Boeuf et al. 1989; Stewart and Delong 1995).

Feeding juvenile northern elephant seals dive for slightly shorter periods (13–18 min), but they dive to similar depths (978 to 1,500 ft) and spend a similar proportion (86–92 percent) of their time submerged (Le Boeuf et al. 2000).

Acoustics—The northern elephant seal produces loud, low-frequency in-air vocalizations (Bartholomew and Collias 1962). The mean fundamental frequencies are in the range of 147 to 334 Hz for adult males (Le Boeuf and Petrinovich 1974). The mean source level of the male-produced vocalizations during the breeding season is 110 dB re 20 μPa (Sanvito and Galimberti 2003). In-air calls made by aggressive males include: (1) snoring, which is a low intensity threat; (2) a snort (0.2 to 0.6 kHz) made by a dominant male when approached by a subdominant male; and (3) a clap threat (<2.5 kHz) which may contain signature information at the individual level (Richardson et al. 1995). These sounds appear to be important social cues (Shipley et al. 1992). The mean fundamental frequency of airborne calls for adult females is 500 to 1,000 Hz (Bartholomew and Collias 1962). In-air sounds produced by females include a <0.7 kHz belch roar used in aggressive situations and a 0.5 to 1 kHz bark used to attract the pup (Bartholomew and Collias 1962). As noted by Kastak and Schusterman (1999), evidence for underwater sound production by this species is scant. Except for one unsubstantiated report), none have been definitively identified (Fletcher et al. 1993; Burgess et al. 1998). Burgess et al. (1998) detected possible vocalizations in the form of click trains that resembled those used by males for communication in air.

The audiogram of the northern elephant seal indicates that this species is well-adapted for underwater hearing; sensitivity is best between 3.2 and 45 kHz, with greatest sensitivity at 6.4 kHz and an upper frequency cutoff of approximately 55 kHz (Kastak and Schusterman 1999).

Pacific Harbor Seal (Phoca vitulina richardii) California Stock

Population Status—The California population has increased from the mid-1960s to the mid-1990s, although the rate of increase may have slowed during the 1990s (Hanan 1996). The minimum population estimate of the California Stock is 25,720 (Carretta 2005).

Distribution—Harbor seals are considered abundant throughout most of their range from Baja California to the eastern Aleutian Islands. The Southern California Bight is near the southern limit of the harbor seal's range (Bonnell and Dailey 1993). Some harbor seals haul out and breed on Santa Barbara and Santa Catalina islands within the SOCAL Range Complex, but most harbor seals haul out further north.

Life history- Peak numbers of harbor seals haul out on land during late May to early June, which coincides with the peak of their molt. They generally favor sandy, cobble, and gravel beaches (Stewart and Yochem 1994), and most haul out on the mainland (Carretta et al. 2007). When at sea during May and June (and March to May for breeding females), they generally remain in the vicinity of haul-out sites and forage close to shore in relatively shallow waters. Nursing of pups begins in late February, and pups start to become weaned in May. Breeding occurs between late March and early May. Harbor seals are found in the SOCAL Range Complex throughout the year (Carretta et al. 2000).

Reproduction/Breeding—Pupping in late January, and pups start to become weaned in May. Breeding occurs between late March and early May.

Diving-While feeding, harbor seals dive to depths of 33–130 ft (10–40 m) in the case of females with nursing pups, and 260–390 ft (79–119 m) in the case of other seals. Dives as deep as 1,463 ft (446 m) have been recorded, although dives greater than 460 ft (140 m) are infrequent.

Acoustics—Harbor seals produce a variety of airborne vocalizations including snorts, snarls, and belching sounds (Bigg 1981). Adult males produce low frequency vocalizations underwater during the breeding season (Hanggi and Schusterman 1994; Van Parijs et al. 2003). Male harbor seals produce communication sounds in the frequency range of 100 to 1,000 Hz (Richardson et al. 1995).

The harbor seal hears almost equally well in air and underwater (Kastak and Schusterman 1998). Harbor seals hear best at frequencies from 1 to 180 kHz; the peak hearing sensitivity is at 32 kHz in water and 12 kHz in air (Terhune and Turnball 1995; Kastak and Schusterman 1998; Wolski et al. 2003). Kastak and Schusterman (1996) observed a TTS of 8 dB at 100 Hz from 6-7 hours of intermitten broadband continuous construction noise (sandblasting; 200-2000 Hz at 95-105 dB SPL unweighted in the seal's enclosure) per day for six days, with complete recovery approximately one week following exposure. Kastak et al. (1999) determined that underwater noise of moderate intensity (65 to 75 dB above the animals hearing threshold at 100, 500 and 1000 Hz) and continuous duration of 20 min is sufficient to induce a small TTS of 4.8 dB in harbor seals.

California Sea Lion (Zalophus californianus) United States Stock

Population Status—The California sea lion is not listed under the ESA, and the U.S. Stock, some of which occurs in the SOCAL Range Complex, is not considered a strategic stock under the MMPA. The U.S. Stock has increased from the early 1900s to the present; the counts of pups increased at an annual rate of 5.4% between 1975 and 2001 (Carretta et al. 2007). The minimum population estimate of the U.S. Stock, based on a 2001 census, is 138,881 (Carretta et al. 2007).

Distribution—Nearly all of the U.S. Stock (more than 95%) breeds and gives birth to pups on San Miguel, San Nicolas, and Santa Barbara islands, only one of which–Santa Barbara, the smallest–is in the SOCAL Range Complex. Smaller numbers of pups are born on San Clemente Island, the Farallon Islands, and Año Nuevo Island (Lowry et al. 1992). The California sea lion is by far the most commonly-sighted pinniped species at sea or on land in the vicinity of the SOCAL Range Complex. In California waters, sea lions made up 87.7% (2,976 of 3,393) of identified pinniped sightings at sea during all of the studies summarized in the SCIRC EIS/OEIS. Similarly, they represented 97% (381 of 393) of identified pinniped sightings at sea during the 1998–1999 NMFS surveys (Carretta et al. 2000). They were sighted during all seasons and in all areas with survey coverage from nearshore to offshore areas (Carretta et al. 2000).

Life history- Survey data from 1975 to 1978 were analyzed to describe the seasonal shifts in the offshore distribution of California sea lions (Bonnell and Ford 1987). During summer, the highest densities were found immediately west of San Miguel Island. During autumn, peak densities of sea lions were centered on Santa Cruz Island. During winter and spring, peak densities occurred just north of San Clemente Island. The seasonal changes in the center of distribution were attributed to changes in the distribution of the prey species. If California sea lion distribution is determined primarily by prey abundance, these same areas might not be the center of sea lion distribution every year.

The distribution and habitat use of California sea lions vary with the sex of the animals and their reproductive phase. Adult males haul out on land to defend territories and breed from mid-to-late May until late July. Individual males remain on territories for 27–45 days without going to sea to feed. During August and September, after the mating season, the adult males migrate northward to feeding areas as far away as Washington (Puget Sound) and British Columbia (Lowry et al. 1992). They remain there until spring (March–May), when they migrate back to the breeding colonies. Thus, adult males are present in offshore areas of the SOCAL Range Complex only briefly as they move to and from rookeries. Distribution of immature California sea lions is less well known, but some make northward migrations that are shorter in length than the migrations of adult males (Huber 1991). However, most immature seals are presumed to remain near the rookeries, and thus remain in or near the SOCAL Range Complex for most of the year (Lowry et al. 1992). Adult females remain near the rookeries throughout the year. Most births occur from mid-June to mid-July (peak in late June).

Higher densities of California sea lions are observed during cold-water months. At-sea densities likely decrease during warm-water months because females spend more time ashore to give birth and attend their pups. Radio-tagged female California sea lions at San Miguel Island spent approximately 70% of their time at sea during the non-breeding season (cold-water months) and pups spent an average of 67% of their time ashore during their mother's absence (Melin et al. 2000). Different age classes of California sea lions are found in the SOCAL Range Complex throughout the year (Lowry et al. 1992). Although adult male California sea lions feed in areas north of the SOCAL Range Complex, animals of all other ages and sexes spend most, but not all, of their time feeding at sea during winter so the winter estimates likely are somewhat low. During warm-water months, a high proportion of the adult males and females are hauled out at terrestrial sites during much of the period, so the summer estimates are low to a greater degree. Information on movements and foraging at sea has been restricted to breeding females (adult males do not forage near the rookeries, do not feed during the breeding season, and migrate north after the breeding season).

Reproduction/Breeding—The pupping and mating season for sea lions begins in late may and continues through July (Heath 2002).

Diving-Over one third of the foraging dives by breeding females are 1–2 min in duration; 75% of dives are <3 min, and the longest recorded dive was 9.9 min (Feldkamp et al. 1989). Approximately 45% of dives were to depths of 66–160 ft (20–50 m) and the maximum depth of a dive was 900 ft (274 m) (Feldkamp et al. 1989). Much of the variation in duration and depth of dives appears to be related to sea lions foraging on vertically-migrating prey. Longer dives to greater depths typically occur during the day, and shorter dives to shallower depths typically occur at night, when prey migrate toward the surface (Feldkamp et al. 1989).

Acoustics—In-air, California sea lions make incessant, raucous barking sounds; these have most of their energy at less than 2 kHz (Schusterman et al. 1967; Richardson et al. 1995). Males vary both the number and rhythm of their barks depending on the social context; the barks appear to control the movements and other behavior patterns of nearby conspecifics (Schusterman 1977). Females produce barks, squeals, belches, and growls in the frequency range of 0.25 to 5 kHz, while pups make bleating sounds at 0.25 to 6 kHz (Richardson et al. 1995). California sea lions produce two types of underwater sounds: clicks (or short-duration sound pulses) and barks (Schusterman et al. 1966, 1967; Schusterman and Baillet 1969). All underwater sounds have most of their energy below 4 kHz (Schusterman et al. 1967).

The range of maximal sensitivity underwater is between 1 and 28 kHz (Schusterman et al. 1972). Functional underwater high frequency hearing limits are between 35 and 40 kHz, with peak sensitivities from 15 to 30 kHz (Schusterman et al. 1972). The California sea lion shows relatively poor hearing at frequencies below 1,000 Hz (Kastak and Schusterman 1998). Peak sensitivities in air are shifted to lower frequencies; the effective upper hearing limit is approximately 36 kHz (Schusterman 1974). The best range of sound detection is from 2 to 16 kHz (Schusterman, 1974). Kastak and Schusterman (2002) determined that hearing sensitivity generally worsens with depth—hearing thresholds were lower in shallow water, except at the highest frequency tested (35 kHz), where this trend was reversed. Octave band noise levels of 65 to 70 dB above the animal's threshold produced an average TTS of 4.9 dB in the California sea lion (Kastak et al. 1999). Center frequencies were 1,000 Hz for corresponding threshold testing at 1000Hz and 2,000 Hz for threshold testing at 2,000 Hz; the duration of exposure was 20 min.

Northern Fur Seal (Callorhinus ursinus) San Miguel Island Stock

Listing Status-The Eastern Pacific Stock of northern fur seal is classified as a strategic stock because it is designated as depleted under the MMPA. The San Miguel Island Stock, which occurs north of the SOCAL Range Complex, is not considered depleted or strategic under the MMPA.

Population Status—The range of the northern fur seal extends from southern California north to the Bering Sea, and west to the Okhotsk Sea and the Sea of Japan (Antonelis and Fiscus 1980). Two separate stocks of northern fur seals are recognized within U.S. waters, the Eastern Pacific Stock and the San Miguel Island Stock (Barlow et al. 1998). The minimum population estimate for the Eastern Pacific Stock is 751,714 (Angliss and Lodge 2004). A minimum population estimate for the San Miguel Island Stock is 4,190 (Carretta et al. 2007).

Distribution—The Eastern Pacific Stock spends May–November in northern waters and at northern breeding colonies. In late November, females and young begin to arrive in offshore waters of California, with some animals moving south into continental shelf and slope waters. Maximum numbers are found in waters from 34ºN to 42ºN during February–April; most are found offshore of the continental slope. By early June, most seals of the eastern Pacific Stock have migrated back to northern waters (Antonelis and Fiscus 1980). Adult males from the Eastern Pacific Stock generally migrate only as far south as the Gulf of Alaska (Kajimura 1984).

Northern fur seals were made locally extinct at San Miguel Island during the mid-1800s by commercial sealing operations. After an absence of over 100 years, they recolonized the island during the late 1950s or early 1960s (DeLong 1982). The population at San Miguel Island has been increasing steadily since 1972, except for a drop in numbers during the El Niño events of 1982 (Barlow et al. 1998) and 1997–1998 (Barlow et al. 1999). The 1997 live pup count was the highest since the colony was reported in 1968, but up to 75% of those pups died within 5 months of birth. A 1998 pup count resulted in a total count of 627 pups, a 79.6% decrease from the 1997 count of 3,068 (Melin and DeLong 2000). In 1999, the population began to recover, and by 2002 the total pup count was 1,946 (Carretta et al. 2007).

Reproduction/Breeding—The northern fur seal pupping and mating season begins in June and continues through July (Bonnell et al. 1978).

Diving-Although they feed primarily in deep offshore waters, average depths of dives of lactating females are relatively shallow (223 ft [68 m]) with an average dive duration of 2.6 min (Reeves et al. 1992).

Acoustics—Northern fur seals produce underwater clicks, and in-air bleating, barking, coughing, and roaring sounds (Schusterman 1978; Richardson et al. 1995). Males vocalize (roar) almost continuously at rookeries (Gentry 1998). In-air and underwater audiograms are available for the northern fur seal. Of all the pinniped species for which hearing information is available, the northern fur seal is the most sensitive to airborne sound (Moore and Schusterman 1987). The underwater hearing range of the northern fur seal ranges from 0.5 Hz to 40 kHz (Moore and Schusterman 1987; Babushina et al. 1991).. The underwater hearing threshold is 90 to 100 dB re 1 µPa-m at 1 kHz; best underwater hearing occurs between 4 and 17 to 28 kHz (Moore and Schusterman 1987; Babushina et al. 1991). The underwater hearing sensitivity of this species is

15 to 20 dB better than in the air (Babushina et al. 1991). The maximum sensitivity in air is at 2 to 16 kHz (Moore and Schustermant 1987; Babushina et al. 1991), after which there is an anomalous hearing loss at around 4 or 5 kHz (Moore and Schusterman 1987; Babushin 1999).

Table 2-2. Biological Information For Marine Mammal Species.

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Baird's beaked whale	-	-	-	-	-	-	-	25-67 min	-	-	Von Saunder and Barlow 1999, Kasuya 2002
Bottlenose dolphin	-	-	-	-	-	-	-	500 m max and 15 min	-	-	Ridgway et al. 1969
Bottlenose dolphin	-	-	-	-	-	-	North Atlantic (Bermuda)	8.9 % of night dives to 450 m with 46.4% > 5 min; day dives 96% to 50 m with 52.7% less than one min; number of dives increased at dusk	-	-	Klatsky et al. 2007
Blainville's beaked whale	-	-	-	-	-	-	-	975 m max dives; 20-45 min	-	-	Barlow 1999, Baird et al. 2004, Johnson et al. 2004
Blue whale	Euphausiid crustaceans, including *Euphasia* sp and *Thysanoessa* sp	Coastal as well as offshore	V-shaped, but wide at bottom of V to accommodate the lunges; foraging dives deeper than non-foraging dives; foraging charaterized by lunge-feeding with greater prey capture during lunge ascent	Greater amount of time at surface to recover positively related to number of lunges during feeding	Perrin et al. (2002); Croll et al. (2001); Acevado et al. (2002)	Feeding at depth	Northeast Pacific (Mexico, California)	Mean depth 140 +- 46 m; mean dive time 7.8 +- 1.9 min	-	Seven whales/ May-August/Time-depth-recorder	Croll et al. (2001)

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Blue whale	-	-	-	-	-	Feeding near surface; surface intervals between deeper dives	Northeast Pacific (central California)	Mean depth 105 +- 13 m; mean dive time 5.8 +- 1.5 min	78% in 0-16 m; 9% in 17-32; 13% in >32 m; most dives to <16 m and 96-152 m ranges, but only 1.2% of total time was spent in deeper range	One whale/ August-September/ Satellite depth-sensor-tag	Lagerquist et al. (2000)
Blue whale	-	-	-	-	-	Non-foraging	Northeast Pacific (Mexico, California)	Mean depth 68 +- 51 m; mean dive time 4.9 +- 2.5 min; most dives to ~30 m with occasional deeper V-shaped dives to >100m	-	Seven whales/ May-August/Time-depth-recorder	Croll et al. (2001)
Bryde's whale	Pelagic schooling fish, small crustaceans (euphausiids, copepods), cephalopods; feeding is regionally different; preferred both anchovy and krill in Northwestern Pacific	Coastal and Offshore; off South Africa inshore form feeds on epipelagic fish (e.g., anchovies) while offshore form feeds on mesopelagic fish and euphausiids	Possibly V-shaped as they are lunge feeders	Unknown	Perrin et al. (2002); Murase et al. (2007); Best (1977)	Feeding	South Pacific and Indian Oceans	Main prey items were euphausiids, including *Euphausia* sp and *Thysanoessa* sp; most feeding apparently at dawn and dusk; 20 min dives	-	Several hundred/ year-round/ stomach content	Kawamura (1980); Cummings 1985
California sea lion			-					80-480 m; 16 min			Feldkamp et al. 1989, Melin 2002

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Cuvier's beaked whale								1,400 m; 45 min			Jefferson et al. 1993, Barlow 1993, Johnson et al. 2004
Dall's porpoise	-	-	-	-	-	-	-	50 m; 2 min	-	-	Hanson and Baird 1998
Dwarf sperm whale	Likely feeds in shallower water than K breviceps; otherwise food is similar	continental slope and deep zones of shelf, epi- and meso-pelagic zones	-	-	Perrin et al. (2002)	-	-	-	-	-	-
Fin whale	Planktonic crustaceans, including *Thyanoessa* sp and *Calanus* sp, as well as scholling fishes such as capelin (*Mallotus*), herring (*Clupea*) and mackerel (*Scomber*)	Pelagic with some occurrence over continental shelf areas	V-shaped, but wide at bottom of V to accommod ate the lunges; foraging dives deeper than non-foraging dives; foraging charaterize d by lunge-feeding with greater prey capture during lunge ascent	Greater amount of time at surface to recover positively related to number of lunges during feeding	Perrin et al. (2002); Croll et al. (2001); Acevado et al. (2002): Notarbartol o-di-Sciara et al. (2003)	Feeding at depth	Northeast Pacific (Mexico, California)	Mean depth 98 +- 33 m; mean dive time 6.3+- 1.5 min	-	Fifteen whales/ April-October/Time-depth-recorder	Croll et al. (2001)
Fin whale	-	-	-	-	-	Non-foraging	Northeast Pacific (Mexico, California)	Mean depth 59 +-30 m; mean dive time 4.2 +- 1.7 min; most dives to ~ 30 m with occasional deeper V-shaped dives to >90 m	-	Fifteen whales/ April-October/Time-depth-recorder	Croll et al. (2001)

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Fin whale	-	-	-	-	-	Feeding	Mediterranean (Ligurian Sea)	shallow dives (mean 26-33 m, with all <100m) until late afternoon; then dives in excess of 400 m (perhaps to 540 m); in one case a whale showed deep diving in midday; deeper dives probably were to feed on specific prey (*Meganyctiphanes norvegica*) that undergo diel vertical migration	-	Three whales/ Summer/ Velocity-time-depth-recorder	Panigada et al. (1999); Panigada et al. (2003); Panigada et al. (2006)
Fin whale	-	-	-	-	-	Traveling	Mediterranean (Ligurian Sea)	shallow dives (mean 9.8 +- 5.3 m, with max 20 m) , shorter dive times and slower swimming speed indicate travel mode; deep dives (mean 181.3 +-195.4 m, max 474 m), longer dive times and faster swimming speeds indicate feeding mode	-	One whale/ Summer/ Velocity-time-depth-recorder	Jahoda et al. (1999)

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Fin whale	-	-	-	-	-	Feeding	Northeast Pacific (Southern California Bight)	mean dive depth 248+-18 m; total dive duration mean 7.0+-1.0 min with mean descent of 1.7+-0.4 min and mean ascet of 1.4+-0.3 min; 60% (i.e., 7.0 min) of total time spent diving with 40% (i.e., 4.7 min) total time spent near sea surface (<50m)	44% in 0-49m (includes surface time plus descent and ascent to 49 m); 23% in 50-225 m (includes descent and ascent times taken from Table 1 minus time spent descending and ascending through 0-49 m); 33% at >225 m (total dive duration minus surface, descent and ascent times)	Seven whales/ August/ Bioacoustic probe	Goldbogen et al. (2006)
Fin whale	-	-	-	-	-	Feeding	Northeast Pacific (Southern California Bight)	Distribution of foraging dives mirrored distribution of krill in water collumn, with peaks at 75 and 200-250 m.	-	Two whales/ September-October/ Time-depth-recorder	Croll et al. (2001)

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Gray whale	Amphipods, including *Ampelisca* sp, and other organisms living in the seafloor; also occasionally surface skim and engulfing; dependent on location	Continental shelf, 4-120 m depth	Migrating dives are generally shallow an dshort (3-5 min); feeding dives are longer and to ~50-60 m	Variable depending on behavior	Perrin et al. (2002); Dunham et al. (2002); Jones and Swartz (2002)	Migrating	Northeast Pacific (coastal Baja California to northern California)	30 of 36 locations in depths <100m deep (mean 39 m); consistent speed indicating directed movement	-	One whale/ February/ Satellite tag	Mate and Urban Ramirez (2003)
Gray whale	-	-	-	-	-	Feeding	Bering and Chukchi Seas	Depths at feeding locations from 5-51 m depth	-	Several whales/ July-November/ Aerial surveys and benthic sampling	Clarke et al. (1989); Clarke and Moore (2002); Moore et al. (2003)
Gray whale	-	-	-	-	-	Feeding	Northeast Pacific (Kodiak Island)	Feeding on cumacean invertebrates	-	Several whales/ Year-round/ Aerial surveys	Moore et al. (2007)
Gray whale	-	-	-	-	-	Feeding	Northeast Pacific (Vancouver Island)	majority of time was spent near the surface on interventilation dives (<3 m depth) and near the bottom (extremely nearshore in a protected bay with mean dive depth of 18 m, range 14-22 m depth; little time spent in the water column between surface and bottom.	40% of time at <4 m (surface and interventilation dives), 38% of time at 3-18 m (active migration), 22% of time at >18 m (foraging).	One whale/ August/ Time-depth recorder	Malcolm et al. (1995/96); Malcolm and Duffus (2000)

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Harbor seal	-	-	-	-	-	-	-	Capable of diving to 450 m (1,476 ft), although dives of 10-150 m (33-492 ft) are more typical, Dives generally last a few minutes, spend as much as 85% of each day diving for food	-	-	Gjertz et al. 2001, Krafft et al. 2002, Eguchi and Harvey 2005
Humpback whale	Pelagic schooling euphausiids and small fish including capelin, herring, mackerel, croaker, spot, and weakfish	Coastal, inshore, near islands and reefs, migration through pelagic waters	lunge feeder using "bubble nets" to corral prey; also known to bottom-feed on sand lance	-	Perrin et al. (2002); Hain et al. (1995); Laerm et al. (1997)	Feeding	North Atlantic (Stellwagen Bank)	Depths <40 m	-	Several whales/ August/ Visual Observations	Hain et al. (1995)
Humpback whale	-	-	-	-	-	Feeding (in breeding area)	Tropical Atlantic (Samana Bay - winter breeding area)	Not provided; lunge feeding with bubblenet	-	One whale/ January/ Visual observations	Baraff et al. (1991)
Humpback whale	-	-	-	-	-	Breeding	North Pacific (Hawaii)	Depths in excess of 170 m recorded; some depths to bottom, others to mid- or surface waters; dive duration was not necessarily related to dive depth	40% in 0-10 m, 27% in 11-20 m, 12% in 21-30 m, 4% in 31-40 m, 3% in 41-50 m, 2% in 51-60 m, 2% in 61-70 m, 2% in 71-80 m, 2% in 81-90 m, 2% in 91-100 m, 3% in >100 m	Ten Males/ February-April/ Time-depth-recorder	Baird et al. (2000)

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Humpback whale	-	-	-	-	-	Feeding	Northeast Atlantic (Greenland)	Dive data was catalogued for time spent in upper 8 m as well as maximum dive depth; diving did not extend to the bottom (~1000 m) with most time in upper 4 m of depth with few dives in excess of 400 m	37% of time in <4 m, 25% of time in 4-20 m, 7% of time in 21-35m, 4% of time in 36-50 m, 6% of time in 51-100 m, 7% of time in 101-150 m, 8% of time in 151-200 m, 6% of time in 201-300 m, and <1% in >300 m (from Figure 3.10)	Four whales/ June-July/ Satellite transmitters	Dietz et al. (2002)
Humpback whale	-	-	-	-	-	Feeding	North Pacific (Southeast Alaska)	Dives were short and shallow (<60 m); percent of time at surface increased with increased dive depth and with dives exceeding 60 m	-	?? Whales/ July-September/ Passive sonar	Dolphin (1987)
Killer whale	-	-	-	-	-	-	-	30-264 m; 17 min	-	-	Dahlheim and Heyning 1999, Baird et al. 2005
Longman's beaked whale	-	-	-	-	-	-	-	18-25 min max time	-	-	Gallo-Reynoso and Figueroa-Carranza 1995
Melon-headed whale	-	-	-	-	-	-	-	1,500 m	-	-	Jefferson and Barros 1997

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Minke whale	Regionally dependent; can include euphausiids, copepods, small fish: Japanese anchovy preferred in western North Pacific	Coastal, inshore and offshore	Possibly V-shaped due to lunge feeding (patchy prey concentration); also bird-association feeding near surface (concentrated prey)	Unknown	Perrin et al. (2002); Jefferson et al. (1993); Wells et al. (1999); Murase et al. (2007)	Feeding, Searching	North Atlantic (Norway)	Searching for capelin at less than 20 m, then lunge-feeding at depths from 15 to 55 m, then searching again at shallower depths	Based on time series in Figure 2, 47% of time was spent foraging from 21-55 m; 53% of time was spent searching for food from 0-20 m	One whale/ August/ Dive-depth-transmitters	Blix and Folkow (1995)
North Pacific right whale	-	-	-	-	-	-	-	80-300 m; 5-15 min	-	-	Winn et al. 1995, Barlow et al. 1997, Mate et al. 1997, NMFS 2002, Baumgartner and Mate 2003
Northern elephant seal	-	-	-	-	-	-	-	Deepest diving of the pinnipeds and spend 80-90% of their time underwater, Interdive periods at the surface are usually only a few minutes	-	-	DeLong and Stewart 1991, Stewart and Huber 1993, Asaga et al. 1994, Cocker et al. 1994
Pacific white-sided dolphin	-	-	-	-	-	-	-	120 m max	-	-	Fitch and Brownell 1968
Pygmy beaked whale	-	-	-	-	-	-	-	18-25 min max time	-	-	Gallo-Reynoso and Figueroa-Carranza 1995

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Pygmy sperm whale	mid and deep water cephalopods , fish, crustaceans; probably feeding at or near bottom, possibly using suction feeding	continental slope and deep zones of shelf, epi- and meso-pelagic zones			Perrin et al., (2002); McAlpine et al. (1997)	Feeding	Northwest Atlantic (Canada)	Prey items included squid beaks, fish otolith and crustacean; squids representative of mesopelagic slope-water community		One whale/ December/ Stomach contents	McAlpine et al. (1997)
Risso's dolphin	-	-	-	-	-	-	-	30 min	-	-	Kruse et al. 1999
Rough-toothed dolphin	-	-	-	-	-	-	-	70 m max; 15 min max	-	-	Miyazaki and Perrin 1994
Sei whale	Copepods, amphipods, euphausiids, shoaling fish and squid	More open ocean than coastal	Unknown	Unknown	Perrin et al. (2002); Jefferson et al. (1993); Nemoto and Kawamura (1977)	Feeding	Northwest Pacific - coastal	skim feeder that takes swarms in low density	-	Several/ Year-round/ Stomach content analysis	Nemoto and Kawamura (1977)
Short-finned pilot whale	-	-	-	-	-	-	-	fast, energetic deep dives with mean duration of 15 minutes (max 20 min). Concentrated on mid-water prey at two depth ranges, centered at 270 m and 670 m	-	-	Baird et al. 2003, Aguilar De Soto et al. 2005
Sperm whale	Squids and other cephalopods , demersal and mesopelagic fish; varies according to region	Deep waters, areas of upwelling	U-shaped dives, generally vertical ascent and descent with foraging at bottom of dive; may or may not dive to bottom	Prolonged resting at surface both in large matrilineal groups as well as solitary males	Perrin et al. (2002)	Feeding	Mediterranea n Sea	Overall dive cycle duration mean = 54.78 min, with 9.14 min (17% of time) at the surface between dives; no measurement of depth of dive	-	16 whales/ July-August/ visual observations and click recordings	Drouot et al. (2004

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
			depth								
Sperm whale	-	-	-	-	-	Feeding	South Pacific (Kaikoura, New Zealand)	83% of time spent underwater; no change in abundance between summer and winter but prey likely changed between seasons	-	>100 whales/ Year-round/ visual observations	Jacquet et al. (2000)
Sperm whale	-	-	-	-	-	Feeding	Equatorial Pacific (Galapagos)	Fecal sampling indicated four species of cephalopods predominated diet, but is likely biased against very small and very large cephalopods; samples showed variation over time and place	-	Several whales/ January-June/ fecal sampling	Smith and Whitehead (2000)
Sperm whale	-	-	-	-	-	Feeding	Equatorial Pacific (Galapagos)	Dives were not to ocean floor (2000-4000 m) but were to mean 382 m in one year and mean of 314 in another year; no diurnal patterns noted; general pattern was 10 min at surface followed by dive of 40 min; clicks (indicating feeding) started usually after descent to few hundred meters	-	Several whales/ January-June/ acoustic sampling	Papastavrou et al. (1989)

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Sperm whale	-	-	-	-	-	Feeding	North Pacific (Baja California)	Deep dives (>100m) accounted for 26% of all dives; average depth 418 +- 216 m; most (91%) deep dives were to 100-500 m; deepest dives were 1250-1500m; average dive duration was 27 min; average surface time was 8.0; whale dives closely correlated with depth of squid (200-400 m) during day; nighttime squid were shallower but whales still dove to same depths	74% in <100 m; 24% in 100-500 m; 2% in >500m	Five whales/ October-November/ Satellite-linked dive recorder	Davis et al. (2007)
Sperm whale	-	-	-	-	-	Resting/ socializing	North Pacific (Baja California)	Most dives (74%) shallow (8-100 m) and short duration; likely resting and/or socializing	-	Five whales/ October-November/ Satellite-linked dive recorder	Davis et al. (2007)
Sperm whale	-	-	-	-	-	Feeding	North Atlantic (Norway)	Maximum dive depths near seafloor and beyond scattering layer	-	Unknown # male whales/ July/ hydrophone array	Wahlberg (2002)
Sperm whale	-	-	-	-	-	Feeding	North Pacific (Southeast Alaska)	Maximum dive depth if 340 m when fishing activity was absent; max dive depth during fishing activity was 105 m	-	Two whales/ May/ acoustic monitoring	Tiemann et al. (2006)

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Sperm whale	-	-	-	-	-	Feeding	Northwest Atlantic (Georges Bank)	Dives somewhat more U-shaped than observed elsewhere; animals made both shallow and deep dives; average of 27% of time at surface; deepest dive of 1186 m while deepest depths in area were 1500-3000 m so foraging was mid-water column; surface interval averaged 7.1 min	-	Nine Whales/ July 2003/ DTAG	Palka and Johnson (2007)
Sperm whale	-	-	-	-	-	Feeding	Northwest Atlantic (Georges Bank)	37% of total time was spent near surface (0-10m); foraging dive statistics provided in Table 1 and used to calculate percentages of time in depth categories, adjusted for total time at surface	48% in <10 m; 3% in 10-100 m; 7% in 101-300 m; 7% in 301-500 m; 4% in 501-636 m; 31% in >636 m	Six females or immatures/ September-October/ DTAG	Watwood et al. (2006)
Sperm whale	-	-	-	-	-	Feeding	Mediterranean Sea	20% of total time was spent near surface (0-10m); foraging dive statistics provided in Table 1 and used to calculate percentages of time in depth categories, adjusted for total time at surface	35% in <10 m; 4% in 10-100 m; 9% in 101-300 m; 9% in 301-500 m; 5% in 501-623 m; 38% in >636 m	Eleven females or immatures/ July/ DTAG	Watwood et al. (2006)

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Sperm whale	-	-	-	-	-	Feeding	Gulf of Mexico	28% of total time was spent near surface (0-10m); foraging dive statistics provided in Table 1 and used to calculate percentages of time in depth categories, adjusted for total time at surface	41% in <10 m; 4% in 10-100 m; 8% in 101-300 m; 7% in 301-468 m; 40% >468 m	20 females or immatures/ June-September/ DTAG	Watwood et al. (2006)
Sperm whale	-	-	-	-	-	Feeding/ Resting	North Pacific (Japan)	Dives to 400-1200 m; active bursts in velocity at bottom of dive suggesting search-and-pursue strategy for feeding; 14% of total time was spent at surface not feeding or diving at all, with 86% of time spent actively feeding; used numbers from Table 1 to determine percentages of time in each depth category during feeding then adjusted by total time at surface	31% in <10 m (surface time); 8% in 10-200 m; 9% in 201-400 m; 9% in 401-600 m; 9% in 601-800m; 34% in >800 m	One female/ June/ Time-depth-recorder	Amano and Yoshioka (2003)
Sperm whale	-	-	-	-	-	Feeding/ Resting	North Atlantic (Caribbean)	Whales within 5 km of shore during day but moved offshore at night; calves remained mostly at surface with one or more adults; night time tracking more difficult due to increased biological noise from scattering layer; both whales spent long periods of time (>2hr) at surface during diving periods	-	Two whales/ October/ Acoustic transponder	Watkins et al. (1993)

Common Name	Food Preference	Depth or Oceanic Preference	Dive Pattern(s)	Surface Pattern(s)	Refs	Behavioral State	Geographic Region	Depth Information	Depth Dist-ribution	Sample Size/ Time of Year/Method	References
Sperm whale	-	-	-	-	-		North Atlantic (Caribbean)	Dives did not approach bottom of ocean (usually >200 m shallower than bottom depth); day dives deeper than night dives but not significantly; 63% of total time in deep dives with 37% of time near surface or shallow dives (within 100 m of surface)	-	One whale/ April/ Time-depth tag	Watkins et al. (2002)
Sperm whale	-	-	-	-	-	Feeding	South Pacific (New Zealand)	Primarily cephalopod prey of genus *Histioteuthis* sp, mostly immatures, which is know to undergo vertical migrations; also mysides that are usually found at 650 m during day and between 274 and 650 m at night; some prey species also found in shallower (<100 m) depths in trawls	-	27 whales/ Year round/ Stomach contents	Beatson (2007)
Short-beaked common dolphin	-	-	-	-	-	-	-	200 m	-	-	Evans 1971, Evans 1994, Goold 2000
Striped dolphin	-	-	-	-	-	-	-	200-700 m	-	-	Archer and Perrin 1999

This page intentionally left blank

2.1.3 San Clemente Island-Pinnipeds

Six species of pinnipeds may occur on or near San Clemente Island (SCI), including the California sea lion, northern elephant sea, Pacific harbor seal, Guadalupe fur seal, Steller sea lion, and northern fur seal. Only one of the species, the California sea lion, is abundant and breeds regularly on SCI. Two other species, the harbor seal and the northern elephant seal, haul out regularly in small numbers and occasionally pup on SCI. The overall abundance of these species increased rapidly on the Channel Islands between the end of commercial exploitation in the 1920s and the mid-1980s. The growth rates of populations of some species appear to have declined in the SOCAL OEIS/EIS Study Area after the mid-1980s, and some recent survey data suggest that localized populations of some species may be declining. The declines may be a result of either interspecific competition or population numbers having exceeded the carrying capacity of the environment (Stewart et al. 1993; Hanan 1996). However, most populations continue to increase rapidly, and in some cases seals have recently occupied new rookeries and haul-out areas. The aforementioned pinniped species are not listed as endangered or threatened under the ESA (Barlow et al. 1997).

Three of the six pinniped species; the northern fur seal, the Guadalupe fur seal, and the Steller sea lion, that could potentially be found near SCI are less common. The northern fur seal breeds on San Miguel Island northwest of SCI, and is occasionally seen feeding in offshore waters. The Guadalupe fur seal is an occasional visitor to the Channel Islands but only breeds on Guadalupe Island, Mexico, which is approximately 225 nm (416 km) south of SCI. This species is thought to have expanded its range from Guadalupe Island in recent years (Maravilla-Chavez and Lowry 1999). An adult male Guadalupe fur seal has been observed hauled out among the breeding California sea lions on SCI during several recent breeding seasons (J. Carretta, Southwest Fisheries Science Center, National Marine Fisheries Service, pers. comm.). The Steller sea lion was once abundant in the northern portion of the SOCAL EIS/OEIS Study Area, but has declined rapidly since 1938. The northern fur seal is not listed as endangered or threatened under the ESA. The Guadalupe fur seal and the Steller sea lion are both designated as threatened under the ESA, and depleted under the MMPA. Their stocks are considered to be strategic. The state of California also lists the Guadalupe fur seal as threatened per the Fish and Game Commission California Code of Regulations (Title 14, Section 670.5, b, 6, H).

The only pinniped that is seen in large numbers on or near SCI is the California sea lion. It hauls out on rockier sections of the island and nearshore rocky outcroppings near SCI. Small numbers of northern elephant seals haul out and breed at SCI, and harbor seals are the least commonly seen of the three pinniped species. A single male Guadalupe fur seal hauled out with California sea lions for several years prior to the 1997–1998 El Niño event (J. Carretta and M. Lowry, pers. comm.).

Recent NMFS/SWFSC surveys of pinnipeds hauled out at sites on SCI involved the use of both ground surveys and aerial photogrammetric surveys (Carretta et al. 2000). This report uses aerial counts obtained in the surveys for estimates of the numbers of pinnipeds hauled out because aerial photographs are considered more precise than ground counts (ground counts are often obstructed by natural structures, and animal movements often result in recounting the same individual) (Lowry 1999). However, the occurrence of pinnipeds at haul-out sites that were not photographed is also noted.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Harbor seal												
adult males				B	M	M						
adult females			N	B N	N M	M						
pups			N	N	N							
juveniles					M	M						
Northern elephant seal												
adult males	B	B				M	M	M				
adult females	B N	B N	M N	M	M							N
pups	N	N	N									N
juveniles			M	M	M							
California sea lion												
adult males						B	B	B				
adult females	N					B N	B N	B N	N M	N	N	N
pups	N					N	N	N	N	N	N	N
juveniles												

Note: Green indicates not near SOCAL(> 100 km; elephant seals may migrate several thousand km to forage and sea lion males move up to central California to Washington to forage), Yellow indicates found in SOCAL at sea and hauled out periodically, but not engaged in sensitive activities, and Red indicates found in SOCAL at sea and hauled out for prolonged periods engaged in sensitive activities: M = molting, B = Breeding, N = Nursing.

Figure 2-1. Activities Of Pinnipeds Throughout The Year At San Clemente Island

California Sea Lion

The general biology, seasonal distribution, and movements of California sea lions in Southern California are described in Section 2.1.1. The following is a description of their use of terrestrial haul-out sites on and near SCI. The California sea lion is the most abundant pinniped species that hauls out on SCI, and it has been sighted in nearshore areas and onshore at SCI during all seasons. Areas where they have been observed to haul out include Mail Point, NW Harbor Islet, Tiki Area, Seal Cove, China Point, Citadel Rock, The Shack, and Bird Rock (immediately northwest of Northwest Harbor) (Figure 2-2). They have also been observed at other locations scattered along the south coast of SCI. Small numbers have been seen hauled out on rocky outcrops outside the breeding season.

Adult females often remain near rookeries throughout the year, and return there to give birth to their pups and breed. As in other areas in the Southern California Bight, most births occur from mid-June to mid-July (with a peak in late June). Females nurse their pups for ~8 days before going to sea to feed for two days. Subsequent feeding trips range from 1.7 to 3.9 days in duration, and subsequent nursing periods are 1.7–1.9 days long.

Male California sea lions arrive at breeding areas at the same time as females. Males display towards other males and females in a form of territorial defense (Boness 1991), where it appears that females choose which male they mate with based on both the male's characteristics and qualities of the site they occupy. The operational sex ratio of females to males appears to be relatively high at larger breeding colonies (although not necessarily at SCI), and the maximum number of females mated by a single male is 27 (Boness 1991). The greatest numbers of hauled-out California sea lions are usually seen during June and July, when adults tend to be found at or near breeding areas (Figure 2-2 and Table 2-1). This pattern was evident for adult males in both 1998 and 1999 on SCI, as most of the 317 males were sighted during the breeding season of the NMFS/SWFSC photogrammetric aerial surveys (Figure 2-2). In 1998, more adult female

California sea lions were also hauled out during the breeding season relative to the non-breeding portions of the survey (conducted in April and October) (Figure 2-2 and Table 2-1). However, in 1999 the pattern was reversed. Relatively more animals were hauled out in both January (2,483) and April (2,942) than during the breeding month of July (1,814). Fewer pups (600) were observed on SCI during the 1998 breeding season than during the same period in 1999 (1,005) (Figure 2-2 and Table 2-1). The decrease probably resulted from increased pup mortality attributable to decreased attendance by California sea lion mothers as they prolonged their foraging bouts in attempts to find food limited by the effects of the 1997–1998 El Niño event. However, the extent of the difference in pup numbers between 1998 and 1999 may be suspect, as surveys were conducted at different dates and times in July, and weather and tidal conditions may have differed between the years. All of these factors are known to influence haul-out behavior of pinnipeds, including California sea lion pups (Melin et al. 2000).

The population on SCI appears to be relatively small when compared with San Nicolas Island to the north (USDoN 1998), and numbers hauled out are variable (Figure 2-2 and Table 2-1). El Niño events have caused substantial reductions in numbers of pups produced in 1983, 1992, 1993, 1997, and 1998 (Forney et al. 2000). Estimates of pup numbers in 1997 (1,259), 1998 (657), and 1999 (645) suggest that the breeding success of California sea lions on SCI has been reduced during the recent El Niño event (Carretta et al. 2000; M. Lowry, pers. comm.).

Northern Elephant Seal

Northern elephant seals have been seen near and on SCI, although in total numbers far less than those of California sea lions. Haul-out sites include China Point, Mail Point/The Shack, Tiki Arae, Citadel Rock/ Seal Cove Point, and NW Harbor Inlet (Figure 2-3). Individuals include seals of all age classes, including some pups. Northern elephant seals probably breed in low numbers on SCI; the number of pups seen each year has been consistently <20 (J. Carretta, pers. comm.). One pup was sighted at the Mail Point Area during the pupping season (January) in 1999, eight pups were sighted during April 1998, and four pups were sighted in April 1999.

The general biology, seasonal distribution, and movements of northern elephant seals through the SCIRC are described in Section 2.1.1.

In larger colonies, northern elephant seals prefer gradually sloping sandy beaches or sand spits as haul-out sites. If sandy beaches are not available, they will haul out on pebbles or, as a last resort, on boulders and rocky shores (as some appear to do on SCI).

In early December, all bulls are hauled out at the rookeries. Pregnant females begin to arrive in mid-December and peak numbers are present at the end of January and in early February. Numbers of females then begin to decline until the first week in March when they have left the beaches to regain energy stores depleted during their fasting lactation period. Younger adult males begin to leave the rookery in late February, but some of the older males remain there until late March (Clinton 1994). This generalized pattern, characteristic of the larger colonies such as those at San Nicolas Island to the north of SCI, may not be in evidence at SCI, as the population density is relatively low. No adult males were sighted on SCI during photographic aerial surveys conducted by NMFS/SWFSC in 1998–1999, and only one adult male was sighted at Mail Point during a ground survey in January 1999 (Carretta et al. 2000).

NMFS/SWFSC has conducted ground surveys of northern elephant seals at SCI since 1982 and aerial surveys since 1988. Between 1982 and 2001, pup births increased at an average annual rate of 13.4 percent. SCI is, however, the smallest elephant seal rookery in southern California; during some years, no pups are born, and the largest number of pups born in any single year was 16 in 1996.

It is estimated that there are usually fewer than ~100 elephant seals of all age classes on SCI over the course of the year (M. Lowry, pers. comm.). That represents only ~0.18 percent of the California stock and ~21 percent of the population that occurs in the SCI.

Harbor Seal

Much of the general biology and status of harbor seals is described in Section 2.1.1. Harbor seals remain near their terrestrial haul-out sites and frequently haul out on land throughout the year, at least for brief periods. However, at most haul-out sites, harbor seals are seen on land only during the pupping, nursing, and molting periods. On SCI, as at most sites along the southern coast of California, the pupping period extends from late February to early April, with a peak in pupping in late March. The nursing period extends from late February to early May. Females and pups haul out for long periods at this time of year. The molting period is in late May–June, and all ages and sexes of harbor seals haul out at that time.

The harbor seal is a year-round resident at SCI. Results from the recent NMFS/SWFSC surveys (Carretta et al. 2000) of SCI indicate that five sites on San Clemente Island are used regularly by harbor seals for hauling out. They include Northwest Harbor Islet, The Shack, South Point, SHOBA, and China Point (Figure 2-4). Three other sites were used less frequently (Eastern Side, Mail Point, and the area from Tiki to Mail Point). Harbor seals may have avoided Mail Point, despite its proximity to other haul-out sites, because both California sea lions and northern elephant seals haul out regularly at that location. Of all of the harbor seal sites, only two, NW Harbor Islet and The Shack, were occupied by harbor seals during all six aerial photographic surveys conducted by NMFS in 1998 and 1999. Also, relatively more harbor seals hauled out at those two sites (26.4 percent of total at NW Harbor Islet and 18.5 percent at The Shack). Most harbor seals (44.4 percent of total) were observed hauled out during the survey on 23 April 1999. Harbor seals hauled out during both the warm and cold seasons at most haul-out sites. None of the NMFS/SWFSC surveys were conducted during molt (late May–June), when peak numbers of harbor seals are known to haul out. Therefore, it is difficult to provide comparable haul-out numbers to other studies.

Since 1983, scientists have conducted annual counts of harbor seals in the Southern California Bight, including those hauled out at SCI (Hanan 1996). In the early to mid-1980s, usually fewer than 100 harbor seals were counted there during the molting period (from 31 in May 1983 to 245 in June 1989). From 1983 to 1998, 31–95 harbor seals were counted in May–June during the index counts conducted by D. Hanan (1996; 1999; pers. comm.). Aerial counts of this type underestimate total numbers using the area, as animals at sea during the time of the count are not recorded.

Northern Fur Seal

Northern fur seals have not been seen hauled out on SCI. Their distribution during the winter and spring, when they are most abundant in the general area, is offshore.

Guadalupe Fur Seal

Several sightings of a male Guadalupe fur seal have been made on SCI beginning in July 1991 near Mail Point. These were of an adult male seen hauled out among California sea lions. This seal (if it is the same individual) has not been sighted since the onset of the 1997–1998 El Niño event (J. Carretta and M. Lowry, NMFS/SWFSC, pers. comm.).

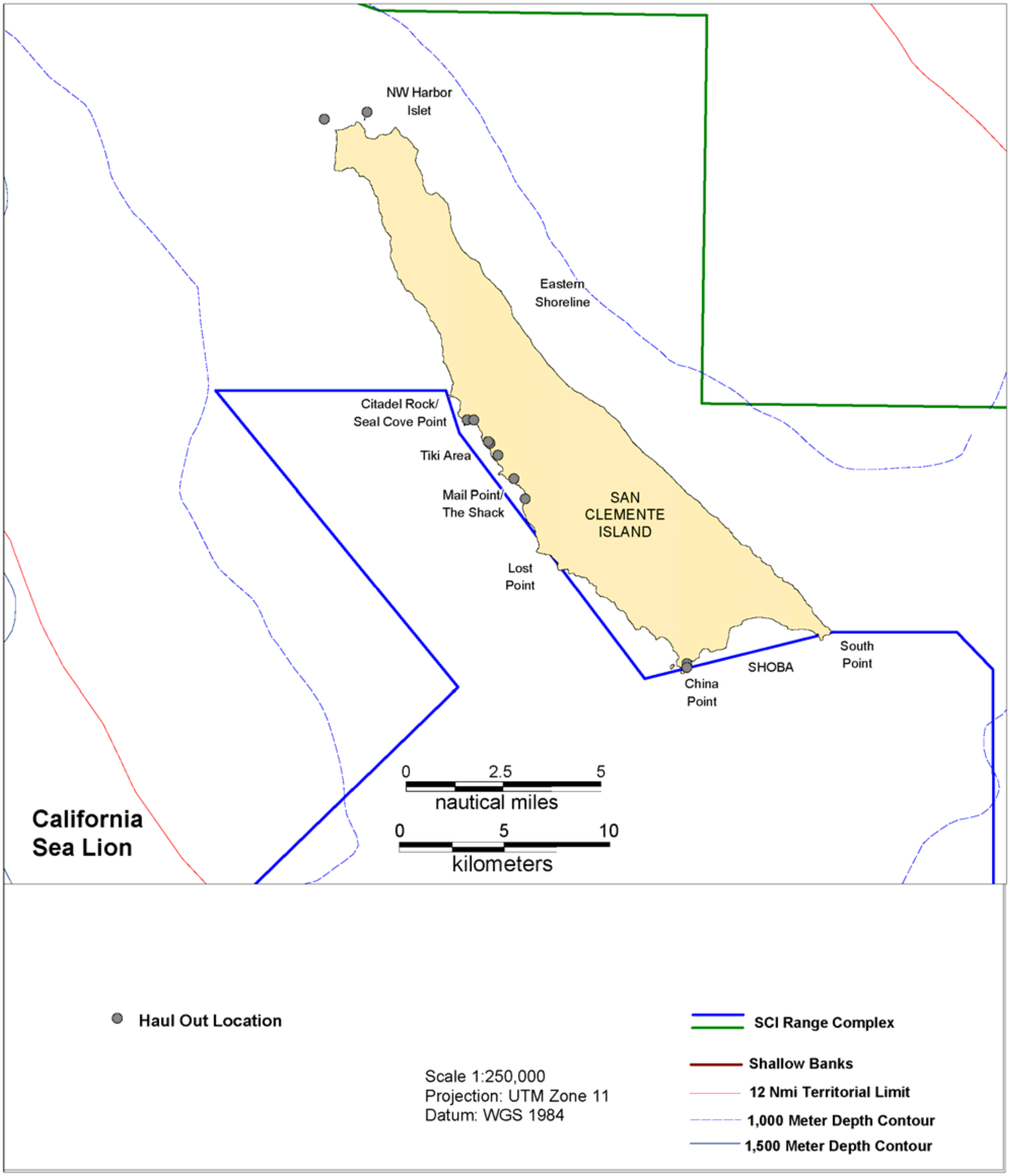
Steller Sea Lion

There are no published records of Steller sea lion sightings on SCI. Furthermore, no adults have been sighted in the Channel Islands since 1983 (see Section 2.1.1).

Sea Otter

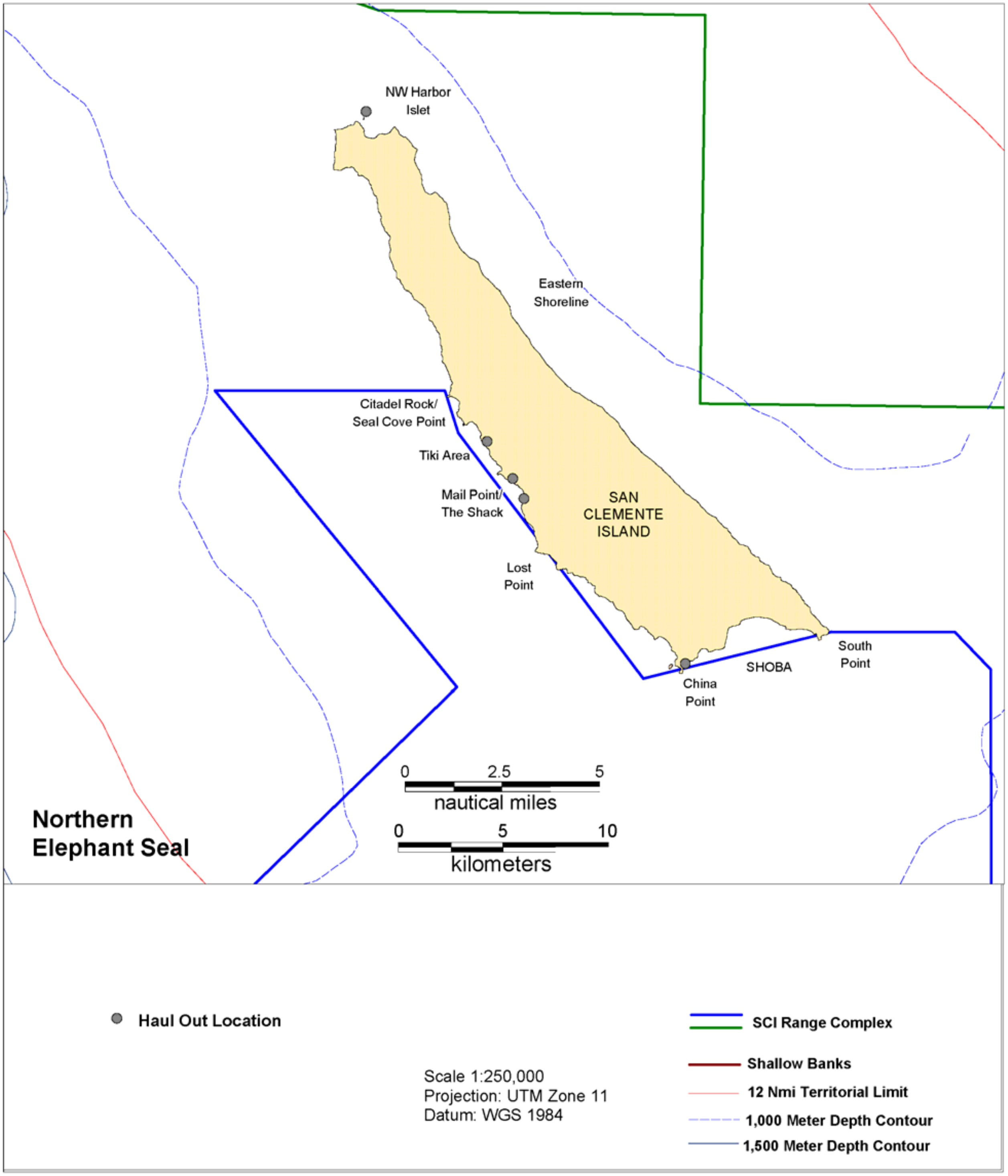
The distribution and life history of sea otters in California is described in Section 2.1.1. Prior to the fur trade, sea otters were common throughout the SCI. There have been rare sightings of a sea otter along the coast south of SCI. South of Point Conception, sea otters are rare but expanding southward along the coast.

SCI has been designated as an “otter free” zone by the USFWS, sea otters attempting to reside or colonize the island may be removed to other areas at the discretion of the USFWS. Recently the USFWS has sought to overturn the “otter free” zone because of the failure of the San Nicolas Island translocation (USFWS 2003) and has not been enforcing that zone since 2001 (USFWS 2001).



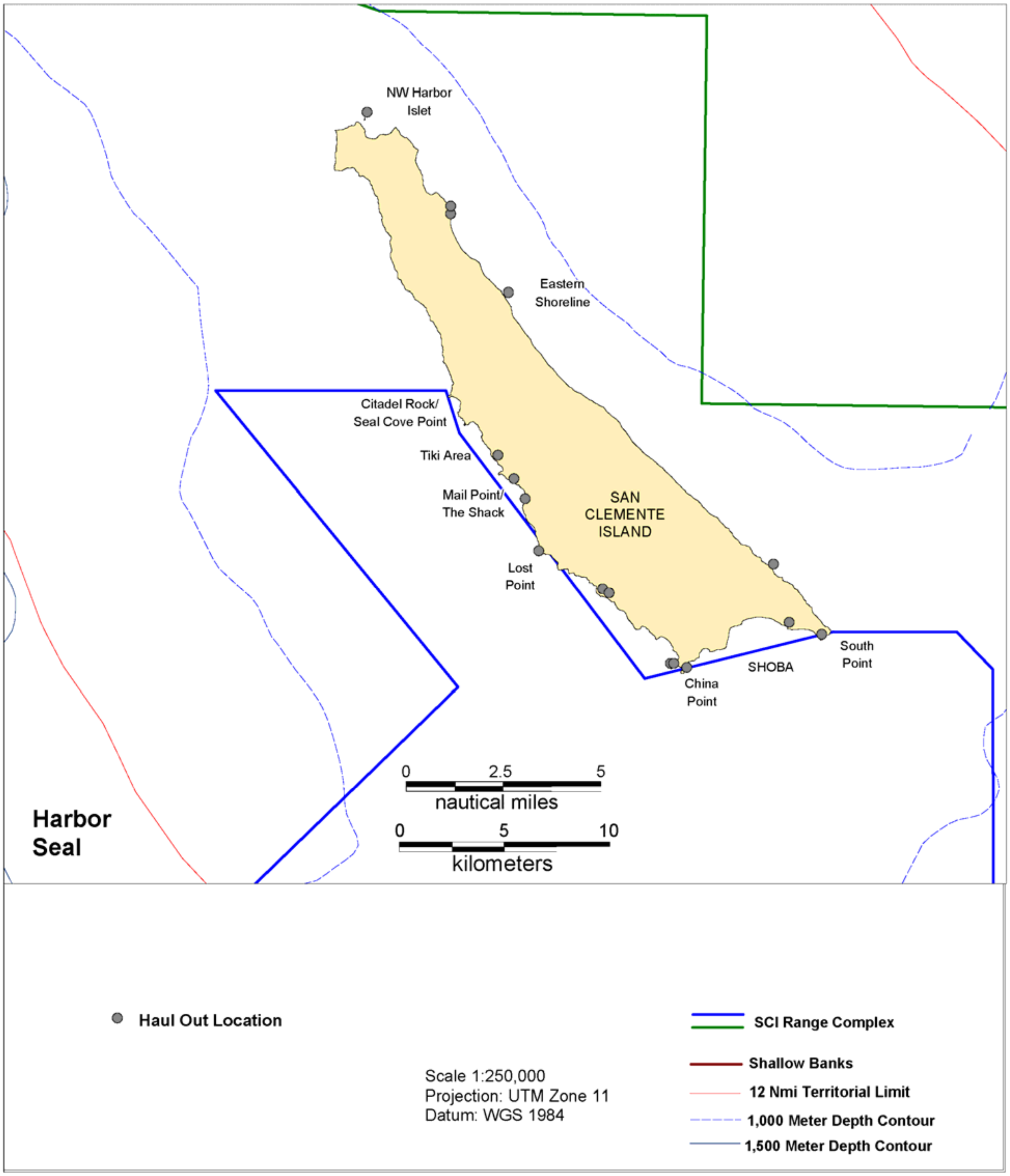
Source: Caretta et al. 2000 and Maravilla-Chavez (in press)

Figure 2-2. California Sea Lion Haul-out Locations On SCI



Source: Caretta et al. 2000 and Lowry 2002

Figure 2-3. Northern Elephant Seal SCI Haul-out Locations



Source: Caretta et al. 2000 and Lowry and Carretta 2003

Figure 2-4. Harbor Seal Haul Out Locations On San Clemente Island

2.2 MARINE MAMMAL ACOUSTICS

2.2.1 Summary

Cetaceans

Cetaceans have an auditory anatomy that follows the basic mammalian pattern, with some adaptations to the demands of hearing underwater. The typical mammalian ear is divided into an outer ear, middle ear, and inner ear. The outer ear is separated from the inner ear by a tympanic membrane, or eardrum. In terrestrial mammals, the outer ear, eardrum, and middle ear transmit airborne sound to the inner ear, where the sound is detected in a fluid. Since cetaceans already live in a fluid medium, they do not require this matching, and thus do not have an air-filled external ear canal. Sound may enter through the lower jaw in cetaceans (Brill et al. 1988; Ketten 1997, 2000). The inner ear is where sound energy is converted into neural signals that are transmitted to the central nervous system via the auditory nerve. Acoustic energy causes the basilar membrane in the cochlea to vibrate. Sensory cells at different positions along the basilar membrane are excited by different frequencies of sound (Tyack 1999). Marine mammal vocalizations often extend both above and below the range of human hearing. Vocalizations with frequencies lower than 18 Hertz (Hz) are labeled as infrasonic and those higher than 20 kilohertz (kHz) as ultrasonic. Measured data on the hearing abilities of cetaceans are sparse, and are non-existent for the larger cetaceans such as the baleen whales. The auditory thresholds of some of the smaller odontocetes have been determined in captivity. It is generally believed that cetaceans should at least be sensitive to the frequencies of their own vocalizations. Comparisons of the anatomy of cetacean inner ears and models of the structural properties and the response to vibrations of the ear's components in different species provide an indication of likely sensitivity to various sound frequencies. The ears of small toothed whales are optimized for receiving high-frequency sound, while baleen whale inner ears are best in low to infrasonic frequencies (Ketten 1992, 1997, 1998).

Baleen whales primarily use the lower frequencies, producing tonal sounds in the frequency range of 15 to 3,000 Hz, with good suggested sensitivity from 20 Hz to 2 kHz depending on the species (Ketten 1998). Clark and Ellison (2004) suggested that baleen whales use low frequency sounds not only for long-range communication, but also as a simple form of echo ranging, using echoes to navigate and orient relative to physical features of the ocean. Information on auditory function in mysticetes is extremely lacking. Sensitivity to low-frequency sound by baleen whales has been inferred from observed vocalization frequencies, observed reactions to playback of sounds, and anatomical analyses of the auditory system.

Baleen whale vocalizations are composed primarily of frequencies below 1 kHz, and some contain fundamental frequencies as low as 16 Hz (Watkins et al. 1987; Richardson et al. 1995; Rivers 1997; Moore et al. 1998; Stafford et al. 1999; Wartzok and Ketten 1999) but can be as high as 24 kHz (humpback whale; Au et al. 2006). Although there is apparently much variation, the source levels of most baleen whale vocalizations lie in the range of 150-190 dB re 1 µPa at 1 m. Low-frequency vocalizations made by baleen whales and their corresponding auditory anatomy suggest that they have good low-frequency hearing (Ketten 2000), although specific data on sensitivity, frequency or intensity discrimination, or localization abilities are lacking. Marine mammals, like all mammals, have typical U-shaped audiograms that begin with relatively low sensitivity (high threshold) at some specified low frequency with increased sensitivity (low threshold) to a species specific optimum followed by a generally steep rise at higher frequencies (high threshold) (Fay 1988).

The majority of blue and fin whales vocalizations are less than 222 Hz (Cummings and Thompson 1971 Thompson *et al*. 1992; Berchok *et al*. 2003a, 2003b; Mellinger and Clarke 2003; Clarke 2004; Rankin *et al.* 2004). Blue whales produce a variety of low-frequency sounds in a

10-100 Hz band (Cummings and Thompson 1971; Edds 1982; Thompson and Friedl 1982; Alling and Payne 1991; McDonald *et al*. 1995; Clark and Fristrup, 1997; Rivers, 1997; Stafford et al., 1998; Stafford et al., 1999; McDonald *et al*. 2001). Off California, the most typical blue whale signals are very long, patterned sequences of tonal infrasonic sounds in the 15-100 Hz range (Aburto *et al*. 1997; Teranishi *et al*. 1997; McDonald et al. 2001; Oleson *et al*. 2005), and are typically infrequently produced by a small subset of males (Calambokidis *et al*. 2004; Oleson et al. 2005).

Fin whales produce a variety of low frequency sounds, primarily in the 15-200 Hz band (Watkins, 1981; Watkins et al. 1987; Edds, 1988; Thompson et al. 1992; McDonald and Fox 1999). The most typical signals are long, patterned sequences of short duration (0.5-2 seconds) infrasonic pulses in the 18-35 Hz range (Patterson and Hamilton 1964; Watkins et al. 1987).

Three sounds are produced by humpback whales: "songs" produced in late fall, winter, and spring by single animals; sounds produced by groups of humpback whales (possibly associated with aggressive behavior among males) on the winter breeding grounds; and sounds produced on the summer feeding grounds. Dominant frequencies of these songs range from 40 Hz to 24 kHz, with components of up to 8 kHz (Thompson et al. 1979; Richardson et al. 1995, Au et al. 2006). Source levels average 155 dB re 1 µPa at 1 m and range from 144 to 174 dB re 1 µPa at 1 m (Thompson et al., 1979). Sounds often associated with possible aggressive behavior by males are quite different from songs, extending from 50 Hz to 10 kHz (or higher), with most energy in components below 3 kHz (Tyack and Whitehead 1983). Sounds are produced less frequently on summer feeding grounds and are at approximately 20-2000 Hz, with median durations of 0.2-0.8 sec and source levels of 175-192 dB re 1 µPa at 1 m (Thompson et al. 1986). Filter-bank models of the humpback whale's ear have been developed from anatomical features of the humpback's ear and optimization techniques (Houser et al. 2001). The results suggest that humpbacks are sensitive to frequencies between 700 Hz and 10 kHz, but best sensitivity is likely to occur between 2 and 6 kHz.

Minke whales produce a variety of sounds, primarily in the 80-5,000 Hz range. In the Northern Hemisphere, sounds recorded include grunts, thumps, and ratchets from 80-850 Hz and pings and clicks from 3-20 kHz (Winn and Perkins 1976; Thompson et al. 1979; Stewart and Leatherwood 1985; Mellinger et al. 2000).

The toothed whales produce a wide variety of sounds, which include species-specific broadband "clicks" with peak energy between 10 and 200 kHz, individually variable "burst pulse" click trains, and constant frequency or frequency-modulated (FM) whistles ranging from 4 to 16 kHz (Wartzok and Ketten 1999). The general consensus is that the tonal vocalizations (whistles) produced by toothed whales play an important role in maintaining contact between dispersed individuals, while broadband clicks are used during echolocation (Wartzok and Ketten 1999). Burst pulses have also been strongly implicated in communication, with some scientists suggesting that they play an important role in agonistic encounters (McCowan and Reiss 1995), while others have proposed that they represent "emotive" signals in a broader sense, possibly representing graded communication signals (Herzing 1996). Sperm whales, however, are known to produce only clicks, which are used for both communication and echolocation (Whitehead 2003). Most of the energy of toothed whales social vocalizations is concentrated near 10 kHz, with source levels for whistles as high as 100-180 dB re 1 µPa at 1 m (Richardson et al. 1995). No odontocete has been shown audiometrically to have acute hearing (<80 dB re 1 µPa) below 500 Hz (DoN 2001). Sperm whales produce clicks, which may be used to echolocate (Mullins et al., 1988), with a frequency range from less than 100 Hz to 30 kHz and source levels up to 230 dB re 1 µPa 1 m or greater (Møhl et al. 2000). There are no specific data on the hearing sensitivity of sperm whales, but immature animals, at least, appear to have medium- and high-frequency hearing abilities similar to the other odontocete species tested (Carder and Ridgway 1990).

Pinnipeds

Sounds produced by pinnipeds include airborne and underwater vocalizations (Richardson et al. 1995). Calls include grunts, barks, and growls, in addition to the more conventional whistles, clicks, and pulses. The majority of pinniped sounds are in the sonic range (20 Hz to 20 kHz) (Ketten 1998; Wartzok and Ketten 1999). In general, phocids are far more vocal underwater than are otariids. Phocid calls are commonly between 100 Hz and 15 kHz, with peak spectra less than 5 kHz, but can range as high as 40 kHz (Ketten 1998; Wartzok and Ketten 1999). There is no evidence that pinnipeds echolocate (Schusterman et al. 2000). Pinniped hearing falls within the range of MFA sonar but to date there is little information on the effect of sonar on pinnipeds. Most of the acoustic behavior of pinnipeds takes place onshore at rookeries or just offshore for species that may hold territories in the water. The northern elephant seal produces loud, low-frequency in-air vocalizations (Bartholomew and Collias 1962). The mean fundamental frequencies are in the range of 147 to 334 Hz for adult males (Le Boeuf and Petrinovich 1974). The mean source level of the male-produced vocalizations during the breeding season is 110 dB re 20 μPa (Sanvito and Galimberti 2003). The harbor seal hears almost equally well in air and underwater (Kastak and Schusterman 1998). Harbor seals hear best at frequencies from 1 to 180 kHz; the peak hearing sensitivity is at 32 kHz in water and 12 kHz in air (Terhune and Turnball 1995; Kastak and Schusterman, 1998; Wolski et al. 2003). The range of maximal sensitivity underwater for the California sea lions is between 1 and 28 kHz (Schusterman et al. 1972). Functional underwater high frequency hearing limits are between 35 and 40 kHz, with peak sensitivities from 15 to 30 kHz (Schusterman et al. 1972).

In comparison with toothed whales, pinnipeds tend to have lower best frequencies, lower high-frequency cutoffs, and poorer sensitivity at the best frequency (Richardson et al. 1995). However, some pinnipeds (especially phocids) may have better sensitivity at low frequencies (<1 kHz) than do toothed whales (Richardson et al. 1995). The pinniped ear appears to have been constrained during its evolution by the necessity of functioning in two acoustically dissimilar media (air and water). The patterns of air and water hearing sensitivity appear to correspond to the patterns of life history of the pinniped species (Kastak and Schusterman 1998). Comparisons of the hearing characteristics of otariids and phocids suggest two types of pinniped ears, with phocids being better adapted for underwater hearing (Richardson et al. 1995; Kastak and Schusterman 1998; Ketten 1998; Wartzok and Ketten 1999). In phocids tested, peak sensitivities ranged between 10 and 30 kHz, with a functional high frequency limit of about 60 kHz (Richardson et al. 1995; Ketten 1998; Wartzok and Ketten 1999).

General reviews of cetacean and pinniped sound production and hearing may be found in Richardson et al. (1995), Edds-Walton (1997), Wartzok and Ketten (1999), and Au et al. (2000), May-Collado et al. (2007). For a discussion of acoustic concepts, terminology, and measurement procedures, as well as underwater sound propagation, Urick (1983) and Richardson et al. (1995) are recommended.

2.2.2 Discussion of Controlled Exposure Experiments

Controlled Exposure Experiments (CEE) are used to determine the short term effects of anthropogenic sound sources on species of concern (Tyack *et al*. 2004; Nowacek *et al*. 2007). Correlation studies have tried to determine sound effects from opportunistic observations of animals in the area of the sound source but the sample sizes are generally small and may take many years to determine if there is an effect or not. In CEEs, the instrumented animals are known and the sound source can be moved to them instead of waiting for the animal to approach the sound source area if they stay in the vicinity of the CEE area. The animal can be instrumented with a radio transmitter to follow its movements or fitted with satellite tag to record its movements and combined with an acoustic recorder to record the received sound level at the animal (Johnson and Tyack 2003). In addition, sensors to record heart rate, swim speed, and oceanographic parameters (e.g. water temperature) can be used to better understand the response and movements of the animals (Miksis et al. 2001). The sound source can be deployed near the instrumented animal and the sound intensity increased in small increments to elicit a response from the focal animal or animals. In addition, an instrumented area with temporary or permanent moored acoustic buoys can be used to track vocalizing animals and the sound source (e.g. navy instrumented ranges such as AUTEC, PMRF and SOAR). A recent behavioral response study (BRS) was conducted on the AUTEC range to study the response of cetaceans to active sonar (NOAA-NMFS 2007).

2.3 MARINE MAMMAL HABITAT AND DISTRIBUTION WITHIN SOUTHERN CALIFORNIA

Marine mammals inhabit most marine environments, from deep ocean canyons to shallow estuarine waters. They are not randomly distributed. Marine mammal distribution is affected by demographic, evolutionary, ecological, habitat-related, and anthropogenic factors (Bowen et al. 2002; Bjørge 2002; Forcada 2002; Stevick et al. 2002).

Movements are often related to feeding or breeding activity (Stevick et al. 2002). A migration is the periodic movement of all, or significant components of an animal population from one habitat to one or more other habitats and back again. Migration is an adaptation that allows an animal to monopolize areas where favorable environmental conditions exist for feeding, breeding, and/or other phases of the animal’s life history. Some baleen whale species, such as humpback whales, make extensive annual migrations to low-latitude mating and calving grounds in the winter and to high-latitude feeding grounds in the summer (Corkeron and Connor 1999). These migrations undoubtedly occur during these seasons due to the presence of highly productive waters and associated cetacean prey species at high latitudes and of warm water temperatures at low latitudes (Corkeron and Connor 1999; Stern 2002). The timing of migration is often a function of age, sex, and reproductive class. Females tend to migrate earlier than males and adults earlier than immature animals (Stevick et al. 2002; Craig et al. 2003). Not all baleen whales, however, migrate. Some individual gray, fin, Bryde’s, minke, and blue whales may stay year-round in a specific area.

Cetacean movements can also reflect the distribution and abundance of prey (Gaskin 1982; Payne et al. 1986; Kenney et al. 1996). Cetacean movements have also been linked to indirect indicators of prey, such as temperature variations, sea-surface chl a concentrations, and features such as bottom depth (Fiedler 2002). Oceanographic conditions such as upwelling zones, eddies, and turbulent mixing can create regionalized zones of enhanced productivity that are translated into zooplankton concentrations, and/or entrain prey as density differences between two different water masses aggregate phytoplankton and zooplankton (Etnoyer et al. 2004). High concentrations of fish and invertebrate larvae along with high rates of primary productivity are associated with shelf break and pelagic frontal features (Roughgarden et al. 1988; Munk et al. 1995). Frontal features in the SOCAL Range Complex and vicinity tend to be ephemeral in space and time, shifting to the north and south by 10 to 1,000 km depending on the season, the year, and the state of the El Niño (Etnoyer et al. 2004).

As noted by MacLeod and Zuur (2005), however, even in the best studied marine mammal species, determining the fundamental reasons behind the linkage between habitat variables and distribution can be problematic, and often requires extensive datasets. For example, though topography might increase primary productivity, and as a result, provide a local increased availability of prey, not every marine mammal species is necessarily concentrated in that area. Additional factors may be involved, such as habitat segregation between other species that share the same ecological niche (MacLeod and Zuur 2005). The degree of similarity in diet between two or more predators that occur in the same habitat will affect the level of competition between these predators. Competition between predators can result in the exclusion of one, or more, of them from a specific habitat. For example, MacLeod et al. (2003) suggested that an example of niche segregation might be that Mesoplodon whales occupy a separate dietary niche from bottlenose whales (Hyperoodon) and Cuvier's beaked whales (Ziphius) though they shared the same distribution. In contrast, Hyperoodon and Ziphius appear to occupy very similar dietary niches, but have geographically segregated distributions, with Hyperoodon occupying cold-temperate to polar waters and Ziphius occupying warm-temperate to tropical waters.

Since most toothed whales do not have the fasting capabilities of the baleen whales, toothed whales probably follow seasonal shifts in preferred prey or are opportunistic feeders, taking advantage of whatever prey happens to be in the area. Likewise, Thode et al. (2000) suggested that blue whales might associate with tidal bores, which are known to concentrate zooplankton.

Long-ranging movements are quite common in pinnipeds; hooded seals and northern elephant seals are both good examples, since they make extensive movements. Pinniped movements depend on the abundance of prey, its energy content, and the seasonality of prey distribution (Forcada 2002). Additionally, the pinniped reproductive cycle mandates that individuals return to land or ice to pup (give birth), nurse, and rear their offspring and molt. Pinnipeds will also haul out for resting, thermoregulation, and to escape predators. As with migrating cetaceans, there are variations in the timing of these movements and in the patterns between age classes (Forcada 2002).

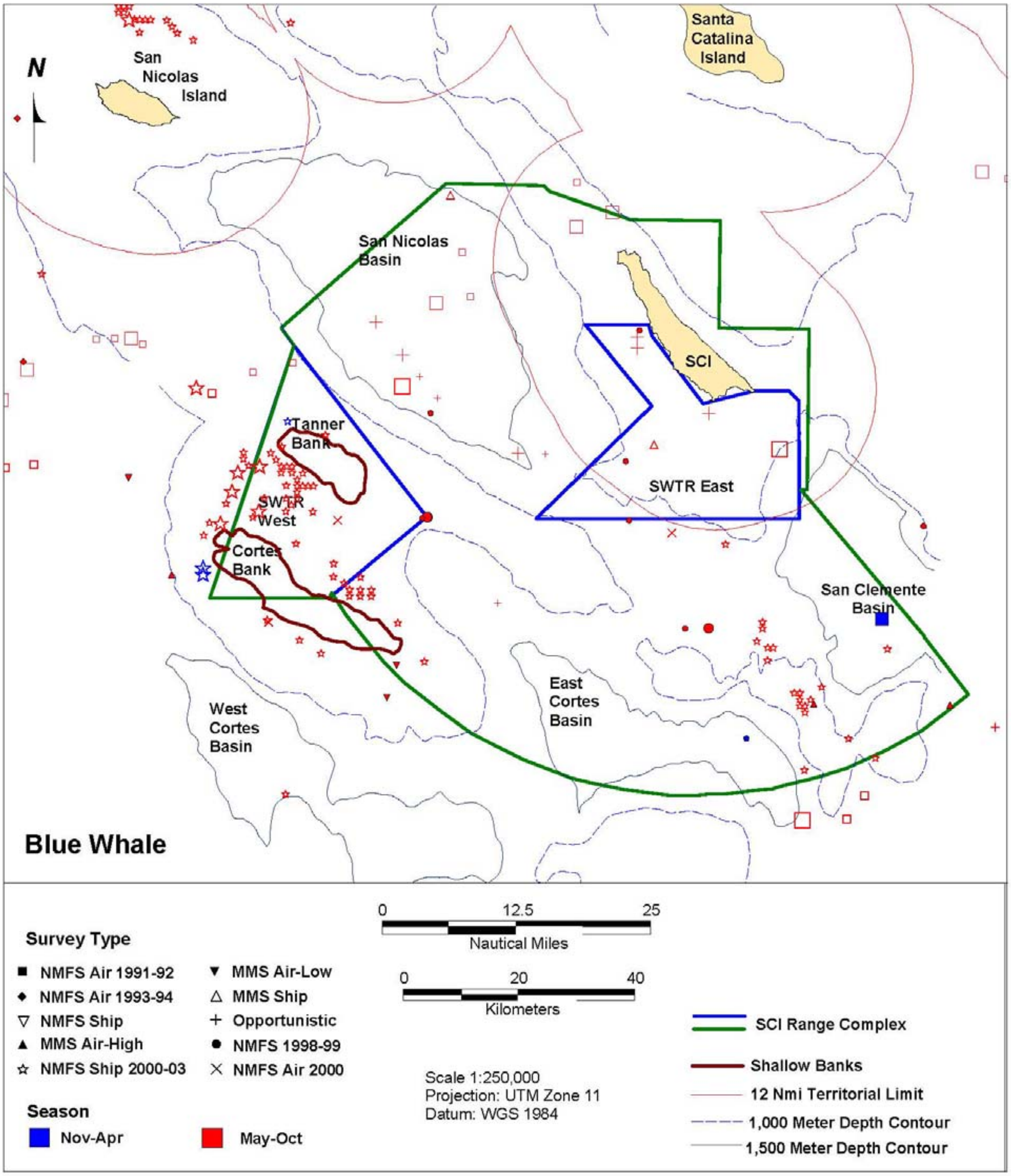
Occurrence of cetaceans outside the area with which they are usually associated may reflect fluctuations in food availability. Some studies have correlated shifts in the distribution of some baleen whale and toothed whale populations with ecological shifts in prey patterns after intense fishing efforts by commercial fisheries in the western North Atlantic (Payne et al. 1986, 1990; Kenney et al. 1996). DeMaster et al. (2001) predicted, based upon current data on human population growth and marine mammal fisheries interactions, that in the future, the most common type of competitive interaction would be ones in which a fishery has an adverse effect on one or more marine mammal populations without necessarily overfishing the target species of the fishery.

Pinniped movements, as noted earlier, are a reflection of both foraging ecology and the need to return to land for the purpose of breeding and molting. Like cetaceans, pinnipeds are often associated with either transient (oceanographic features such as frontal systems) or non-transient, physical features that serve to concentrate prey. Individual seal foraging behavior is probably related to oceanographic features in the water column, such as thermal discontinuities that act to concentrate prey species (Field et al. 2001). McConnell and Fedak (1996) hypothesized that seals out in the open ocean may be influenced by mesoscale frontal systems with locally enhanced prey abundance. Thompson et al. (1991) observed that the spatial and temporal occurrence of feeding harbor seals was in response to fish distribution which also shifts spatially and temporally, with concentrations over trenches and holes more than 10 m deep during daylight hours.

All pinniped species leave the water periodically to haul out on land or ice to molt, sleep, mate, pup, or avoid marine predators (Riedman 1990). The incidence, biological significance, and controlling factors for haul out at other times of the year, when weather is coldest, are essentially unknown (Moulton et al. 2000). For harbor seals, tidal stage has a significant effect on haulout behavior (Schneider and Payne 1983). Human disturbance can affect haulout behavior by causing seals to return to the water, thereby reducing the amount of time mothers spend nursing pups (Moulton et al. 2000; Schneider and Payne 1983).

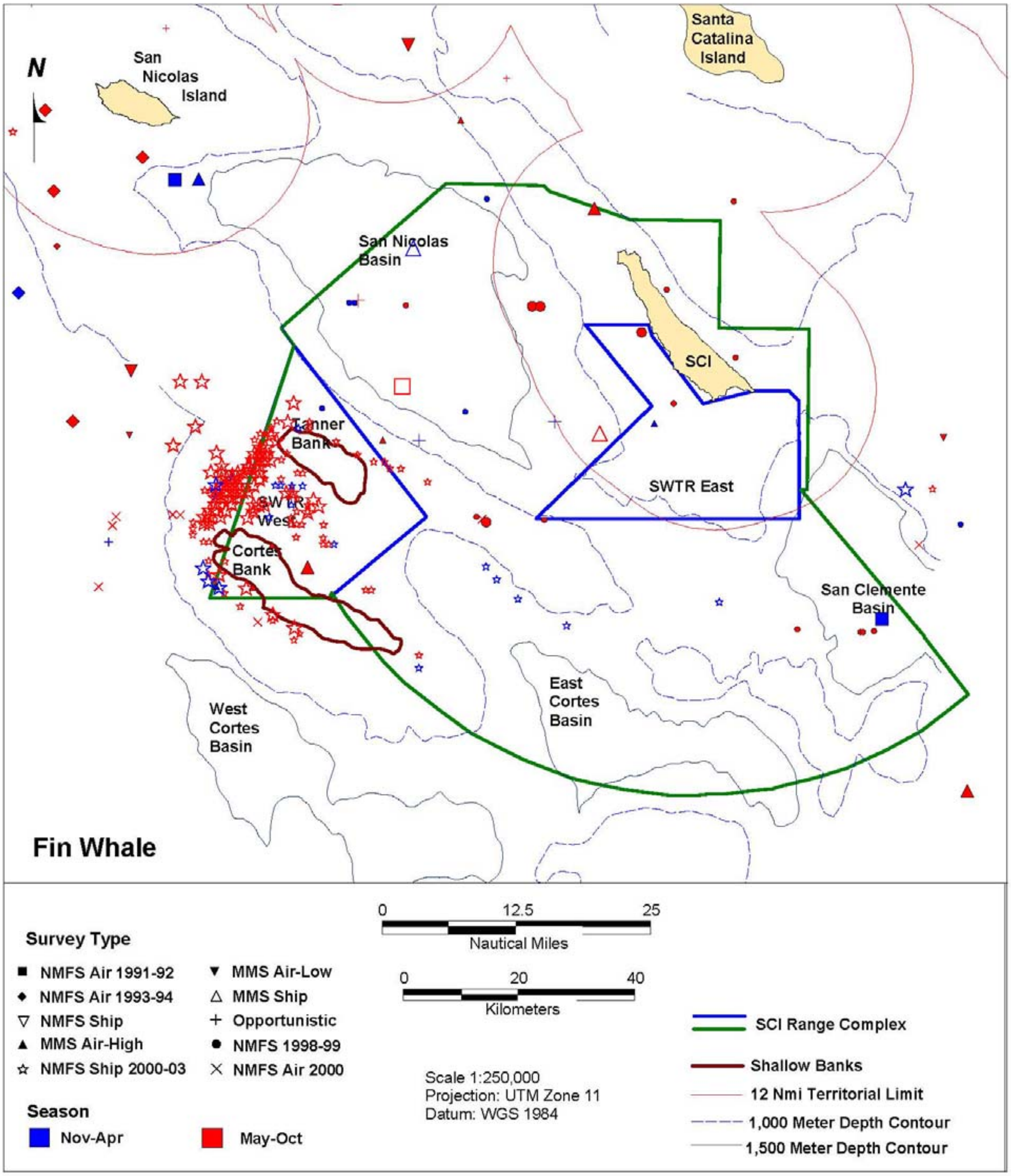
Climatic fluctuations have produced a growing concern about the effects of climate change on marine mammal populations (MacGarvin and Simmonds 1996; IWC 1997; Evans 2002; Würsig et al. 2002). Responses of marine mammals to climate change are difficult to interpret due to the confounding effects of natural responses and human influences. Additionally, the time scale on which marine mammals respond to direct or indirect effects of climate change may be diluted or muted. Large-scale climatic events and long-term temperature change may affect the distribution and abundance of marine mammal species, either impacting them directly or indirectly through alterations of habitat characteristics and distribution or prey availability (Kenney et al. 1996; IWC 1997; Harwood 2001; Greene and Pershing 2004). The impacts on pinnipeds and other marine mammals during the 1982/1983 El Niño event differed from region to region, but generally included a diminished food supply for the species. For example, sea lions in the southern California region were less successful in obtaining sufficient food of good quality, even on more extensive foraging trips (Feldkamp et al. 1991). The loss of food induced by warm waters resulted in nutritionally stressed adult females with pups and lower milk production, leading to a higher mortality rate among sea lion pups and juveniles and lower pup growth rates. This pattern was again evident in the 1997/1998 El Niño event (Hayward 2000). Similar patterns indicative of reduced foraging success and increased nutritional stress are also evident in elephant seals in central California during the cyclic warming periods (Le Boeuf and Crocker 2005). Decreased squid abundance during El Niño events has been attributed to shifts in marine mammal distribution and abundance. For example, short-finned pilot whales virtually disappearing from the Santa Catalina Island area and being replaced by Risso's dolphins (Shane 1994, 1995). In Monterey Bay, following the onset of El Niño 1997/1998, both the diversity and abundance of toothed whales in Monterey Bay increased (Benson et al. 2002). The increase in diversity was caused by an influx of warm-water species coupled with the persistence of temperate species typically found off central California (Benson et al. 2002).

The distribution of each marine mammal species in the applicable parts of Southern California is presented in Figures 2-5- to 2-20, mapped using marine mammal data available through 2003, as described in Section 2.4.



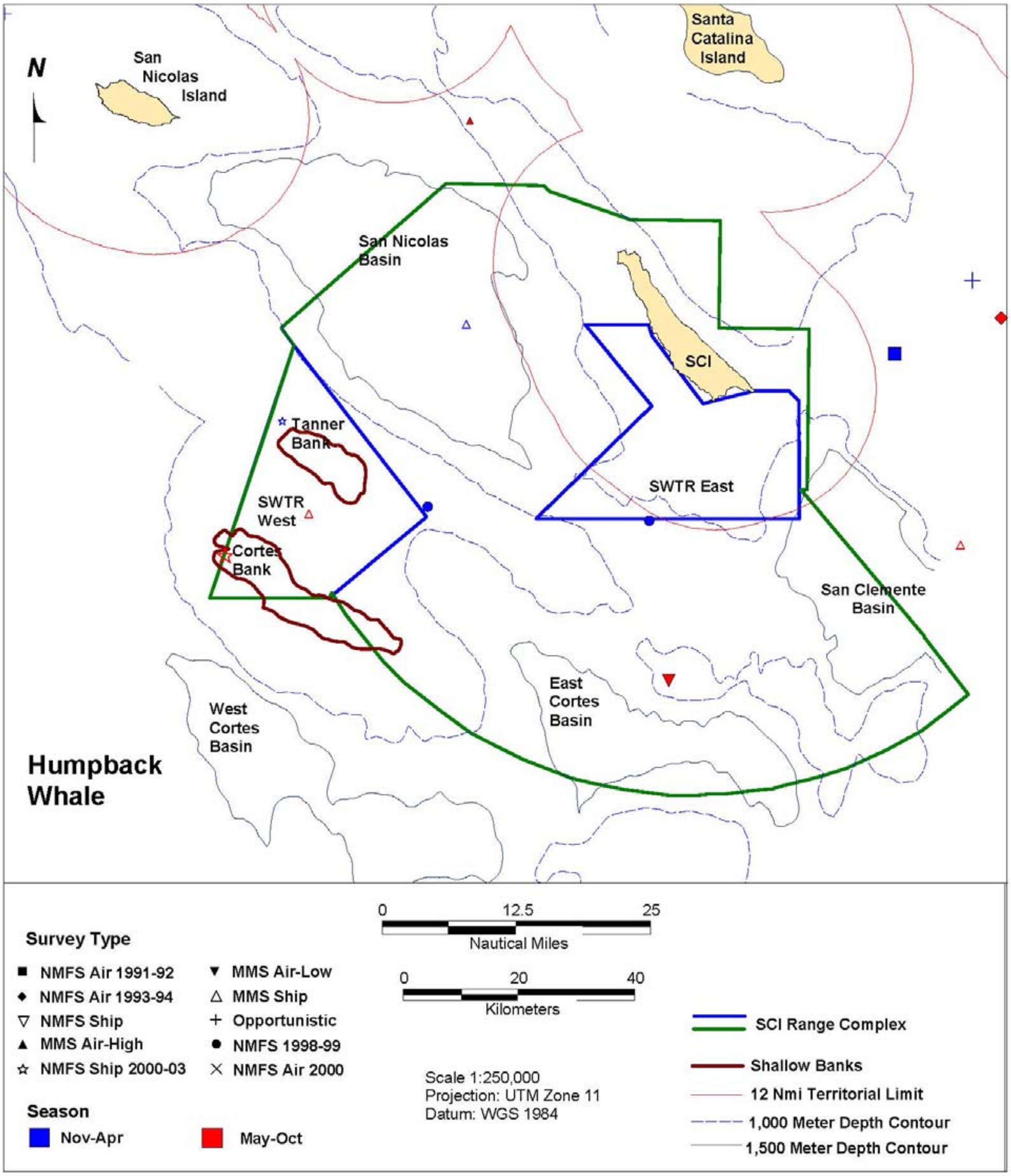
Small symbols are sightings of 1-10 individuals and large symbols are sightings of >10 individuals

Figure 2-5. Sightings of Blue Whales during Cold-water and Warm-water Seasons 1975–2003



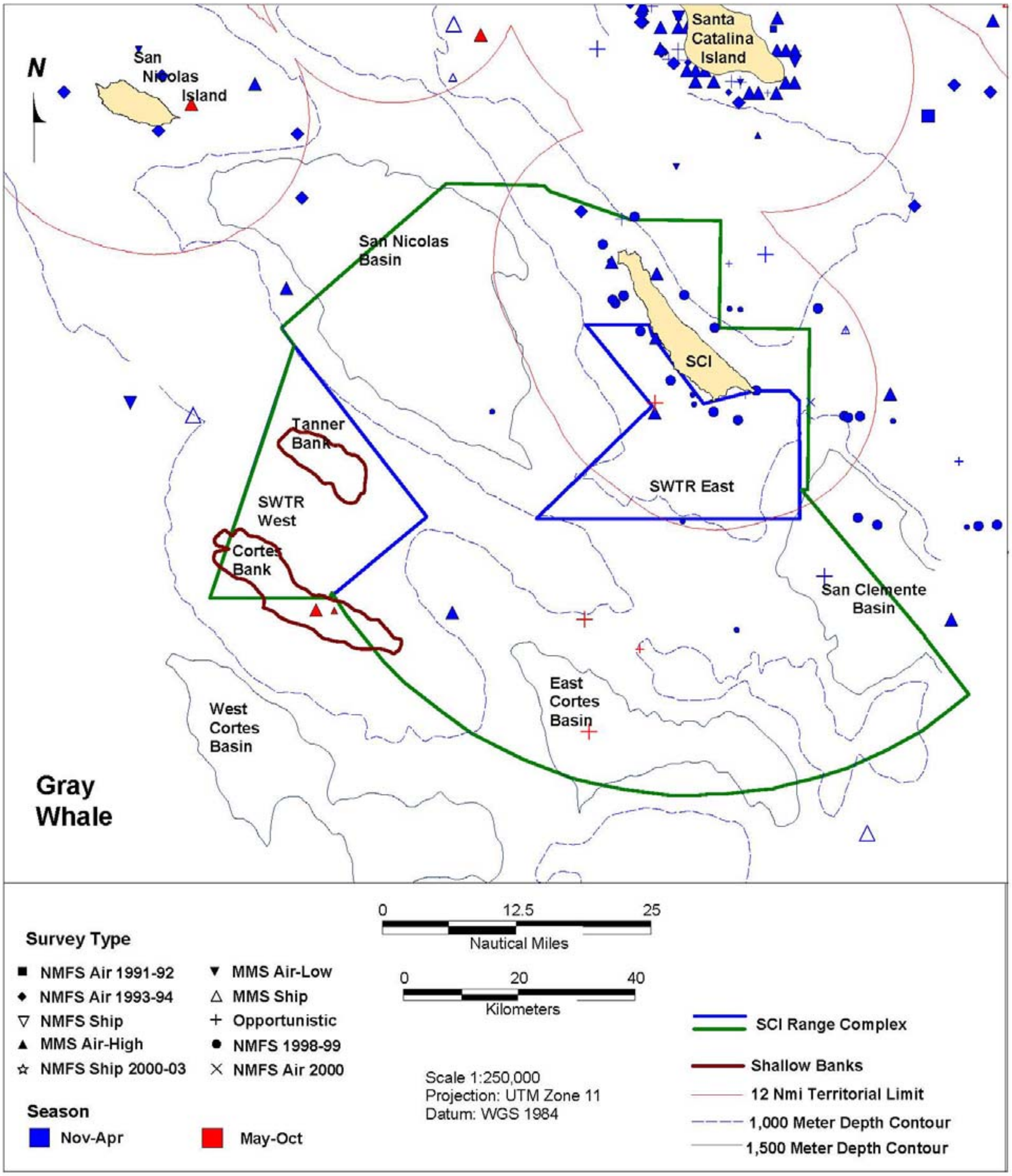
Small symbols are single sightings and large symbols are sightings of >2 individuals.

Figure 2-6. Sightings of Fin Whales during Cold-water and Warm-water Seasons 1975–2003



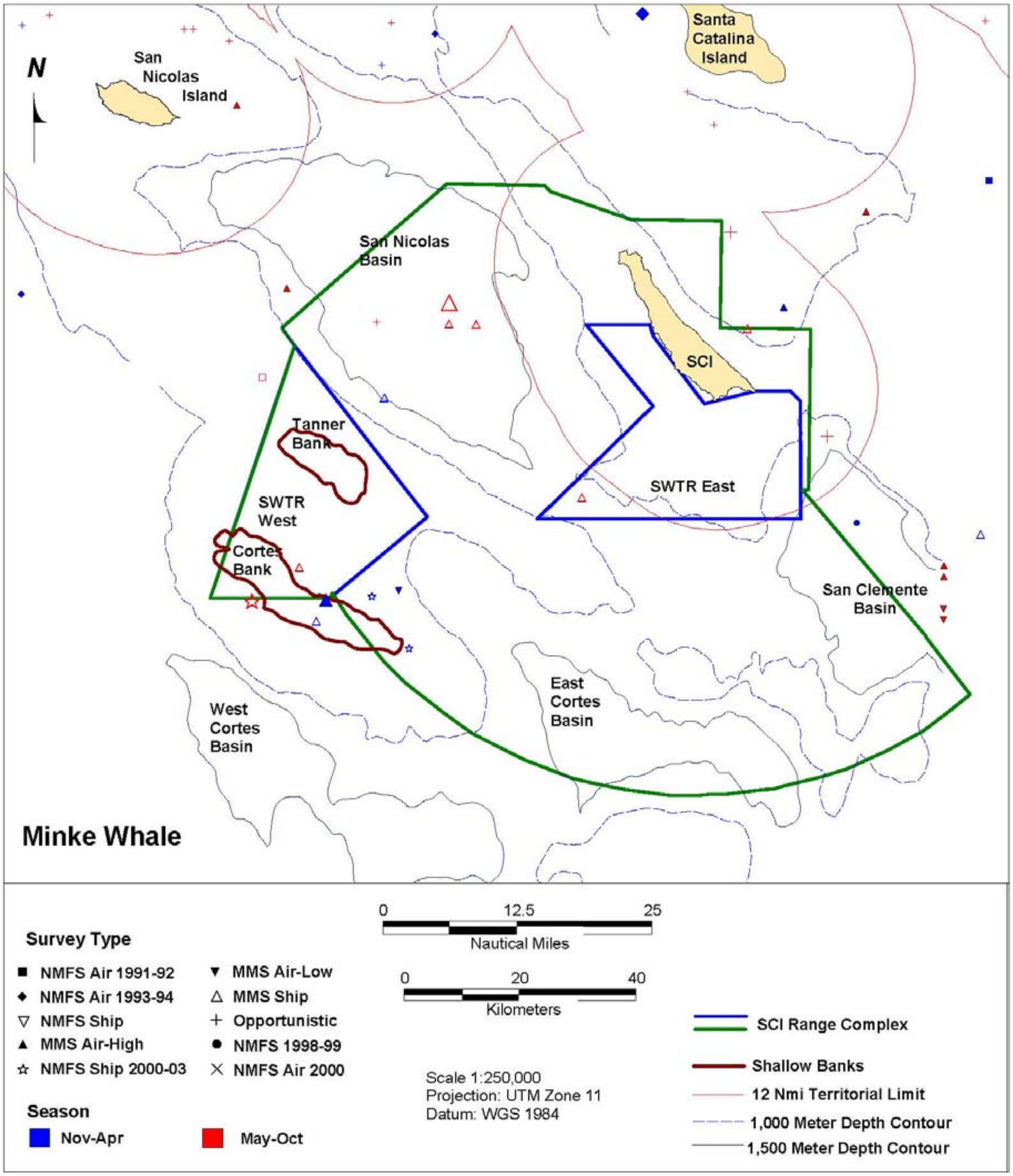
Small symbols are sightings of 1-10 individuals and large symbols are sightings of >10 individuals

Figure 2-7. Sightings of Humpback Whales during Cold-water and Warm-water Seasons 1975–2003



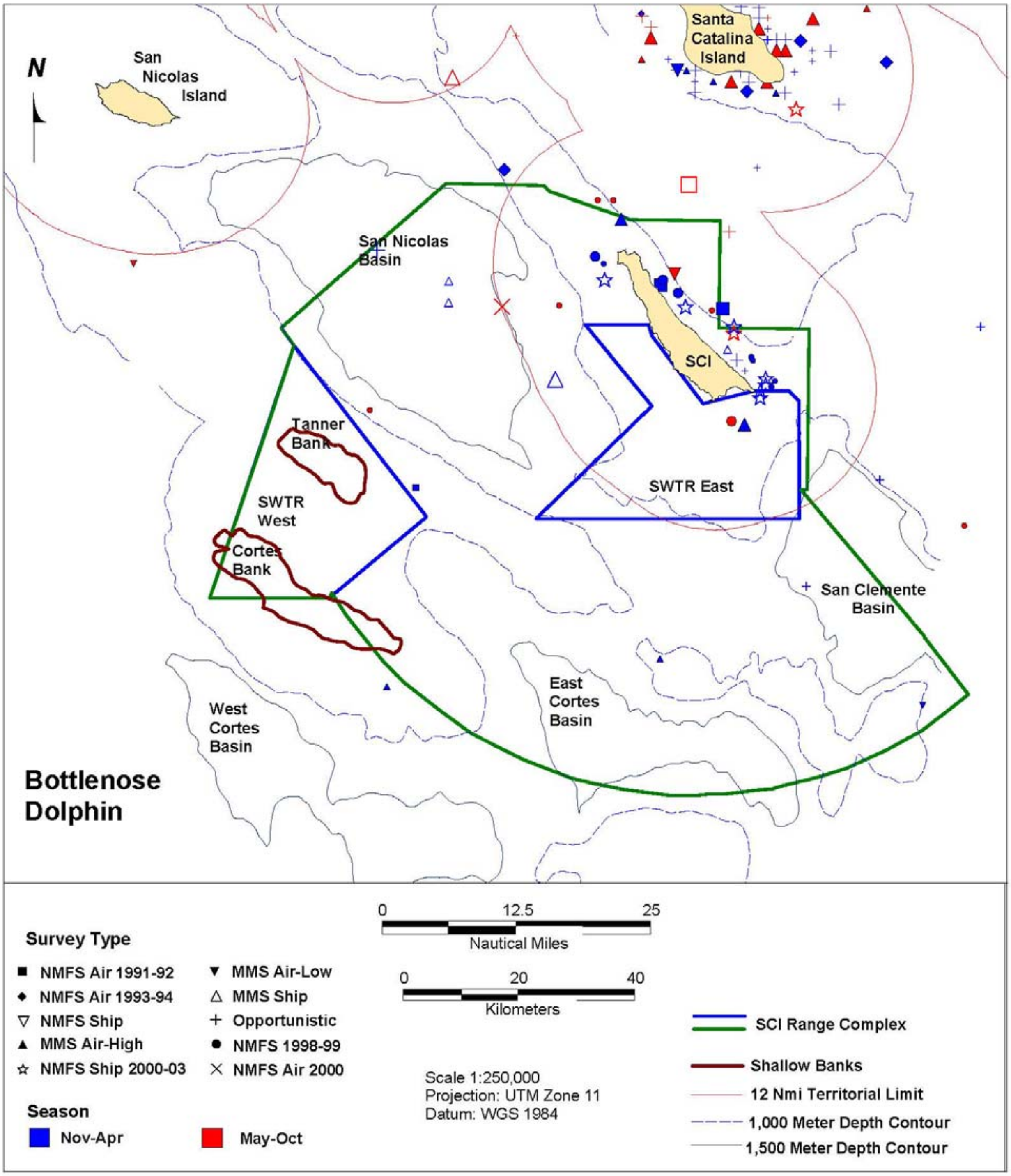
Small symbols are sightings of 1-10 individuals and large symbols are sightings of >10 individuals

Figure 2-8. Sightings of Gray Whales during Cold-water and Warm-water Seasons 1975–2003



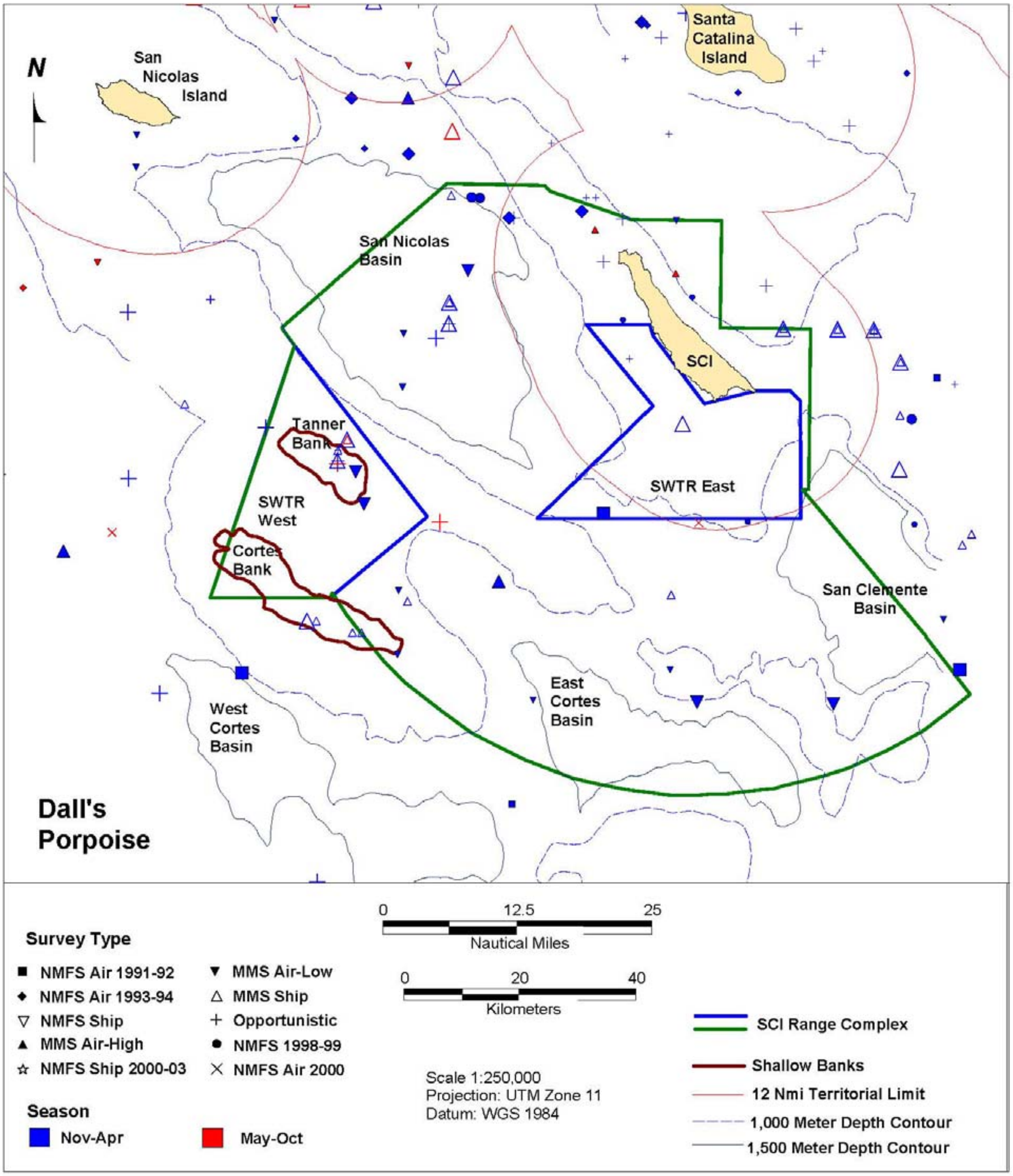
Small symbols are single sightings and large symbols are sightings of >2 individuals.

Figure 2-9. Sightings of Minke Whales during Cold-Water and Warm-Water Seasons 1975–2003



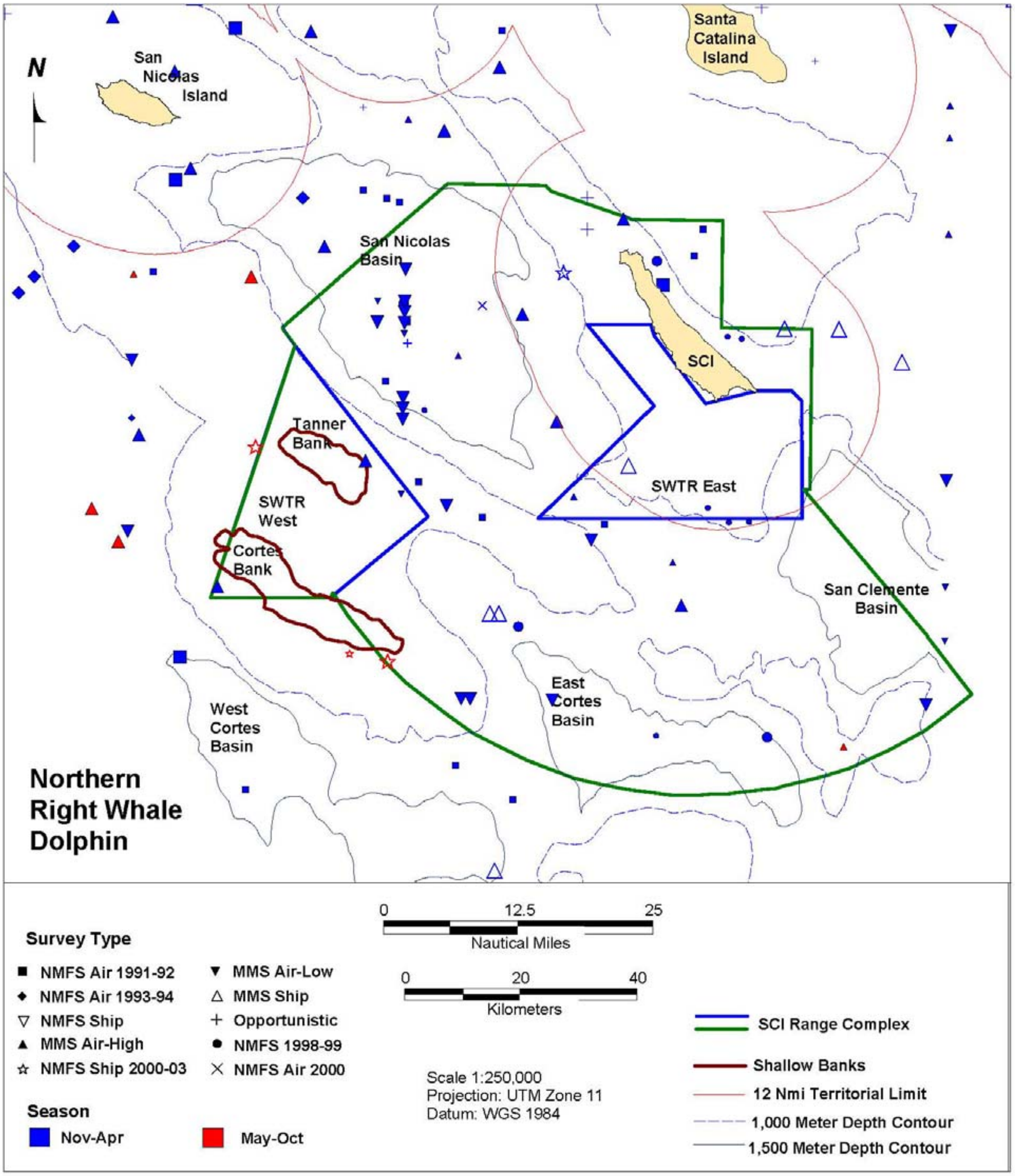
Small symbols are sightings of 1-10 individuals and large symbols are sightings of >10 individuals.

Figure 2-10. Sightings of Bottlenose Dolphins during the Cold-water and Warm-water Seasons 1975–2003



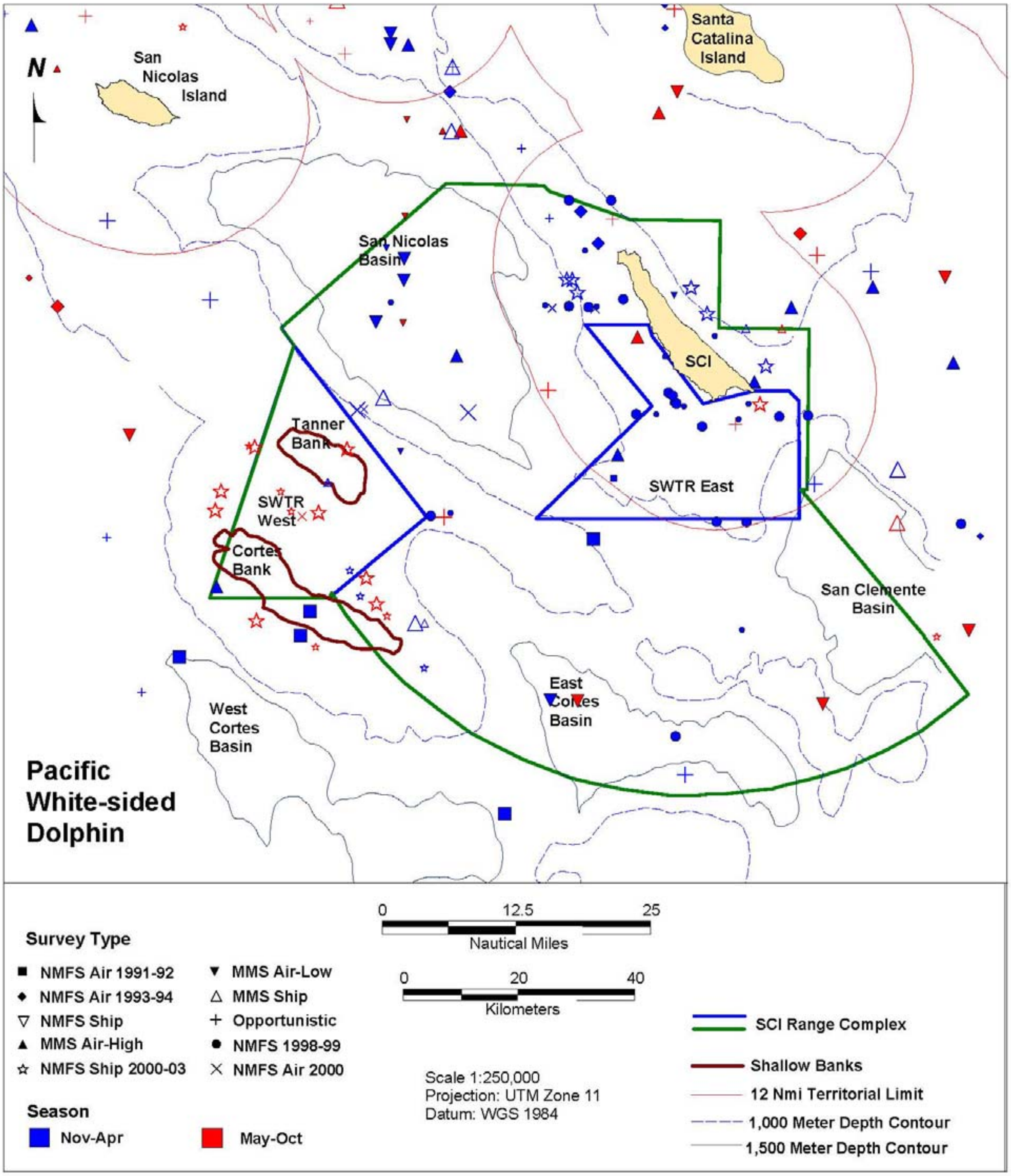
Small symbols are sightings of 1-10 individuals and large symbols are sightings of >10 individuals.

Figure 2-11. Sightings of Dall's Porpoises during the Cold-Water and Warm-Water Seasons 1975–2003



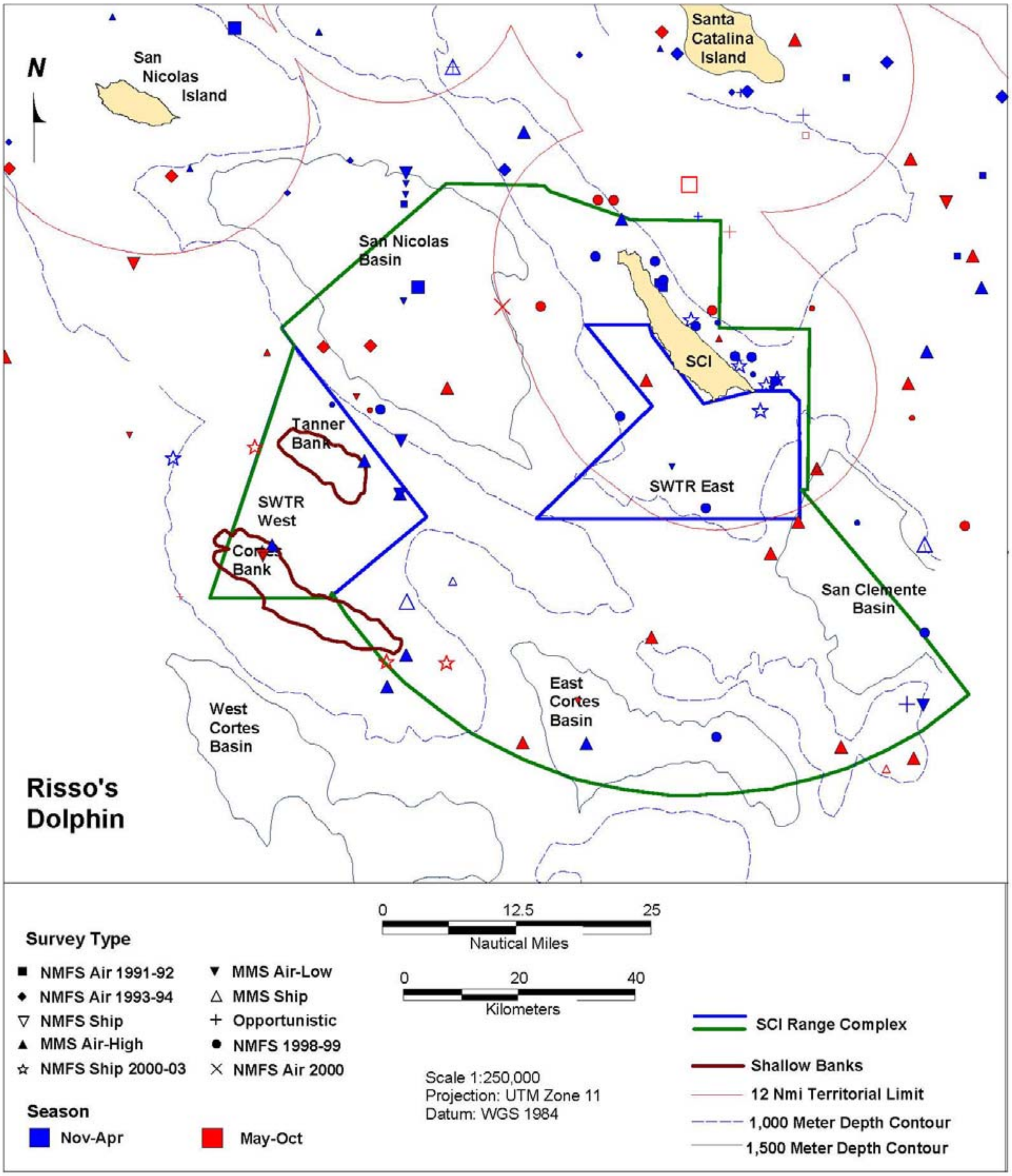
Small symbols are sightings of 1-10 individuals and large symbols are sightings of >10 individuals.

Figure 2-12. Sightings of Northern Right Whale Dolphins during Cold-water and Warm-water Seasons 1975–2003



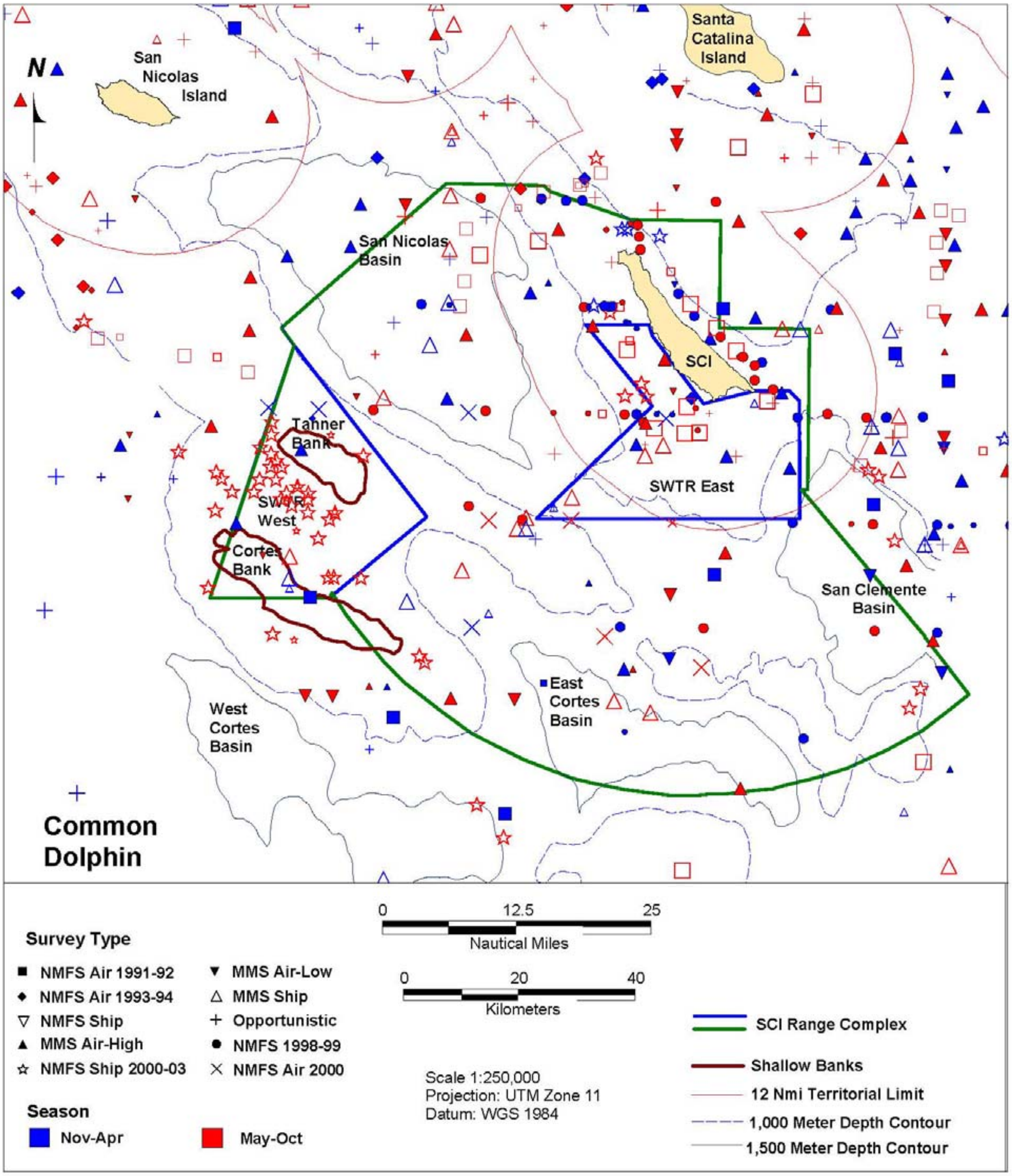
Small symbols are sightings of 1-10 individuals and large symbols are sightings of >10 individuals.

Figure 2-13. Sightings of Pacific White-sided Dolphins during the Cold-water and Warm-water Seasons 1975–2003



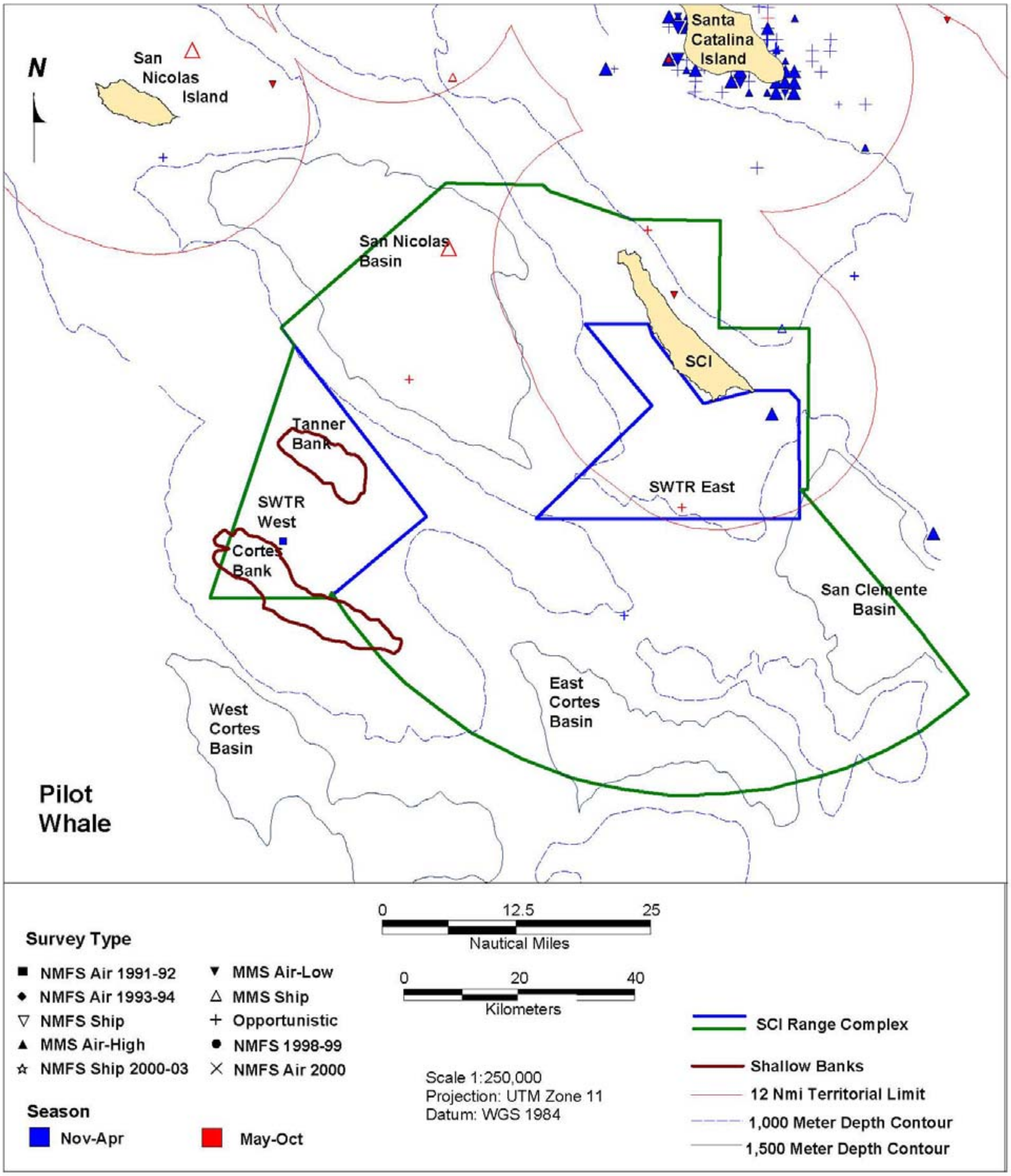
Small symbols are sightings of 1-10 individuals and large symbols are sightings of >10 individuals.

Figure 2-14. Sightings of Risso's Dolphins during the Cold-water and Warm-water Seasons 1975–2003



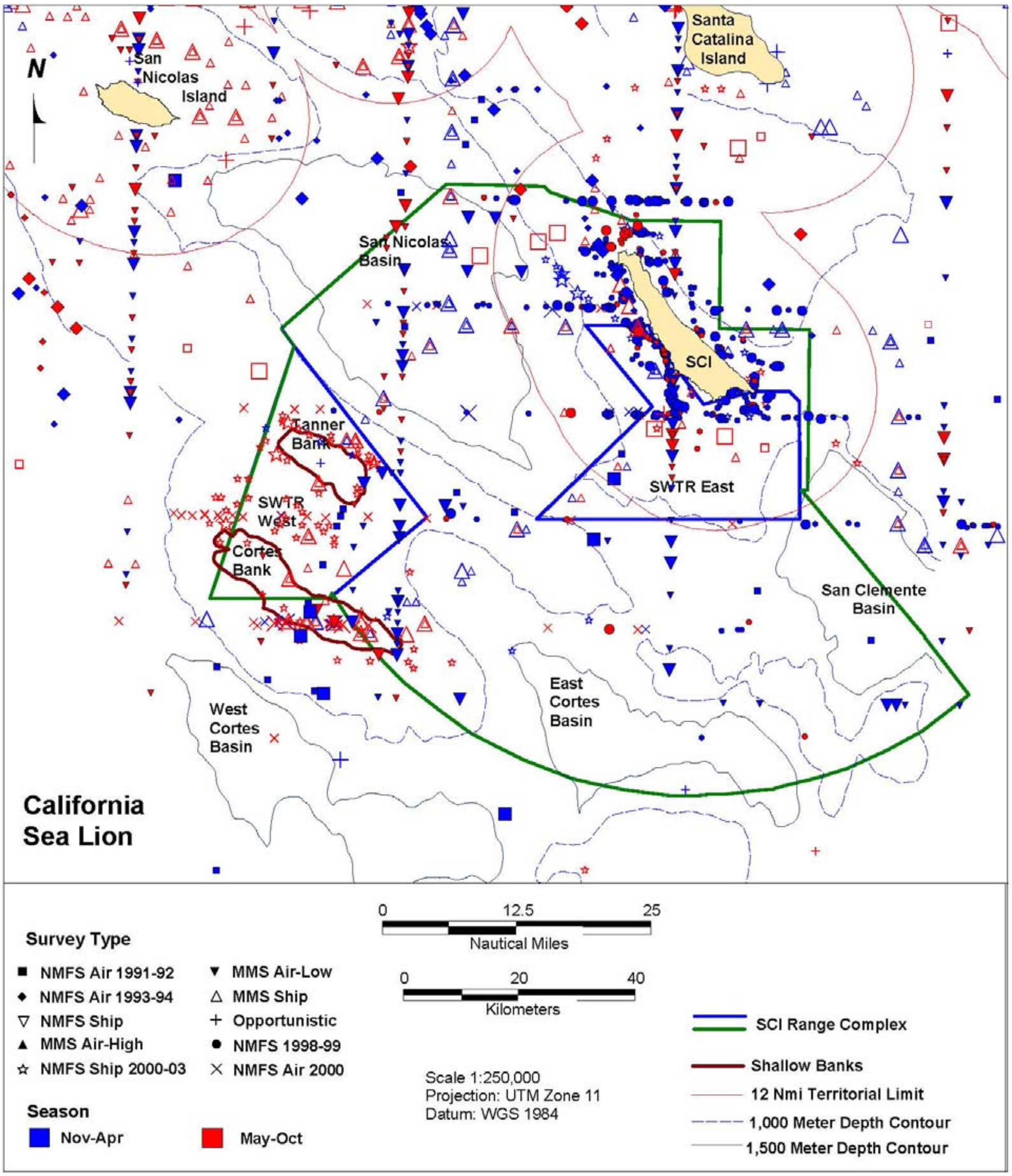
Small symbols are sightings of 1-10 individuals and large symbols are sightings of >10 individuals.

Figure 2-15. Sightings of Common Dolphins during the Cold-water and Warm-water Seasons 1975–2003



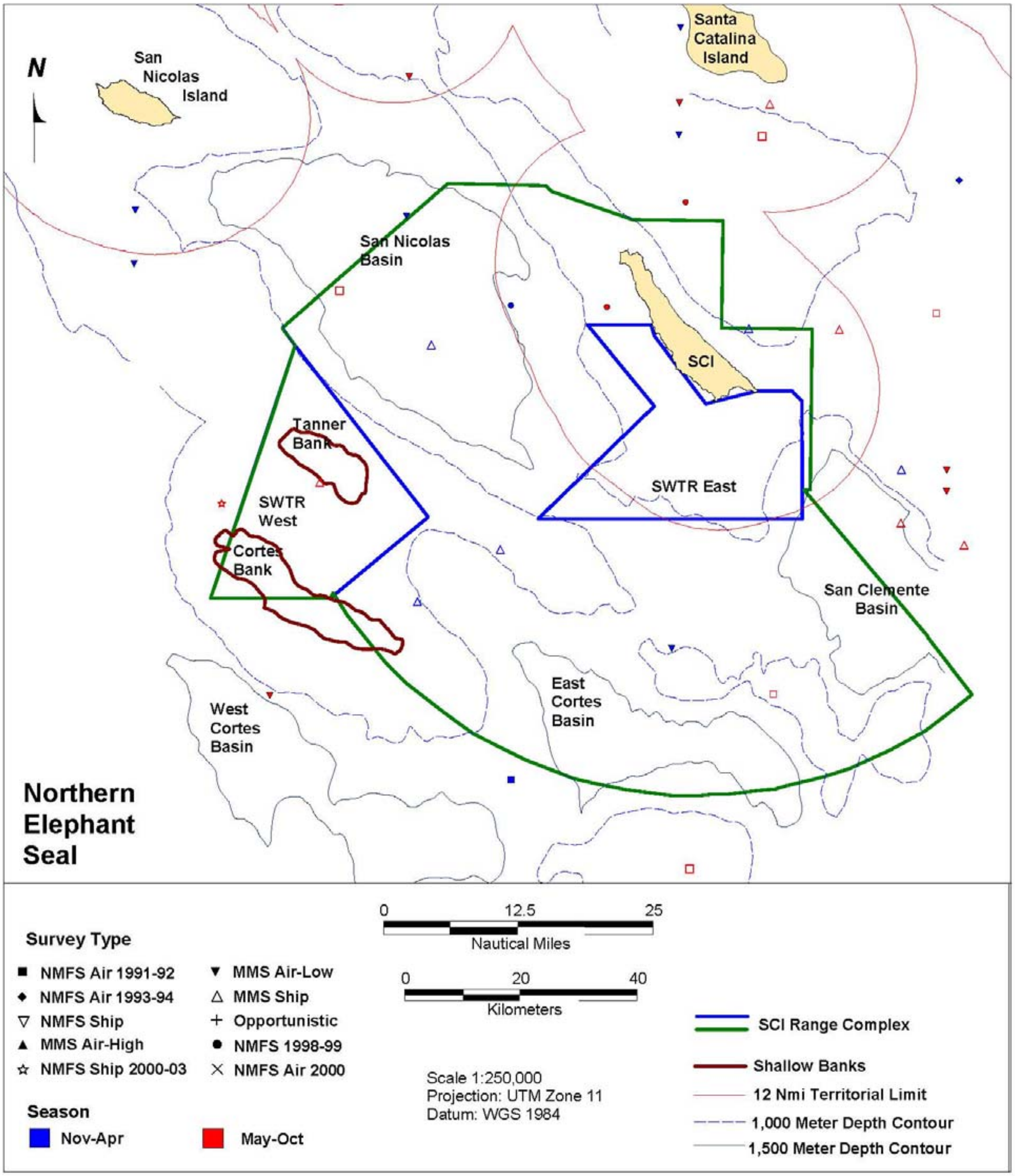
Small symbols are sightings of 1-10 individuals and large symbols are sightings of >10 individuals

Figure 2-16. Sightings Of Short-Finned Pilot Whales During Cold-Water And Warm-Water Seasons 1975–2003



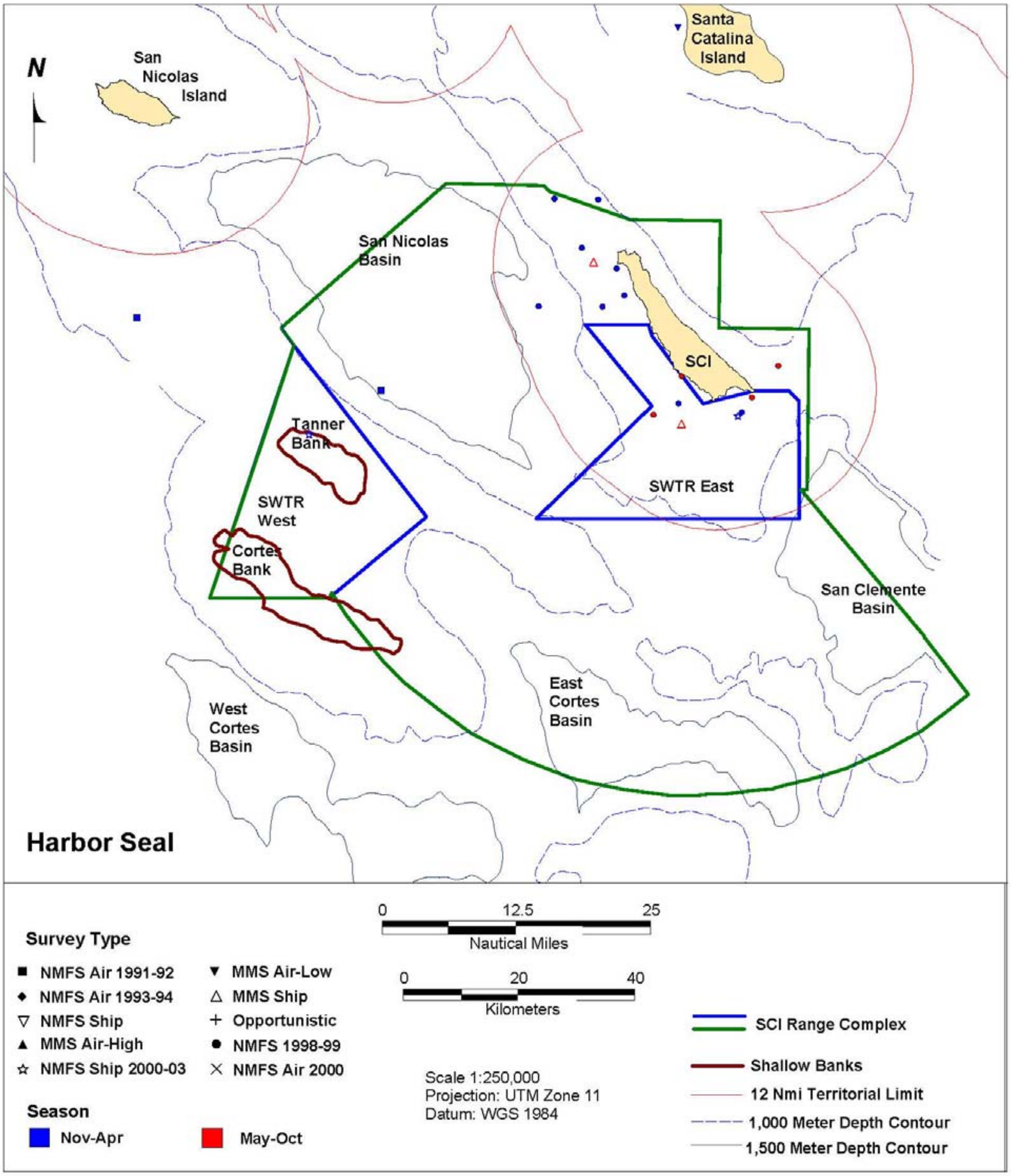
Small symbols are single sightings and large symbols are sightings of >2 individuals

Figure 2-17. Sightings Of California Sea Lions During The Cold-Water And Warm-Water Season 1975–2003



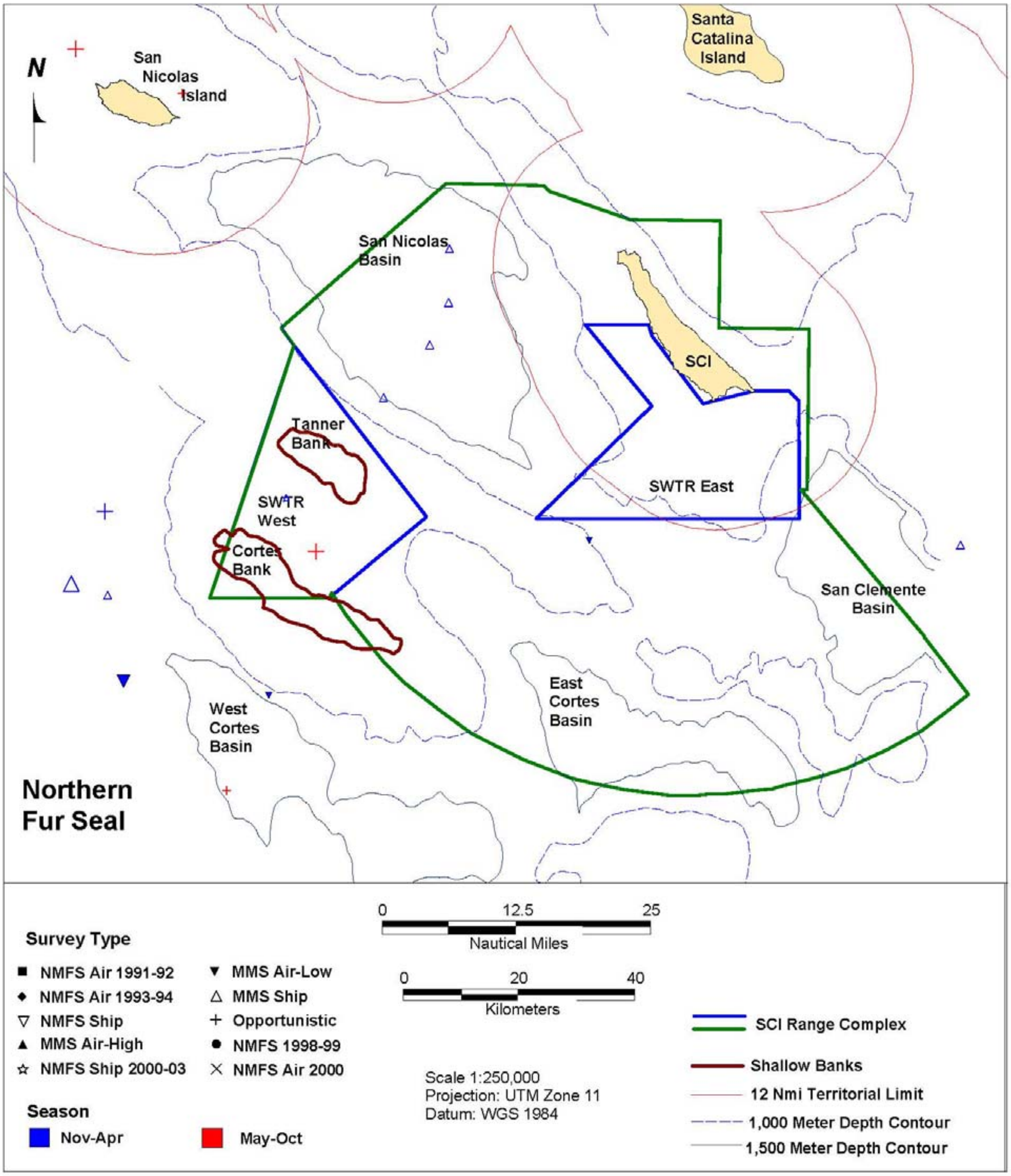
Small symbols are single sightings and large symbols are sightings of >2 individuals.

Figure 2-18. Sightings Of Northern Elephant Seals During Cold-Water And Warm-Water Seasons 1975–2003



Small symbols are single sightings and large symbols are sightings of >2 individuals.

Figure 2-19. Sightings Of Pacific Harbor Seals During Cold-Water And Warm-Water Seasons 1975–2003



Small symbols are single sightings and large symbols are sightings of >2 individuals

Figure 2-20. Sightings of Northern Fur Seals During Cold-Water And Warm-Water Seasons 1975–2003

2.3.1 Marine Mammal Abundance and Density Estimates for Southern California

Marine mammal species occurring off southern California include baleen whales (mysticetes), toothed whales (odontocetes), seals and sea lions (commonly referred to as pinnipeds), and sea otters. Baleen and toothed whales, collectively known as cetaceans, spend their entire lives in the water and spend most of the time (>90% for most species) entirely submerged below the surface. When at the surface, cetacean bodies are almost entirely below the water's surface, with only the blowhole exposed to allow breathing. This makes cetaceans difficult to locate visually and also exposes them to underwater noise, both natural and anthropogenic, essentially 100% of the time because their ears are nearly always below the water's surface. Seals and sea lions (pinnipeds) spend significant amounts of time out of the water during breeding, molting and hauling out periods. In the water, pinnipeds spend varying amounts of time underwater, as some species regularly undertake long, deep dives (e.g., elephant seals) and others are known to rest at the surface in large groups for long amounts of time (e.g., California sea lions). When not actively diving, pinnipeds at the surface often orient their bodies vertically in the water column and often hold their heads above the water surface. Consequently, pinnipeds may not be exposed to underwater sounds to the same extent as cetaceans. Sea otters generally do not spend significant amounts of time on land, but they also often hold their heads above the water's surface, reducing the amount of exposure to underwater noise.

For the purposes of this analysis, we have adopted a conservative approach to underwater noise and marine mammals:

Cetaceans – assume 100% of time is spent underwater and therefore exposed to noise

Pinnipeds – adjust densities to account for time periods spent at breeding areas, haulouts, etc.; but for those animals in the water, assume 100% of time is spent underwater and therefore exposed to noise

Sea otters – assume 100% of time is spent underwater and therefore exposed to underwater noise.

2.3.1.1 Density

The southern California region has been systematically surveyed for several years (1991-1993, 1996, 2001, 2005) by the National Marine Fisheries Service (NMFS), both via aircraft (e.g., Carretta and Forney, 1993) and vessel (e.g., Ferguson and Barlow, 2003; Barlow, 2003; Forney, 2007). Line-transect methods were used to analyze data collected from Southwest Fisheries Science Center (SWFSC) ship surveys in 1991, 1993, 1996, 2001, and 2005 off the U.S. west coast. A new multiple-covariate, line-transect approach (Marques and Buckland, 2003) was used to account for multiple factors that affect the distance at which cetaceans can be seen in different conditions. The most recent vessel survey was conducted in the US Exclusive Economic Zone (EEZ) and out to 300 nm offshore California, Oregon and Washington by NMFS in summer and fall 2005 (Forney, 2007). There has also been regional survey effort in the area, particularly around San Clemente Island and in extreme near shore areas (e.g., Carretta et al., 2000; Carretta, 2003). Consequently there are several density estimates available for most cetacean species in southern California. Compiled densities from vessel surveys conducted since 1986 have been analyzed by NMFS, and were provided as Government Furnished Information (GFI). Density calculation procedures and protocols used by NMFS for this analysis are described in Barlow (2007), Barlow and Forney (2007), and Forney (2007). These density compilations prorate densities of "unidentified" species groups (such as unidentified dolphins, small whales, rorquals, large whales, etc) with densities of identified species, so likely represent the most conservative densities at this time for the southern California region. Densities are presented for warm (May-

October) and cold water (November-April) seasons in water depths >1000 m north of 30°N. Gray whale densities were taken from Carretta et al. (2000), and are applicable for January-April only. Species with rare or extralimital occurrence off southern California are included in the species summaries; however, there are no densities available and they are not included in Table 2-1. The geographic distributions of cetacean species for which densities are available in this area overlap completely with all eight sonar areas (shown in Figure 2-21), so further refinement of densities to sonar areas was not necessary. Area 8, includes all areas outside the previous seven areas that are within the quasi-rectangular region bounded in latitude by 29° N and 34° N, and in longitude by 120° 30' W and 116° 30' W but is not shown on Figure 2-21.

Pinniped at-sea density is not often available because pinniped abundance is obtained via shore counts of animals at known rookeries and haulouts. Therefore, densities of pinnipeds were derived quite differently from those of cetaceans. Several parameters were identified from the literature, including area of stock occurrence, number of animals (which may vary seasonally) and season, and those parameters were then used to calculate density. Once density per "pinniped season" was determined, those values were prorated to fit the warm water (May-October) and cold water (November-April) seasons. Pinniped geographic distributions do not overlap all sonar areas, so density was further refined as the percentage of each sonar area actually overlapped by the species distribution. Determining density in this manner is risky as the parameters used usually contain error (e.g., geographic range is not exactly known and needs to be estimated, abundance estimates usually have large variances) and, as is true of all density estimates, it assumes that animals are always distributed evenly within an area which is likely never true. However, this remains one of the few means available to determine at-sea density for pinnipeds.

Sea otters occur along the central California coast and there is an experimental population of relocated otters at San Nicolas Island.

2.3.1.2 Depth Distribution

There are limited depth distribution data for most marine mammals. This is especially true for cetaceans, as they must be tagged at-sea and by using a tag that either must be implanted in the skin/blubber in some manner or adhere to the skin. There is slightly more data for some pinnipeds, as they can be tagged while on shore during breeding or molting seasons and the tags can be glued to the pelage rather than implanted. There are a few different methodologies/techniques that can be used to determine depth distribution percentages, but by far the most widely used technique currently is the time-depth recorder. These instruments are attached to the animal for a fairly short period of time (several hours to a few days) via a suction cup or glue, and then retrieved immediately after detachment or when the animal returns to the beach. Depth information can also be collected via satellite tags, sonic tags, digital tags, and, for sperm whales, via acoustic tracking of sounds produced by the animal itself.

There are somewhat suitable depth distribution data for a few marine mammal species. Sample sizes are usually extremely small, nearly always fewer than 10 animals total and often only one or two animals. Depth distribution information often must be interpreted from other dive and/or preferred prey characteristics. Depth distributions for species for which no data are available are extrapolated from similar species.

2.3.1.3 Density And Depth Distribution Combined

Density is nearly always reported for an area, e.g., animals/km^2. Analyses of survey results using Distance Sampling techniques include correction factors for animals at the surface but not seen as well as animals below the surface and not seen. Therefore, although the area (e.g., km^2) appears to represent only the surface of the water (two-dimensional), density actually implicitly includes animals anywhere within the water column under that surface area. Density assumes that animals are uniformly distributed within the prescribed area, even though this is likely rarely true. Marine mammals are usually clumped in areas of greater importance, for example, areas of high productivity, lower predation, safe calving, etc. Density can occasionally be calculated for smaller areas that are used regularly by marine mammals, but more often than not there are insufficient data to calculate density for small areas. Therefore, assuming an even distribution within the prescribed area remains the norm.

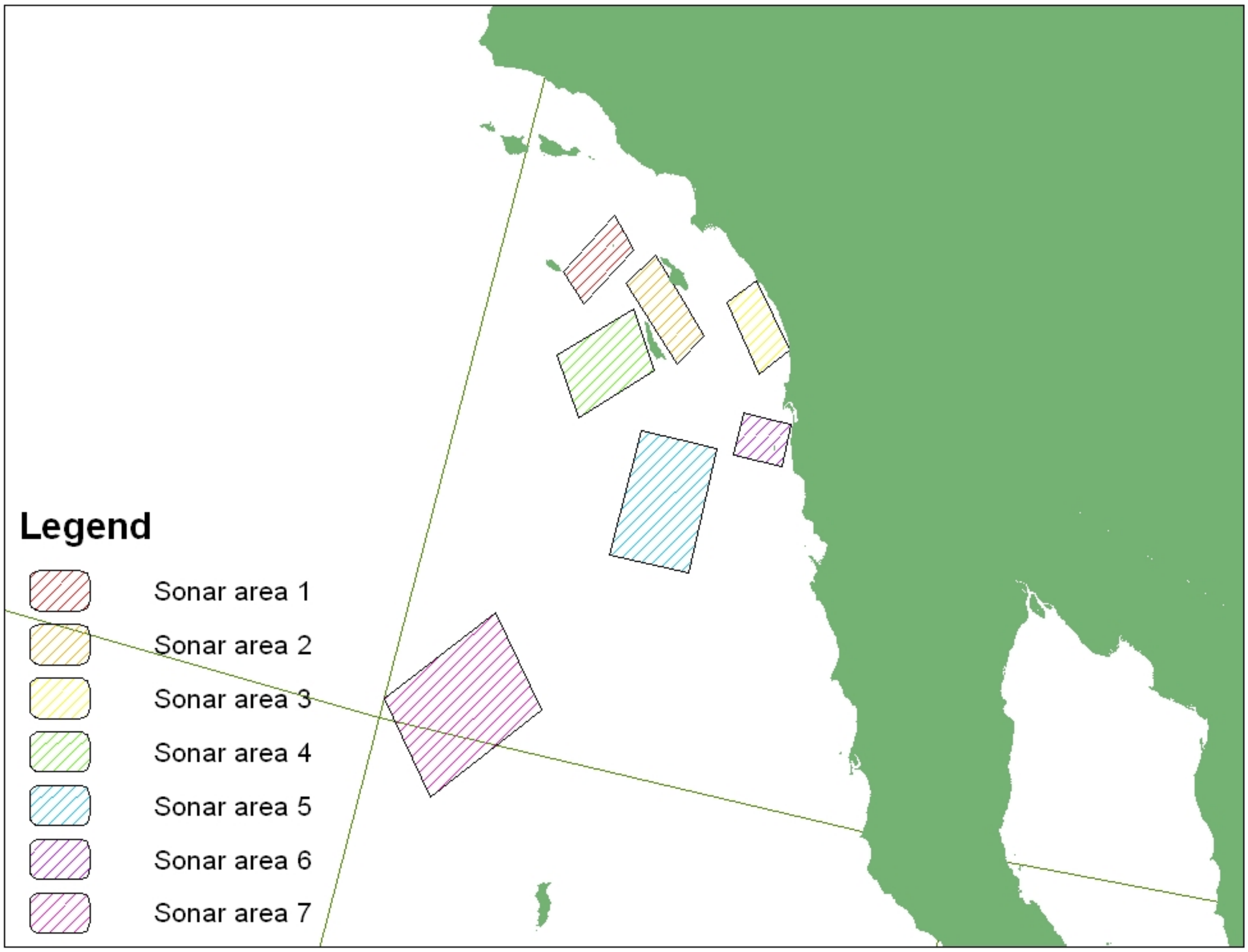


Figure 2-21. Sonar Modeling Areas

Assuming that marine mammals are distributed evenly within the water column is not accurate. The ever-expanding database of marine mammal behavioral and physiological parameters obtained through tagging and other technologies has demonstrated that marine mammals use the water column in various ways, with some species capable of regular deep dives (<800 m) and others regularly diving to <200 m, regardless of the bottom depth. Assuming that all species are evenly distributed from surface to bottom is almost never appropriate and can present a distorted view of marine mammal distribution in any region.

By combining marine mammal density with depth distribution information, a more accurate three-dimensional density estimate is possible. These 3-D estimates allow more accurate modeling of potential marine mammal exposures from specific noise sources. The Marine Resource Assessment (MRA) for the Southern California Operating Area lists 45 marine mammals in the "vicinity" of the Range Complex (Department of the Navy 2005). However, several of the species listed in the MRA are rare or extralimital in southern California waters and do not regularly occur. Only species with regular occurrence and for which density is available are included in Table 2-3.

Table 2-3. Summary of marine mammal densities used for exposure modeling.

Species Name	Warm Season density/km^2	Cold Season density/km^2	Source	Notes
ESA Species				
Blue whale	0.0041222	0.0041222	Barlow (2007)	
Fin whale	0.0024267	0.0008008	Barlow (2007)	
Humpback whale	0.0001613	0.0000984	Barlow (2007)	
Sei whale	0.0000081	0.000005	Barlow (2007)	
Sperm whale	0.0014313	0.0008731	Barlow (2007)	
Guadalupe fur seal	0.007	0.007	Gallo-Reynoso (1994)	Applicable to 100% of the seven sonar areas; unknown % in area 8
California sea otter	0.3	0.3	US Fish and Wildlife Service (2003)	Applicable to 0.06% of sonar area 1 and 0% of areas 2,3,4,5,6,7; unknown % of area 8
MYSTICETES				
Bryde's whale	0.0000081	0.0000081	Barlow (2007)	
Gray whale	0	0.051	Carretta et al. (2000)	Applies to Jan-Apr only
Minke whale	0.0010313	0.0010313	Barlow (2007)	
ODONTOCETES				
Baird's beaked whale	0.0001434	0.0001434	Barlow (2007)	
Bottlenose dolphin	0.0123205	0.0184808	Barlow (2007)	
Cuvier's beaked whale	0.0036883	0.0036883	Barlow (2007)	
Dall's porpoise	0.0016877	0.0081008	Barlow (2007)	
Killer whale	0.0000812	0.0000812	Barlow (2007)	
Long-beaked common dolphin	0.0965747	0.0366984	Barlow (2007)	
Mesoplodonts	0.0011125	0.0011125	Barlow (2007)	
Northern right whale dolphin	0.0056284	0.0270163	Barlow (2007)	
Pacific white-sided dolphin	0.0160748	0.0160748	Barlow (2007)	
Pygmy sperm whale	0.0013785	0.0013785	Barlow (2007)	
Short-finned pilot whale	0.0003315	0.0003315	Barlow (2007)	
Risso's dolphin	0.0180045	0.0540134	Barlow (2007)	
Short-beaked common dolphin	0.8299606	0.315385	Barlow (2007)	
Striped dolphin	0.0175442	0.0107019	Barlow (2007)	
Ziphiid whales	0.0008214	0.0008214	Barlow (2007)	
PINNIPEDS				
Northern elephant seal	0.042	0.025	Caretta et al. (2007); Lowry (2002)	Applicable to 100% of sonar areas 1 and 2, 94% of area 3, 18% of area 4 and 0% of areas 5,6,7; unknown % in area 8
Harbor seal	0.19	0.19	Lowry et al. (2005)	Applicable to 4% of sonar area 1, 20% of area 2, 5% of area 4, and 0% of areas 3,5,6,7; unknown % in area 8
California sea lion	0.605	0.87	Lowry and Maravilla-Chavez (2005)	Applicable to 100% of sonar areas 1,2,3 and 6; 49% of area 4, 62% of area 5 and 0% of area 7; unknown % in area 8
Northern fur seal	0.027	0.027	National Marine Fisheries Service (2006); Carretta et al. (2007)	applicable to 0% of the seven OPAREA sonar areas; unknown % in area 8

Lowry 2002, Lowry et al. (2005), Barlow (2007), and Carretta et al. (2007) are government furnished information from NMFS reports or technical memorandum. Warm season = May – September Cold season = November - April

2.4 CETACEAN STRANDINGS AND THREATS

Strandings can be a single animal or several to hundreds. An event where animals are found out of their normal habitat is considered a stranding even though animals do not necessarily end up beaching (such as the July 2004 Hanalei Mass Stranding Event; Southall et al. 2006). Several hypotheses have been given for the mass strandings which include the impact of shallow beach slopes on odontocete sonar, disease or parasites, geomagnetic anomalies that affect navigation, following a food source in close to shore, avoiding predators, social interactions that cause other cetaceans to come to the aid of stranded animals, and human actions. Generally, inshore species do not strand in large numbers but generally just as a single animal. This may be due to their familiarity with the coastal area whereas pelagic species that are unfamiliar with obstructions or sea bottom tend to strand more often in larger numbers (Woodings 1995). The Navy has studied several stranding events in detail that may have occurred in association with Navy sonar activities. To better understand the causal factors in stranding events that may be associated with Navy sonar activities, the main factors, including bathymetry (i.e. steep drop offs), narrow channels (less than 35 nm), environmental conditions (e.g. surface ducting), and multiple sonar ships (see Section on Stranding Events Associated with Navy Sonar) were compared between the different stranding events.

2.4.1 What is a Stranded Marine Mammal?

When a live or dead marine mammal swims or floats onto shore and becomes "beached" or incapable of returning to sea, the event is termed a "stranding" (Geraci et al., 1999; Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NMFS, 2007). The legal definition for a stranding within the U.S. is that "a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance." (16 United States Code [U.S.C.] 1421h).

The majority of animals that strand are dead or moribund (NMFS, 2007). For animals that strand alive, human intervention through medical aid and/or guidance seaward may be required for the animal to return to the sea. If unable to return to sea, rehabilitation at an appropriate facility may be determined as the best opportunity for animal survival. An event where animals are found out of their normal habitat is may be considered a stranding depending on circumstances even though animals do not necessarily end up beaching (Southhall, 2006).

Three general categories can be used to describe strandings: single, mass, and unusual mortality events. The most frequent type of stranding is a single stranding, which involves only one animal (or a mother/calf pair) (NMFS, 2007).

Mass stranding involves two or more marine mammals of the same species other than a mother/calf pair (Wilkinson, 1991), and may span one or more days and range over several miles (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; Walsh et al., 2001; Freitas, 2004). In North America, only a few species typically strand in large groups of 15 or more and include sperm whales, pilot whales, false killer whales, Atlantic white-sided dolphins, white-beaked dolphins, and rough-toothed dolphins (Odell 1987, Walsh et al. 2001). Some species, such as pilot whales, false-killer whales, and melon-headed whales occasionally strand in groups of 50 to 150 or more (Geraci et al. 1999). All of these normally pelagic off-shore species are highly sociable and usually infrequently encountered in coastal waters. Species that commonly strand in smaller numbers include pygmy killer whales, common dolphins, bottlenose dolphins, Pacific white-sided dolphin Frasier's dolphins, gray whale and humpback whale (West Coast only), harbor porpoise, Cuvier's beaked whales, California sea lions, and harbor seals (Mazzuca et al. 1999, Norman et al. 2004, Geraci and Lounsbury 2005).

Unusual mortality events (UMEs) can be a series of single strandings or mass strandings, or unexpected mortalities (i.e., die-offs) that occur under unusual circumstances (Dierauf and Gulland, 2001; Harwood, 2002; Gulland, 2006; NMFS, 2007). These events may be interrelated: for instance, at-sea die-offs lead to increased stranding frequency over a short period of time, generally within one to two months. As published by the NMFS, revised criteria for defining a UME include include (71 FR 75234, 2006):

(1) A marked increase in the magnitude or a marked change in the nature of morbidity, mortality, or strandings when compared with prior records.

(2) A temporal change in morbidity, mortality, or strandings is occurring.

(3) A spatial change in morbidity, mortality, or strandings is occurring.

(4) The species, age, or sex composition of the affected animals is different than that of animals that are normally affected.

(5) Affected animals exhibit similar or unusual pathologic findings, behavior patterns, clinical signs, or general physical condition (e.g., blubber thickness).

(6) Potentially significant morbidity, mortality, or stranding is observed in species, stocks or populations that are particularly vulnerable (e.g., listed as depleted, threatened or endangered or declining). For example, stranding of three or four right whales may be cause for great concern whereas stranding of a similar number of fin whales may not.

(7) Morbidity is observed concurrent with or as part of an unexplained continual decline of a marine mammal population, stock, or species.

UMEs are usually unexpected, infrequent, and may involve a significant number of marine mammal mortalities. As discussed below, unusual environmental conditions are probably responsible for most UMEs and marine mammal die-offs (Vidal and Gallo-Reynoso, 1996; Geraci et al., 1999; Walsh et al., 2001; Gulland and Hall, 2005).

United States Stranding Response Organization

Stranding events provide scientists and resource managers information not available from limited at-sea surveys, and may be the only way to learn key biological information about certain species such as distribution, seasonal occurrence, and health (Rankin, 1953; Moore et al., 2004; Geraci and Lounsbury, 2005). Necropsies are useful in attempting to determine a reason for the stranding, and are performed on stranded animals when the situation and resources allow.

In 1992, Congress amended the MMPA to establish the Marine Mammal Health and Stranding Response Program (MMHSRP) under authority of the NMFS. The MMHSRP was created out of concern started in the 1980s for marine mammal mortalities, to formalize the response process, and to focus efforts being initiated by numerous local stranding organizations and as a result of public concern.

Major elements of the MMHSRP include (NMFS, 2007):

• National Marine Mammal Stranding Network

• Marine Mammal UME Program

• National Marine Mammal Tissue Bank (NMMTB) and Quality Assurance Program

• Marine Mammal Health Biomonitoring, Research, and Development

• Marine Mammal Disentanglement Network

• John H. Prescott Marine Mammal Rescue Assistance Grant Program (a.k.a. the Prescott Grant Program)

• Information Management and Dissemination.

The United States has a well-organized network in coastal states to respond to marine mammal strandings. Overseen by the NMFS, the National Marine Mammal Stranding Network is comprised of smaller organizations manned by professionals and volunteers from nonprofit organizations, aquaria, universities, and state and local governments trained in stranding response animal health, and diseased investigation. Currently, 141 organizations are authorized by NMFS to respond to marine mammal strandings (National Marine Fisheries Service, 2007o). Through a National Coordinator and six regional coordinators, NMFS authorizes and oversees stranding response activities and provides specialized training for the network.

NMFS Regions and Associated States and Territories

NMFS Northeast Region- ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, VA

NMFS Southeast Region- NC, SC, GA, FL, AL, MS, LA, TX, PR, VI

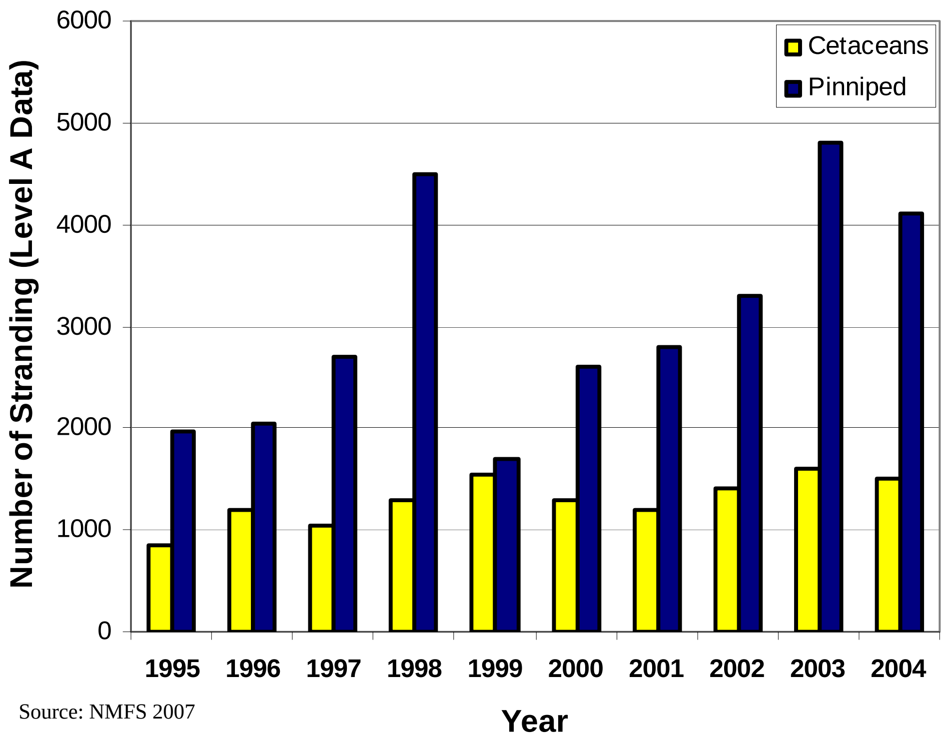
NMFS Southwest Region- CA

NMFS Northwest Region- OR, WA

NMFS Alaska Region- AK

NMFS Pacific Islands Region- HI, Guam, American Samoa, Commonwealth of the Northern Mariana Islands (CNMI)

Stranding reporting and response efforts over time have been inconsistent, although effort and data quality within the U.S. have been improving within the last 20 years (NMFS, 2007). Given the historical inconsistency in response and reporting, however, interpretation of long-term trends in marine mammal stranding is difficult (NMFS, 2007). During the past decade (1995 – 2004), approximately 40,000 stranded marine mammals (about 12,400 are cetaceans) have been reported by the regional stranding networks, averaging 3,600 strandings reported per year (NMFS, 2007). The highest number of strandings were reported between the years 1998 and 2003 (NMFS, 2007). Detailed regional stranding information including most commonly stranded species can be found in Zimmerman (1991), Geraci and Lounsbury (2005), and NMFS (2007).



Source: NMFS 2007

Figure 2-22. United States Annual Cetacean And Pinniped Stranding From 1995-2004.

Table 2-4. Cetacean And Pinniped Stranding Count By NMFS Region 2001-2004.

NMFS Region	# of Cetaceans	# of Pinnipeds
Northeast	1,620	4,050
Southeast	2,830	45
Southwest	12,900	45
Northwest	188	1,430
Alaska	269	348
Pacific Islands	59	10
Four Year Total	17,866	5,928

2.4.1.1 Unusual Mortality Events (UMEs)

Table 2-5 contains a list of documented UMEs within the U.S.

Table 2-5. Documented UMEs within the United States.

Year	Composition	Determination
1993	Harbor seals, Steller sea lions, and California sea lions on the central Washington coast	Human Interaction
1993/1994	Bottlenose dolphins in the Gulf of Mexico	Morbillivirus
1994	Common dolphins in California	Cause not determined
1996	Right whales off Florida/Georgia coast	Evidence of human interactions
1996	Manatees on the west coast of Florida	Brevetoxin
1996	Bottlenose dolphins in Mississippi	Cause not determined
1997	Harbor seals in California	Unknown infectious respiratory disease
1997	Pinnipeds on the Pacific coast	El Niño
1998	California sea lions in central California	Harmful algal bloom; Domoic acid
1999	Harbor porpoises on the East Coast	Determined not to meet criteria for UME because of multiplicity of causes
1999/2000	Bottlenose dolphins in the Panhandle of Florida	Harmful algal bloom is suspected; still under investigation
1999/2000	Gray whales from Alaska to Mexico	Still under investigation
2004	Bottlenose dolphins along the Florida Panhandle	Uncertain, red tide is suspected
2005	Bottlenose dolphins, manatees, sea turtles, and seabirds in west central Florida	Unknown

Source: NMFS 2007c

2.4.2 Threats to Marine Mammals and Potential Causes for Stranding

Reports of marine mammal strandings can be traced back to ancient Greece (Walsh et al., 2001). Like any wildlife population, there are normal background mortality rates that influence marine mammal population dynamics, including starvation, predation, aging, reproductive success, and disease (Geraci et al. 1999; Carretta et al. 2007). Strandings in and of themselves may be reflective of this natural cycle or, more recently, may be the result of anthropogenic sources (i.e., human impacts). Current science suggests that multiple factors, both natural and man-made, may be acting alone or in combination to cause a marine mammal to strand (Geraci et al., 1999; Culik, 2002; Perrin and Geraci, 2002; Hoelzel, 2003; Geraci and Lounsbury, 2005; NRC, 2006). While post-stranding data collection and necropsies of dead animals are attempted in an effort to find a possible cause for the stranding, it is often difficult to pinpoint exactly one factor that can be blamed for any given stranding. An animal suffering from one ailment becomes susceptible to various other influences because of its weakened condition, making it difficult to determine a primary cause. In many stranding cases, scientists never learn the exact reason for the stranding.

Specific potential stranding causes can include both natural and human influenced (anthropogenic) causes listed below and described in the following sections:

Natural Stranding Causes

- Disease
- Natural toxins
- Weather and climatic influences
- Navigation errors
- Social cohesion
- Predation

Human Influenced (Anthropogenic) Stranding Causes

- Fisheries interaction
- Vessel strike
- Pollution and ingestion
- Noise

2.4.2.1 Natural Stranding Causes

Significant natural causes of mortality, die-offs, and stranding discussed below include disease and parasitism; marine neurotoxins from algae; navigation errors that lead to inadvertent stranding; and climatic influences that impact the distribution and abundance of potential food resources (i.e., starvation). Other natural mortality not discussed in detail includes predation by other species such as sharks (Cockcroft et al., 1989; Heithaus, 2001), killer whales (Constantine et al. 1998; Guinet et al. 2000; Pitman et al. 2001), and some species of pinniped (Hiruki et al. 1999; Robinson et al. 1999).

Disease

Like other mammals, marine mammals frequently suffer from a variety of diseases of viral, bacterial, parasitic, and fungal origin (Visser et al. 1991; Dunn et al. 2001; Harwood 2002). Gulland and Hall (2005) provide a more detailed summary of individual and population effects of marine mammal diseases.

Microparasites such as bacteria, viruses, and other microorganisms are commonly found in marine mammal habitats and usually pose little threat to a healthy animal (Geraci et al. 1999). For example, long-finned pilot whales that inhabit the waters off of the northeastern coast of the U.S. are carriers of the morbillivirus, yet have grown resistant to its usually lethal effects (Geraci et al. 1999). Since the 1980s, however, virus infections have been strongly associated with marine mammal die-offs (Domingo et al., 1992; Geraci and Lounsbury, 2005). Morbillivirus is the most significant marine mammal virus and suppresses a host’s immune system, increasing risk of secondary infection (Harwood 2002). A bottlenose dolphin UME in 1993 and 1994 was caused by infectious disease. Die-offs ranged from northwestern Florida to Texas, with an increased number of deaths as it spread (NMFS 2007c). A 2004 UME in Florida was also associated with dolphin morbillivirus (NMFS 2004). Influenza A was responsible for the first reported mass mortality in the U.S., occurring along the coast of New England in 1979-1980 (Geraci et al. 1999; Harwood 2002). Canine distemper virus (a type of morbillivirus) has been responsible for large scale pinniped mortalities and die-offs (Grachev et al. 1989; Kennedy et al., 2000; Gulland and Hall, 2005), while a bacteria, *Leptospira pomona*, is responsible for periodic die-offs in California sea lions about every four years (Gulland et al. 1996; Gulland and Hall 2005). It is difficult to determine whether microparasites commonly act as a primary pathogen, or whether they show up as a secondary infection in an already weakened animal (Geraci et al. 1999). Most marine mammal die-offs from infectious disease in the last 25 years, however, have had viruses associated with them (Simmonds and Mayer 1997; Geraci et al. 1999; Harwood 2002).

Macroparasites are usually large parasitic organisms and include lungworms, trematodes (parasitic flatworms), and protozoans (Geraci and St.Aubin 1987; Geraci et al. 1999). Marine mammals can carry many different types, and have shown a robust tolerance for sizeable infestation unless compromised by illness, injury, or starvation (Morimitsu et al. 1987; Dailey et al. 1991; Geraci et al., 1999). Nasitrema, a usually benign trematode found in the head sinuses of cetaceans (Geraci et al. 1999), can cause brain damage if it migrates (Ridgway and Dailey 1972). As a result, this worm is one of the few directly linked to stranding in the cetaceans (Dailey and Walker 1978; Geraci et al. 1999).

Non-infectious disease, such as congenital bone pathology of the vertebral column (osteomyelitis, spondylosis deformans, and ankylosing spondylitis [AS]), has been described in several species of cetacean (Paterson 1984; Alexander et al. 1989; Kompanje 1995; Sweeny et al. 2005). In humans, bone pathology such as AS, can impair mobility and increase vulnerability to further spinal trauma (Resnick and Niwayama 2002). Bone pathology has been found in cases of single strandings (Paterson 1984; Kompanje 1995), and also in cetaceans prone to mass stranding (Sweeny et al. 2005), possibly acting as a contributing or causal influence in both types of events.

Naturally Occurring Marine Neurotoxins

Some single cell marine algae common in coastal waters, such as dinoflagellates and diatoms, produce toxic compounds that can accumulate (termed bioaccumulation) in the flesh and organs of fish and invertebrates (Geraci et al. 1999; Harwood 2002). Marine mammals become exposed to these compounds when they eat prey contaminated by these naturally produced toxins although expsosure can also occur through inhalation and skin contact (Van Dolah 2005). Figure 2 shows U.S. animal mortalities from 1997-2006 resulting from toxins produced during harmful algal blooms.

In the Gulf of Mexico and mid- to southern Atlantic states, “red tides,” a form of harmful algal bloom, are created by a dinoflagellate (*Karenia brevis*). *K. brevis* is found throughout the Gulf of Mexico and sometimes along the Atlantic coast (Van Dolah 2005; NMFS 2007). It produces a neurotoxin known as brevetoxin. Brevetoxin has been associated with several marine mammal UMEs within this area (Geraci 1989; Van Dolah et al. 2003; NMFS 2004; Flewelling et al. 2005; Van Dolah 2005; NMFS 2007). On the U.S. west coast and in the northeast Atlantic, several species of diatoms produce a toxin called domoic acid which has also been linked to marine mammal strandings (Geraci et al. 1999; Van Dolah et al. 2003; Greig et al. 2005; Van Dolah 2005; Brodie et al. 2006; NMFS 2007; Bargu et al. 2008; Goldstein et al. 2008). Other algal toxins associated with marine mammal strandings include saxitoxins and ciguatoxins and are summarized by Van Dolah (2005).

Figure 2-23. Animal Mortalities From Harmful Algal Blooms Within The U.S. From 1997-2006.

Source: Woods Hole Oceanographic Institute (WHO) http://www.whoi.edu/redtide/HABdistribution/HABmap.html

Weather events and climate influences

Severe storms, hurricanes, typhoons, and prolonged temperature extremes may lead to localized marine mammal strandings (Geraci et al., 1999; Walsh et al. 2001). Hurricanes may have been responsible for mass strandings of pygmy killer whales in the British Virgin Islands and Gervais' beaked whales in North Carolina (Mignucci-Giannoni et al. 2000; Norman and Mead 2001). Storms in 1982-1983 along the California coast led to deaths of 2,000 northern elephant seal pups (Le Boeuf and Reiter 1991). Ice movement along southern Newfoundland has forced groups of blue whales and white-beaked dolphins ashore (Sergeant 1982). Seasonal oceanographic conditions in terms of weather, frontal systems, and local currents may also play a role in stranding (Walker et al. 2005).

The effect of large scale climatic changes to the world's oceans and how these changes impact marine mammals and influence strandings is difficult to quantify given the broad spatial and temporal scales involved, and the cryptic movement patterns of marine mammals (Moore 2005; Learmonth et al. 2006). The most immediate, although indirect, effect is decreased prey availability during unusual conditions. This, in turn, results in increased search effort required by marine mammals (Crocker et al. 2006), potential starvation if not successful, and corresponding stranding due directly to starvation or succumbing to disease or predation while in a more weakened, stressed state (Selzer and Payne 1988; Geraci et al. 1999; Moore 2005; Learmonth et al. 2006; Weise et al. 2006).

Two recent papers examined potential influences of climate fluctuation on stranding events in southern Australia, including Tasmania, an area with a history of more than 20 mass stranding since the 1920s (Evans et al. 2005; Bradshaw et al. 2006). These authors note that patterns in animal migration, survival, fecundity, population size, and strandings will revolve around the availability and distribution of food resources. In southern Australia, movement of nutrient-rich waters pushed closer to shore by periodic meridinal winds (occurring about every 12 – 14 years) may be responsible for bringing marine mammals closer to land, thus increasing the probability of stranding (Bradshaw et al. 2006). The papers conclude, however, that while an overarching model can be helpful for providing insight into the prediction of strandings, the particular reasons for each one are likely to be quite varied.

Navigation Error

*Geomagnetism***-** It has been hypothesized that, like some land animals, marine mammals may be able to orient to the Earth's magnetic field as a navigational cue, and that areas of local magnetic anomalies may influence strandings (Bauer et al. 1985; Klinowska 1985; Kirschvink et al. 1986; Klinowska, 1986; Walker et al. 1992; Wartzok and Ketten 1999). In a plot of live stranding positions in Great Britain with magnetic field maps, Klinowska (1985; 1986) observed an association between live stranding positions and magnetic field levels. In all cases, live strandings occurred at locations where magnetic minima, or lows in the magnetic fields, intersect the coastline. Kirschvink et al. (1986) plotted stranding locations on a map of magnetic data for the east coast of the U.S., and were able to develop associations between stranding sites and locations where magnetic minima intersected the coast. The authors concluded that there were highly significant tendencies for cetaceans to beach themselves near these magnetic minima and coastal intersections. The results supported the hypothesis that cetaceans may have a magnetic sensory system similar to other migratory animals, and that marine magnetic topography and patterns may influence long-distance movements (Kirschvink et al. 1986). Walker et al. (1992) examined fin whale swim patterns off the northeastern U.S. continental shelf, and reported that migrating animals aligned with lows in the geometric gradient or intensity. While a similar pattern between magnetic features and marine mammal strandings at New Zealand stranding sites was not seen (Brabyn and Frew, 1994), mass strandings in Hawaii typically were found to occur within a narrow range of magnetic anomalies (Mazzuca et al. 1999).

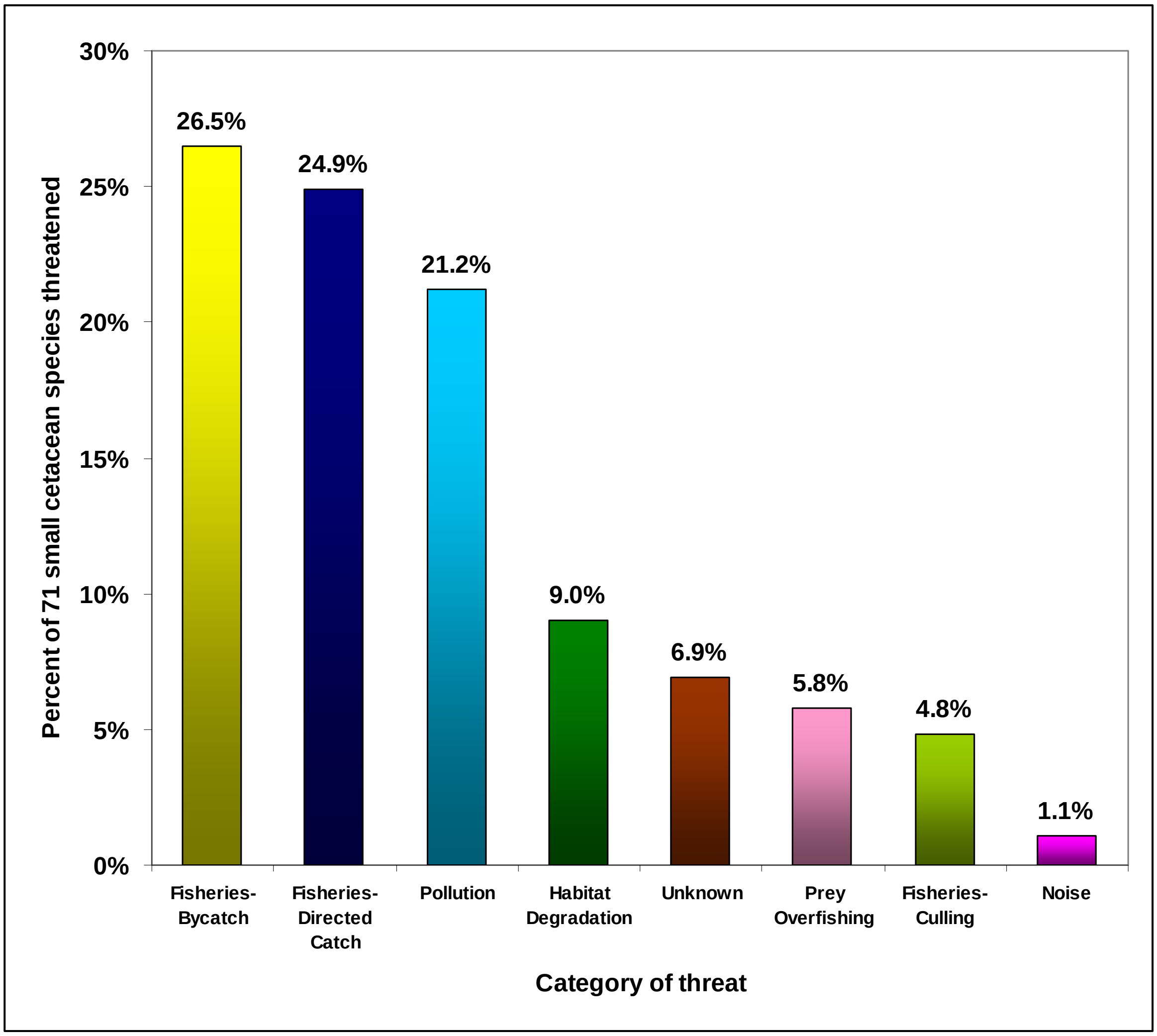
*Echolocation Disruption in Shallow Water***-** Some researchers believe stranding may result from reductions in the effectiveness of echolocation within shallow water, especially with the pelagic species of odontocetes who may be less familiar with coastline (Dudok van Heel 1966; Chambers and James 2005). For an odontocete, echoes from echolocation signals contain important information on the location and identity of underwater objects and the shoreline. The authors postulate that the gradual slope of a beach may present difficulties to the navigational systems of some cetaceans, since it is common for live strandings to occur along beaches with shallow, sandy gradients (Brabyn and McLean 1992; Mazzuca et al. 1999; Maldini et al. 2005; Walker et al. 2005). A contributing factor to echolocation interference in turbulent, shallow water is the presence of microbubbles from the interaction of wind, breaking waves, and currents. Additionally, ocean water near the shoreline can have an increased turbidity (e.g., floating sand or silt, particulate plant matter, etc.) due to the run-off of fresh water into the ocean, either from rainfall or from freshwater outflows (e.g., rivers and creeks). Collectively, these factors can reduce and scatter the sound energy within echolocation signals and reduce the perceptibility of returning echoes of interest.

Social cohesion

Many pelagic species such as sperm whale, pilot whales, melon-head whales, and false killer whales, and some dolphins occur in large groups with strong social bonds between individuals. When one or more animals strand due to any number of causative events, then the entire pod may follow suit out of social cohesion (Geraci et al. 1999; Conner 2000; Perrin and Geraci 2002; NMFS 2007).

2.4.2.2 Anthropogenic Stranding Causes and Potential Risks

With the exception of historic whaling in the 19th and early part of the 20th century, over the past few decades there has been an increase in marine mammal mortalities associated with a variety of human activities (Geraci et al. 1999; NMFS 2007). These include fisheries interactions (bycatch and directed catch), pollution (marine debris, toxic compounds), habitat modification (degradation, prey reduction), direct trauma (vessel strikes, gunshots), and noise. Figure 2-24- shows potential worldwide risk to small toothed cetaceans by source.



(Source: Culik 2002)

Figure 2-24. Human Threats to World Wide Small Cetacean Populations

Fisheries Interaction: By-Catch, Directed Catch, and Entanglement

The incidental catch of marine mammals in commercial fisheries is a significant threat to the survival and recovery of many populations of marine mammals (Geraci et al.,1999; Baird 2002; Culik 2002; Carretta et al. 2004; Geraci and Lounsbury 2005; NMFS 2007). Interactions with fisheries and entanglement in discarded or lost gear continue to be a major factor in marine mammal deaths worldwide (Geraci et al. 1999; Nieri et al. 1999; Geraci and Lounsbury 2005; Read et al. 2006; Zeeber et al. 2006). For instance, baleen whales and pinnipeds have been found entangled in nets, ropes, monofilament line, and other fishing gear that has been discarded out at sea (Geraci et al. 1999; Campagna et al. 2007).

Bycatch- Bycatch is the catching of non-target species within a given fishing operation and can include non-commercially used invertebrates, fish, sea turtles, birds, and marine mammals (NRC 2006). Read et al. (2006) attempted to estimate the magnitude of marine mammal bycatch in U.S. and global fisheries. Data on marine mammal bycatch within the United States was obtained from fisheries observer programs, reports of entangled stranded animals, and fishery logbooks, and was then extrapolated to estimate global bycatch by using the ratio of U.S. fishing vessels to the total number of vessels within the world's fleet (Read et al. 2006). Within U.S. fisheries, between 1990 and 1999 the mean annual bycatch of marine mammals was 6,215 animals, with a standard error of +/- 448 (Read et al. 2006). Eight-four percent of cetacean bycatch occurred in gill-net fisheries, with dolphins and porpoises constituting most of the cetacean bycatch (Read et al. 2006). Over the decade there was a 40 percent decline in marine mammal bycatch, which was significantly lower from 1995-1999 than it was from 1990-1994 (Read et al. 2006). Read et al. (2006) suggests that this is primarily due to effective conservation measures that were implemented during this time period.

Read et al. (2006) then extrapolated this data for the same time period and calculated an annual estimate of 653,365 of marine mammals globally, with most of the world's bycatch occurring in gill-net fisheries. With global marine mammal bycatch likely to be in the hundreds of thousands every year, bycatch in fisheries will be the single greatest threat to many marine mammal populations around the world (Read et al. 2006).

Entanglement- Entanglement in active fishing gear is a major cause of death or severe injury among the endangered whales in the action area. Entangled marine mammals may die as a result of drowning, escape with pieces of gear still attached to their bodies, or manage to be set free either of their own accord or by fishermen. Many large whales carry off gear after becoming entangled (Read et al. 2006). Many times when a marine mammal swims off with gear attached, the end result can be fatal. The gear may be become too cumbersome for the animal, or it can be wrapped around a crucial body part and tighten over time. Stranded marine mammals frequently exhibit signs of previous fishery interaction, such as scarring or gear attached to their bodies, and the cause of death for many stranded marine mammals is often attributed to such interactions (Baird and Gorgone 2005). Because marine mammals that die or are injured in fisheries may not wash ashore and not all animals that do wash ashore exhibit clear signs of interactions, stranding data probably underestimate fishery-related mortality and serious injury (NMFS 2005a)

From 1993 through 2003, 1,105 harbor porpoises were reported stranded from Maine to North Carolina, many of which had cuts and body damage suggestive of net entanglement (NMFS 2005e). In 1999 it was possible to determine that the cause of death for 38 of the stranded porpoises was from fishery interactions, with one additional animal having been mutilated (right flipper and fluke cut off) (NMFS 2005e). In 2000, one stranded porpoise was found with monofilament line wrapped around its body (NMFS 2005e). In 2003, nine stranded harbor porpoises were attributed to fishery interactions, with an additional three mutilated animals (NMFS 2005e). An estimated 78 baleen whales were killed annually in the offshore southern

California/Oregon drift gillnet fishery during the 1980s (Heyning and Lewis 1990). From 1998-2005, based on observer records, five fin whales (CA/OR/WA stock), 12 humpback whales (ENP stock), and six sperm whales (CA/OR/WA stock) were either seriously injured or killed in fisheries off the mainland west coast of the U.S. (California Marine Mammal Stranding Network Database 2006).

Ship Strike

Vessel strikes to marine mammals are another cause of mortality and stranding (Laist et al. 2001; Geraci and Lounsbury 2005; de Stephanis and Urquiola, 2006). An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus 2001; Laist et al. 2001; Vanderlaan and Taggart 2007).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike results in death (Knowlton and Kraus 2001; Laist et al. 2001, Jensen and Silber 2003; Vanderlaan and Taggart 2007). In assessing records in which vessel speed was known, Laist et al. (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 13 knots although most vessels do travel greater than 15 kts. Jensen and Silber (2003) detailed 292 records of known or probable ship strikes of all large whale species from 1975 to 2002. Of these, vessel speed at the time of collision was reported for 58 cases. Of these cases, 39 (or 67%) resulted in serious injury or death (19 or 33% resulted in serious injury as determined by blood in the water, propeller gashes or severed tailstock, and fractured skull, jaw, vertebrae, hemorrhaging, massive bruising or other injuries noted during necropsy and 20 or 35% resulted in death). Operating speeds of vessels that struck various species of large whales ranged from 2 to 51 knots. The majority (79%) of these strikes occurred at speeds of 13 knots or greater. The average speed that resulted in serious injury or death was 18.6 knots. Pace and Silber (2005) found that the probability of death or serious injury increased rapidly with increasing vessel speed. Specifically, the predicted probability of serious injury or death increased from 45 percent to 75 % as vessel speed increased from 10 to 14 knots, and exceeded 90% at 17 knots. Higher speeds during collisions result in greater force of impact, but higher speeds also appear to increase the chance of severe injuries or death by pulling whales toward the vessel. Computer simulation modeling showed that hydrodynamic forces pulling whales toward the vessel hull increase with increasing speed (Clyne 1999, Knowlton et al. 1995).

The growth in civilian commercial ports and associated commercial vessel traffic is a result in the globalization of trade. The Final Report of the NOAA International Symposium on "Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology" stated that the worldwide commercial fleet has grown from approximately 30,000 vessels in 1950 to over 85,000 vessels in 1998 (NRC, 2003; Southall, 2005). Between 1950 and 1998, the U.S. flagged fleet declined from approximately 25,000 to less than 15,000 and currently represents only a small portion of the world fleet. From 1985 to 1999, world seaborne trade doubled to 5 billion tons and currently includes 90 percent of the total world trade, with container shipping movements representing the largest volume of seaborne trade. It is unknown how international shipping volumes and densities will continue to grow. However, current statistics support the prediction that the international shipping fleet will continue to grow at the current rate or at greater rates in the future. Shipping densities in specific areas and trends in routing and vessel design are as, or more, significant than the total number of vessels. Densities along existing coastal routes are expected to increase both domestically and internationally. New routes are also expected to develop as new ports are opened and existing ports are expanded. Vessel propulsion systems are also advancing toward faster ships operating in higher sea states for lower operating costs; and container ships are expected to become larger along certain routes (Southall 2005).

While there are reports and statistics of whales struck by vessels in U.S. waters, the magnitude of the risks of commercial ship traffic poses to marine mammal populations is difficult to quantify or estimate. In addition, there is limited information on vessel strike interactions between ships and marine mammals outside of U.S. waters (de Stephanis and Urquiola 2006). Laist et al. (2001) concluded that ship collisions may have a negligible effect on most marine mammal populations in general, except for regional based small populations where the significance of low numbers of collisions would be greater given smaller populations or populations segments.

U.S. Navy vessel traffic is a small fraction of the overall U.S. commercial and fishing vessel traffic. While U.S. Navy vessel movements may contribute to the ship strike threat, given the lookout and mitigation measures adopted by the U.S. Navy, probability of vessel strikes is greatly reduced. Furthermore, actions to avoid close interaction of U.S. Navy ships and marine mammals and sea turtles, such as maneuvering to keep away from any observed marine mammal and sea turtle are part of existing at-sea protocols and standard operating procedures. Navy ships have up to three or more dedicated and trained lookouts as well as two to three bridge watchstanders during at-sea movements who would be searching for any whales, sea turtles, or other obstacles on the water surface. Such lookouts are expected to further reduce the chances of a collision.

Commercial and Private Marine Mammal Viewing

In addition to vessel operations, private and commercial vessels engaged in marine mammal watching also have the potential to impact marine mammals in Southern California. NMFS has promulgated regulations at 50 CFR 224.103, which provide specific prohibitions regarding wildlife viewing activities. In addition, NMFS launched an education and outreach campaign to provide commercial operators and the general public with responsible marine mammal viewing guidelines. In January 2002, NMFS also published an official policy on human interactions with wild marine mammals which states that: “NOAA Fisheries cannot support, condone, approve or authorize activities that involve closely approaching, interacting or attempting to interact with whales, dolphins, porpoises, seals, or sea lions in the wild. This includes attempting to swim, pet, touch or elicit a reaction from the animals.”

Although considered by many to be a non-consumptive use of marine mammals with economic, recreational, educational, and scientific benefits, marine mammal watching is not without potential negative impacts. One concern is that animals become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle et al. 1993; Wiley et al. 1995). Another concern is that preferred habitats may become abandoned if disturbance levels are too high. A whale’s behavioral response to whale watching vessels depends on the distance of the vessel from the whale, vessel speed, vessel direction, vessel noise, and the number of vessels (Amaral and Carlson 2005; Au and Green 2000; Cockeron 1995; Erbe 2002; Felix 2001; Magalhaes et al. 2002; Richter et al. 2003; Schedat et al. 2004; Simmonds 2005; Watkins 1986; Williams et al. 2002). The whale’s responses changed with these different variables and, in some circumstances, the whales did not respond to the vessels, but in other circumstances, whales changed their vocalizations surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. In addition to the information on whale watching, there is also direct evidence of pinniped haul out site (Pacific harbor seals) abandonment because of human disturbance at Strawberry Spit in San Francisco Bay (Allen 1991).

Ingestion of Plastic Objects and Other Marine Debris And Toxic Pollution Exposure

For many marine mammals, debris in the marine environment is a great hazard and can be harmful to wildlife. Not only is debris a hazard because of possible entanglement, animals may mistake plastics and other debris for food (NMFS, 2007g). There are certain species of cetaceans, along with Florida manatees, that are more likely to eat trash, especially plastics, which is usually fatal for the animal (Geraci et al. 1999).

Between 1990 through October 1998, 215 pygmy sperm whales stranded along the U.S. Atlantic coast from New York through the Florida Keys (NMFS 2005a). Remains of plastic bags and other debris were found in the stomachs of 13 of these animals (NMFS 2005a). During the same time period, 46 dwarf sperm whale strandings occurred along the U.S. Atlantic coastline between Massachusetts and the Florida Keys (NMFS 2005d). In 1987 a pair of latex examination gloves was retrieved from the stomach of a stranded dwarf sperm whale (NMFS 2005d). 125 pygmy sperm whales were reported stranded from 1999 – 2003 between Maine and Puerto Rico; in one pygmy sperm whale found stranded in 2002, red plastic debris was found in the stomach along with squid beaks (NMFS 2005a).

Sperm whales have been known to ingest plastic debris, such as plastic bags (Evans et al. 2003; Whitehead 2003). While this has led to mortality, the scale to which this is affecting sperm whale populations is unknown, but Whitehead (2003) suspects it is not substantial at this time.

High concentrations of potentially toxic substances within marine mammals along with an increase in new diseases have been documented in recent years. Scientists have begun to consider the possibility of a link between pollutants and marine mammal mortality events. NMFS takes part in a marine mammal bio-monitoring program not only to help assess the health and contaminant loads of marine mammals, but also to assist in determining anthropogenic impacts on marine mammals, marine food chains and marine ecosystem health. Using strandings and bycatch animals, the program provides tissue/serum archiving, samples for analyses, disease monitoring and reporting, and additional response during disease investigations (NMFS 2007).

The impacts of these activities are difficult to measure. However, some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Contaminants such as organochlorines do not tend to accumulate in significant amounts in invertebrates, but do accumulate in fish and fish-eating animals. Thus, contaminant levels in planktivorous mysticetes have been reported to be one to two orders of magnitude lower compared to piscivorous odontocetes (Borell 1993; O’Shea and Brownell 1994; O’Hara and Rice 1996; O’Hara et al. 1999).

The manmade chemical PCB (polychlorinated biphenyl), and the pesticide DDT (dichlorodiphyenyltrichloroethane), are both considered persistent organic pollutants that are currently banned in the United States for their harmful effects in wildlife and humans (NMFS, 2007c). Despite having been banned for decades, the levels of these compounds are still high in marine mammal tissue samples taken along U.S. coasts (NMFS, 2007c). Both compounds are long-lasting, reside in marine mammal fat tissues (especially in the blubber), and can be toxic causing effects such as reproductive impairment and immunosuppression (NMFS, 2007c).

Both long-finned and short-finned pilot whales have a tendency to mass strand throughout their range. Short-finned pilot whales have been reported as stranded as far north as Rhode Island, and long-finned pilot whales as far south as South Carolina (NMFS 2005b). For U.S. east coast stranding records, both species are lumped together and there is rarely a distinction between the two because of uncertainty in species identification (NMFS 2005b). Since 1980 within the Northeast region alone, between 2 and 120 pilot whales have stranded annually either individually or in groups (NMFS 2005b). Between 1999 and 2003 from Maine to Florida, 126 pilot whales were reported to be stranded, including a mass stranding of 11 animals in 2000 and another mass stranding of 57 animals in 2002, both along the Massachusetts coast (NMFS 2005b).

It is unclear how much of a role human activities play in these pilot whale strandings, and toxic poisoning may be a potential human-caused source of mortality for pilot whales (NMFS 2005b). Moderate levels of PCBs and chlorinated pesticides (such as DDT, DDE, and dieldrin) have been found in pilot whale blubber (NMFS 2005b). Bioaccumulation levels have been found to be more similar in whales from the same stranding event than from animals of the same age or sex (NMFS 2005b). Numerous studies have measured high levels of toxic metals (mercury, lead, and cadmium), selenium, and PCBs in pilot whales in the Faroe Islands (NMFS 2005b). Population effects resulting from such high contamination levels are currently unknown (NMFS 2005b).

Habitat contamination and degradation may also play a role in marine mammal mortality and strandings. Some events caused by man have direct and obvious effects on marine mammals, such as oil spills (Geraci et al. 1999). But in most cases, effects of contamination will more than likely be indirect in nature, such as effects on prey species availability, or by increasing disease susceptibility (Geraci et al. 1999).

U.S. Navy vessel operation between ports and exercise locations has the potential for release of small amounts of pollutant discharges into the water column. U.S. Navy vessels are not a typical source, however, of either pathogens or other contaminants with bioaccumulation potential such as pesticides and PCBs. Furthermore, any vessel discharges such as bilgewater and deck runoff associated with the vessels would be in accordance with international and U.S. requirements for eliminating or minimizing discharges of oil, garbage, and other substances, and not likely to contribute significant changes to ocean water quality.

For many marine mammals, debris in the marine environment is a great hazard and can be harmful to wildlife. Not only is debris a hazard because of possible entanglement, animals may mistake plastics and other debris for food (NMFS 2007g). There are certain species of cetaceans, along with Florida manatees, that are more likely to eat trash, especially plastics, which is usually fatal for the animal (Geraci et al. 1999).

Between 1990 through October 1998, 215 pygmy sperm whales stranded along the U.S. Atlantic coast from New York through the Florida Keys (NMFS 2005a). Remains of plastic bags and other debris were found in the stomachs of 13 of these animals (NMFS 2005a). During the same time period, 46 dwarf sperm whale strandings occurred along the U.S. Atlantic coastline between Massachusetts and the Florida Keys (NMFS 2005d). In 1987 a pair of latex examination gloves was retrieved from the stomach of a stranded dwarf sperm whale (NMFS 2005d). 125 pygmy sperm whales were reported stranded from 1999 – 2003 between Maine and Puerto Rico; in one pygmy sperm whale found stranded in 2002, red plastic debris was found in the stomach along with squid beaks (NMFS 2005a).

Sperm whales have been known to ingest plastic debris, such as plastic bags (Evans et al. 2003; Whitehead 2003). While this has led to mortality, the scale to which this is affecting sperm whale populations is unknown, but Whitehead (2003) suspects it is not substantial at this time.

High concentrations of potentially toxic substances within marine mammals along with an increase in new diseases have been documented in recent years. Scientists have begun to consider the possibility of a link between pollutants and marine mammal mortality events. NMFS takes part in a marine mammal bio-monitoring program not only to help assess the health and contaminant loads of marine mammals, but also to assist in determining anthropogenic impacts on marine mammals, marine food chains and marine ecosystem health. Using strandings and bycatch animals, the program provides tissue/serum archiving, samples for analyses, disease monitoring and reporting, and additional response during disease investigations (NMFS 2007).

The impacts of these activities are difficult to measure. However, some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Contaminants such as organochlorines do not tend to accumulate in significant amounts in invertebrates, but do accumulate in fish and fish-eating animals. Thus, contaminant levels in planktivorous mysticetes have been reported to be one to two orders of magnitude lower compared to piscivorous odontocetes (Borell 1993; O'Shea and Brownell 1994; O'Hara and Rice 1996; O'Hara et al. 1999).

The manmade chemical PCB (polychlorinated biphenyl), and the pesticide DDT (dichlorodiphyenyltrichloroethane), are both considered persistent organic pollutants that are currently banned in the United States for their harmful effects in wildlife and humans (NMFS 2007c). Despite having been banned for decades, the levels of these compounds are still high in marine mammal tissue samples taken along U.S. coasts (NMFS 2007c). Both compounds are long-lasting, reside in marine mammal fat tissues (especially in the blubber), and can be toxic causing effects such as reproductive impairment and immunosuppression (NMFS 2007c).

Both long-finned and short-finned pilot whales have a tendency to mass strand throughout their range. Short-finned pilot whales have been reported as stranded as far north as Rhode Island, and long-finned pilot whales as far south as South Carolina (NMFS 2005b). For U.S. east coast stranding records, both species are lumped together and there is rarely a distinction between the two because of uncertainty in species identification (NMFS, 2005b). Since 1980 within the Northeast region alone, between 2 and 120 pilot whales have stranded annually either individually or in groups (NMFS, 2005b). Between 1999 and 2003 from Maine to Florida, 126 pilot whales were reported to be stranded, including a mass stranding of 11 animals in 2000 and another mass stranding of 57 animals in 2002, both along the Massachusetts coast (NMFS, 2005b).

It is unclear how much of a role human activities play in these pilot whale strandings, and toxic poisoning may be a potential human-caused source of mortality for pilot whales (NMFS 2005b). Moderate levels of PCBs and chlorinated pesticides (such as DDT, DDE, and dieldrin) have been found in pilot whale blubber (NMFS 2005b). Bioaccumulation levels have been found to be more similar in whales from the same stranding event than from animals of the same age or sex (NMFS 2005b). Numerous studies have measured high levels of toxic metals (mercury, lead, and cadmium), selenium, and PCBs in pilot whales in the Faroe Islands (NMFS 2005b). Population effects resulting from such high contamination levels are currently unknown (NMFS 2005b).

Habitat contamination and degradation may also play a role in marine mammal mortality and strandings. Some events caused by man have direct and obvious effects on marine mammals, such as oil spills (Geraci et al. 1999). But in most cases, effects of contamination will more than likely be indirect in nature, such as effects on prey species availability, or by increasing disease susceptibility (Geraci et al. 1999).

U.S. Navy vessel operation between ports and exercise locations has the potential for release of small amounts of pollutant discharges into the water column. U.S. Navy vessels are not a typical source, however, of either pathogens or other contaminants with bioaccumulation potential such as pesticides and PCBs. Furthermore, any vessel discharges such as bilgewater and deck runoff associated with the vessels would be in accordance with international and U.S. requirements for eliminating or minimizing discharges of oil, garbage, and other substances, and not likely to contribute significant changes to ocean water quality.

Deep Water Ambient Noise

Urick (1983) provided a discussion of the ambient noise spectrum expected in the deep ocean. Shipping, seismic activity, and weather, are the primary causes of deep-water ambient noise. The ambient noise frequency spectrum can be predicted fairly accurately for most deep-water areas based primarily on known shipping traffic density and wind state (wind speed, Beaufort wind force, or sea state) (Urick 1983). For example, for frequencies between 100 and 500 Hz, Urick (1983) estimated the average deep water ambient noise spectra to be 73 to 80 dB for areas of heavy shipping traffic and high sea states, and 46 to 58 dB for light shipping and calm seas.

Shallow Water Ambient Noise

In contrast to deep water, ambient noise levels in shallow waters (i.e., coastal areas, bays, harbors, etc.) are subject to wide variations in level and frequency depending on time and location. The primary sources of noise include distant shipping and industrial activities, wind and waves, marine animals (Urick 1983). At any give time and place, the ambient noise is a mixture of all of these noise variables. In addition, sound propagation is also affected by the variable shallow water conditions, including the depth, bottom slope, and type of bottom. Where the bottom is reflective, the sounds levels tend to be higher, then when the bottom is absorptive.

Noise from Aircraft and Vessel Movement

Surface shipping is the most widespread source of anthropogenic, low frequency (0 to 1,000 Hz) noise in the oceans and may contribute to over 75% of all human sound in the sea (Simmonds and Hutchinson 1996, ICES 2005b). Ross (1976) has estimated that between 1950 and 1975, shipping had caused a rise in ambient noise levels of 10 dB. He predicted that this would increase by another 5 dB by the beginning of the 21st century. The National Resource Council (1997) estimated that the background ocean noise level at 100 Hz has been increasing by about 1.5 dB per decade since the advent of propeller-driven ships. Michel et al. (2001) suggested an association between long-term exposure to low frequency sounds from shipping and an increased incidence of marine mammal mortalities caused by collisions with ships.

Airborne sound from a low-flying helicopter or airplane may be heard by marine mammals and turtles while at the surface or underwater. Due to the transient nature of sounds from aircraft involved in at-sea operations, such sounds would not likely cause physical effects but have the potential to affect behaviors. Responses by mammals and turtles could include hasty dives or turns, or decreased foraging (Soto et al., 2006). Whales may also slap the water with flukes or flippers, swim away from the aircraft track.

Sound emitted from large vessels, particularly in the course of transit, is the principal source of noise in the ocean today, primarily due to the properties of sound emitted by civilian cargo vessels (Richardson et al., 1995; Arveson and Vendittis, 2000). Ship propulsion and electricity generation engines, engine gearing, compressors, bilge and ballast pumps, as well as hydrodynamic flow surrounding a ship's hull and any hull protrusions contribute to a large vessels' noise emission into the marine environment. Prop-driven vessels also generate noise through cavitation, which accounts much of the noise emitted by a large vessel depending on its travel speed. Military vessels underway or involved in naval operations or exercises, also introduce anthropogenic noise into the marine environment. Noise emitted by large vessels can be characterized as low-frequency, continuous, and tonal. The sound pressure levels at the vessel will vary according to speed, burden, capacity and length (Richardson et al. 1995; Arveson and Vendittis, 2000). Vessels ranging from 135 to 337 meters generate peak source sound levels from 169- 200 dB between 8 Hz and 430 Hz, although Arveson and Vendittis (2000) documented components of higher frequencies (10-30 kHz) as a function of newer merchant ship engines and faster transit speeds.

Whales have variable responses to vessel presence or approaches, ranging from apparent tolerance to diving away from a vessel. Unfortunately, it is not always possible to determine whether the whales are responding to the vessel itself or the noise generated by the engine and cavitation around the propeller. Apart from some disruption of behavior, an animal may be unable to hear other sounds in the environment due to masking by the noise from the vessel. Any masking of environmental sounds or conspecific sounds is expected to be temporary, as noise dissipates with a vessel transit through an area. Any masking of environmental sounds or conspecific sounds is expected to be temporary, as noise dissipates with a vessel transit through an area.

Vessel noise primarily raises concerns for masking of environmental and conspecific cues. However, exposure to vessel noise of sufficient intensity and/or duration can also result in temporary or permanent loss of sensitivity at a given frequency range, referred to as temporary or permanent threshold shifts (TTS or PTS). Threshold shifts are assumed to be possible in marine mammal species as a result of prolonged exposure to large vessel traffic noise due to its intensity, broad geographic range of effectiveness, and constancy.

Collectively, significant cumulative exposure to individuals, groups, or populations can occur if they exhibit site fidelity to a particular area; for example, whales that seasonally travel to a regular area to forage or breed may be more vulnerable to noise from large vessels compared to transiting whales. Any permanent threshold shift in a marine animal's hearing capability, especially at particular frequencies for which it can normally hear best, can impair its ability to perceive threats, including ships. Whales have variable responses to vessel presence or approaches, ranging from apparent tolerance to diving away from a vessel. It is not possible to determine whether the whales are responding to the vessel itself or the noise generated by the engine and cavitation around the propeller. Apart from some disruption of behavior, an animal may be unable to hear other sounds in the environment due to masking by the noise from the vessel.

Most observations of behavioral responses of marine mammals to human generated sounds have been limited to short-term behavioral responses, which included the cessation of feeding, resting, or social interactions. Nowacek et al. (2007) provide a detailed summary of cetacean response to underwater noise.

Given the sound propagation of low frequency sounds, a large vessel in this sound range can be heard 139-463 kilometers away (Ross 1976 in Polefka 2004). U.S. Navy vessels, however, have incorporated significant underwater ship quieting technology to reduce their acoustic signature (as compared to a similarly-sized vessel) in order to reduce their vulnerability to detection by enemy passive acoustics (Southall, 2005). Therefore, the potential for TTS or PTS from U.S. Navy vessel and aircraft movement is extremely low given that the exercises and training events are transitory in time, with vessels moving over large area of the ocean. A marine mammal or sea turtle is unlikely to be exposed long enough at high levels for TTS or PTS to occur. Any masking of environmental sounds or conspecific sounds is expected to be temporary, as noise dissipates with a U.S. Navy vessel transiting through an area. If behavioral disruptions result from the presence of aircraft or vessels, it is expected to be temporary. Animals are expected to resume their migration, feeding, or other behaviors without any threat to their survival or reproduction. However, if an animal is aware of a vessel and dives or swims away, it may successfully avoid being struck.

Stranding Events Associated with Navy Sonar

There are two classes of sonars employed by the U.S. Navy: active sonars and passive sonars. Most active military sonars operate in a limited number of areas, and are most likely not a significant contributor to a comprehensive global ocean noise budget (ICES 2005b).

The effects of mid-frequency active naval sonar on marine wildlife have not been studied as extensively as the effects of air-guns used in seismic surveys (Madsen et al. 2006; Stone and Tasker 2006; Wilson et al. 2006; Palka and Johnson 2007; Parente et al. 2007). Maybaum (1989,

1993) observed changes in behavior of humpbacks during playback tapes of the M-1002 system (using 203 dB re 1 µPa-m for study); specifically, a decrease in respiration, submergence, and aerial behavior rates; and an increase in speed of travel and track linearity. Direct comparison of Maybaum's results, however, with U.S Navy mid-frequency active sonar are difficult to make. Maybaum's signal source, the commercial M-1002, is not similar to how naval mid-frequency sonar operates. In addition, behavioral responses were observed during playbacks of a control tape, (i.e. a tape with no sound signal) so interpretation of Maybaum's results are inconclusive.

Research by Nowacek, et al. (2004) on North Atlantic right whales using a whale alerting signal designed to alert whales to human presence suggests that received sound levels of only 133 to 148 pressure level (decibel [dB] re 1 microPascals [µPa]) for the duration of the sound exposure may disrupt feeding behavior. The authors did note, however, that within minutes of cessation of the source, a return to normal behavior would be expected. Direct comparison of the Nowacek et al. (2004) sound source to MFA sonar, however, is not possible given the radically different nature of the two sources. Nowacek et al.'s source was a series of non-sonar like sounds designed to purposely alert the whale, lasting several minutes, and covering a broad frequency band. Direct differences between Nowacek et al. (2004) and MFA sonar is summarized below from Nowacek et al. (2004) and Nowacek et al. (2007):

(1) Signal duration: Time difference between the two signals is significant, 18-minute signal used by Nowacek et al. verses < 1-sec for MFA sonar.

(2) Frequency modulation: Nowacek et al. contained three distinct signals containing frequency modulated sounds:

> 1st - alternating 1-sec pure tone at 500 and 850 Hz
>
> 2nd - 2-sec logarithmic down-sweep from 4500 to 500 Hz
>
> 3rd - pair of low-high (1500 and 2000 Hz) sine wave tones amplitude modulated at 120 Hz

(3) Signal to noise ratio: Nowacek et al.'s signal maximized signal to noise ratio so that it would be distinct from ambient noise and resist masking.

(4) Signal acoustic characteristics: Nowacek et al.'s signal comprised of disharmonic signals spanning northern right whales' estimated hearing range.

Given these differences, therefore, the exact cause of apparent right whale behavior noted by the authors can not be attributed to any one component since the source was such a mix of signal types.

The effects of naval sonars on marine wildlife have not been studied as extensively as have the effects of airguns used in seismic surveys (Nowacek et al. 2007). In the Caribbean, sperm whales were observed to interrupt their activities by stopping echolocation and leaving the area in the presence of underwater sounds surmised to have originated from submarine sonar signals (Watkins and Schevill 1975; Watkins et al. 1985). The authors did not report receive levels from these exposures, and also got a similar reaction from artificial noise they generated by banging on their boat hull. It was unclear if the sperm whales were reacting to the sonar signal itself or to a potentially new unknown sound in general. Madsen et al. (2006) tagged and monitored eight sperm whales in the Gulf of Mexico exposed to seismic airgun surveys. Sound sources were from approximately 2 to 7 nm (4 to 13 km) away from the whales and based on multipath propagation RLs were as high as 162 dB re 1 uPa with energy content greatest between 0.3 to 3.0 kHz. Sperm whales engaged in foraging dives continued the foraging dives throughout exposures to these seismic pulses. In the Caribbean Sea, sperm whales avoided exposure to mid-frequency submarine sonar pulses, in the range 1000 Hz to 10,000 Hz (IWC 2005). Sperm whales have also moved out of areas after the start of air gun seismic testing (Davis et al. 1995). In contrast, during playback experiments off the Canary Islands, André et al. (1997) reported that foraging sperm whales exposed to a 10 kHz pulsed signal did not exhibit any general avoidance reactions.

The Navy sponsored tests of the effects of low-frequency active (LFA) sonar source, between 100 Hz and 1000 Hz, on blue, fin, and humpback whales. The tests demonstrated that whales exposed to sound levels up to 155 dB did not exhibit significant disturbance reactions, though there was evidence that humpback whales altered their vocalization patterns in reaction to the noise. Given that the source level of the Navy's LFA is reported to be in excess of 215 dB, the possibility exists that animals in the wild may be exposed to sound levels much higher than 155 dB.

Acoustic exposures have been demonstrated to kill marine mammals, result in physical trauma, and injury (Ketten 2005). Animals in or near an intense noise source can die from profound injuries related to shock wave or blast effects. Acoustic exposures can also result in noise induced hearing loss that is a function of the interactions of three factors: sensitivity, intensity, and frequency. Loss of sensitivity is referred to as a threshold shift; the extent and duration of a threshold shift depends on a combination of several acoustic features and is specific to particular species (TTS or PTS, depending on how the frequency, intensity and duration of the exposure combine to produce damage). In addition to direct physiological effects, noise exposures can impair an animal's sensory abilities (masking) or result in behavioral responses such as aversion or attraction (see Section 3.19).

Acoustic exposures can also result in the death of an animal by impairing its foraging, ability to detect predators or communicate, or by increasing stress, and disrupting important physiological events. Whales have moved away from their feeding and mating grounds (Bryant *et al*. 1984; Morton and Symnods 2002; Weller et al. 2002), moved away from their migration route (Richardson et al. 1995), and have changed their calls due to noise (Miller et al. 2000). Acoustic exposures such as MFA sonar tend to be infrequent and short in duration, and therefore effects are likely indirect and to be short lived. In situations such as the alteration of gray whale migration routes in response to shipping and whale watching boats, those acoustic exposures were chronic over several years (Moore and Clarke 2002). This was also true of the effect of seismic survey airguns (daily for 39 days) on the use of feeding areas by gray whales in the western North Pacific although whales began returning to the feeding area witin one day of the end of the exposure (Weller et al. 2002).

Below are evaluations of the general information available on the variety of ways in which cetaceans and pinnipeds have been reported to respond to sound, generally, and mid-frequency sonar, in particular.

The Navy is very concerned and thoroughly investigates each marine mammal stranding to better understand the events surrounding strandings (Norman 2006). Strandings can be a single animal or several to hundreds. An event where animals are found out of their normal habitat is considered a stranding even though animals do not necessarily end up beaching (such as the July 2004 Hanalei Mass Stranding Event; Southall et al. 2006). Several hypotheses have been given for the mass strandings which include the impact of shallow beach slopes on odontocete sonar, disease or parasites, geomagnetic anomalies that affect navigation, following a food source in close to shore, avoiding predators, social interactions that cause other cetaceans to come to the aid of stranded animals, and human actions. Generally, inshore species do not strand in large numbers but generally just as a single animal. This may be due to their familiarity with the coastal area whereas pelagic species that are unfamiliar with obstructions or sea bottom tend to strand more often in larger numbers (Woodings 1995). The Navy has studied several stranding events in detail that may have occurred in association with Navy sonar activities. To better understand the causal factors in stranding events that may be associated with Navy sonar activities, the main factors, including bathymetry (i.e. steep drop offs), narrow channels (less than 35 nm), environmental conditions (e.g. surface ducting), and multiple sonar ships were compared between the different stranding events.

When a marine mammal swims or floats onto shore and becomes "beached" or stuck in shallow water, it is considered a "stranding" (MMPA section 410 (16 USC section 1421g;NMFS, 2007a). NMFS explains that "a cetacean is considered stranded when it is on the beach, dead or alive, or in need of medical attention while free-swimming in U.S. waters. A pinniped is considered to be stranded either when dead or when in distress on the beach and not displaying normal haul-out behavior" (NMFS 2007b).

Over the past three decades, several "mass stranding" events [strandings involving two or more individuals of the same species (excluding a single cow-calf pair) and at times, individuals from different species] that have occurred over the past two decades have been associated with naval operations, seismic surveys, and other anthropogenic activities that introduce sound into the marine environment (Canary Islands, Greece, Vieques, U.S. Virgin Islands, Madeira Islands, Haro Strait, Washington State, Alaska, Hawaii, North Carolina).

Information was collected on mass stranding events (events in which two or more cetaceans stranded) that have occurred and for which reports are available, from the past 40 years. Any causal agents that have been associated with those stranding events were also identified (Table 2-5). Major range events undergo name changes over the years, however, the equivalent of COMPTUEX and JTFEX have been conducted in southern California since 1934. Training involving sonar has been conducted since World War II and sonar systems described in the SOCAL EIS/OEIS since the 1970's (Jane's 2005).

2.4.3 Stranding Analysis

Over the past two decades, several mass stranding events involving beaked whales have been documented. While beaked whale strandings have been reported since the 1800s (Geraci and Lounsbury 1993; Cox et al. 2006; Podesta et al. 2006), several mass strandings since have been associated with naval operations that may have included mid-frequency sonar (Simmonds and Lopez-Jurado 1991; Frantzis 1998; Jepson et al. 2003; Cox et al. 2006). As Cox et al. (2006) concludes, the state of science can not yet determine if a sound source such as mid-frequency sonar alone causes beaked whale strandings, or if other factors (acoustic, biological, or environmental) must co-occur in conjunction with a sound source.

A review of historical data (mostly anecdotal) maintained by the Marine Mammal Program in the National Museum of Natural History, Smithsonian Institution reports 49 beaked whale mass stranding events between 1838 and 1999. The largest beaked whale mass stranding occurred in the 1870s in New Zealand when 28 Gray's beaked whales (*Mesoplodon grayi*) stranded. Blainsville's beaked whale (*Mesoplodon densirostris*) strandings are rare, and records show that they were involved in one mass stranding in 1989 in the Canary Islands. Cuvier's beaked whales (*Ziphius cavirostris*) are the most frequently reported beaked whale to strand, with at least 19 stranding events from 1804 through 2000 (DoC and DoN 2001; Smithsonian Institution 2000).

The discussion below centers on those worldwide stranding events that may have some association with naval operations, and global strandings that the U.S. Navy feels are either inconclusive or can not be associated with naval operations.

2.4.3.1 Naval Association

In the following sections, specific stranding events that have been putatively linked to potential sonar operations are discussed. Of note, these events represent a small overall number of animals over an 11 year period (40 animals) and not all worldwide beaked whale strandings can be linked to naval activity (ICES 2005a; 2005b; Podesta et al. 2006). Four of the five events occurred during NATO exercises or events where U.S. Navy presence was limited (Greece, Portugal, Spain). One of the five events involved only U.S. Navy ships (Bahamas).

Beaked whale stranding events associated with potential naval operations.

1996 May	Greece (NATO)
2000 March	Bahamas (US)
2000 May	Portugal, Madeira Islands (NATO/US)
2002 September	Spain, Canary Islands (NATO/US)
2006 January	Spain, Mediterranean Sea coast (NATO/US)

Case Studies of Stranding Events (coincidental with or implicated with naval sonar)

1996 Greece Beaked Whale Mass Stranding (May 12 – 13, 1996)

Description: Twelve Cuvier's beaked whales (*Ziphius cavirostris*) stranded along a 38.2-kilometer strand of the coast of the Kyparissiakos Gulf on May 12 and 13, 1996 (Frantzis, 1998). From May 11 through May 15, the NATO research vessel Alliance was conducting sonar tests with signals of 600 Hz and 3 kHz and root-mean-squared (rms) sound pressure levels (SPL) of 228 and 226 dB re: 1µPa, respectively (D'Amico and Verboom 1998; D'Spain et al. 2006). The timing and the location of the testing encompassed the time and location of the whale strandings (Frantzis 1998).

Findings: Partial necropsies of eight of the animals were performed, including external assessments and the sampling of stomach contents. No abnormalities attributable to acoustic exposure were observed, but the stomach contents indicated that the whales were feeding on cephalods soon before the stranding event. No unusual environmental events before or during the stranding event could be identified (Frantzis 1998).

Conclusions: The timing and spatial characteristics of this stranding event were atypical of stranding in Cuvier's beaked whale, particularly in this region of the world. No natural phenomenon that might contribute to the stranding event coincided in time with the mass stranding. Because of the rarity of mass strandings in the Greek Ionian Sea, the probability that the sonar tests and stranding coincided in time and location, while being independent of each other, was estimated as being extremely low (Frantzis 1998). However, because information for the necropsies was incomplete and inconclusive, the cause of the stranding cannot be precisely determined.

2000 Bahamas Marine Mammal Mass Stranding (March 15-16, 2000)

Description: Seventeen marine mammals comprised of Cuvier's beaked whales, Blainville's beaked whales (*Mesoplodon densirostris*), minke whale (*Balaenoptera acutorostrata*), and one spotted dolphin (*Stenella frontalis*), stranded along the Northeast and Northwest Providence Channels of the Bahamas Islands on March 15-16, 2000 (Evans and England 2001). The strandings occurred over a 36-hour period and coincided with U.S. Navy use of mid-frequency active sonar within the channel. Navy ships were involved in tactical sonar exercises for approximately 16 hours on March 15. The ships, which operated the AN/SQS-53C and AN/SQS-56, moved through the channel while emitting sonar pings approximately every 24 seconds. The timing of pings was staggered between ships and average source levels of pings varied from a nominal 235 dB SPL (AN/SQS-53C) to 223 dB SPL (AN/SQS-56). The center frequency of pings was 3.3 kHz and 6.8 to 8.2 kHz, respectively.

Seven of the animals that stranded died, while ten animals were returned to the water alive. The animals known to have died included five Cuvier's beaked whales, one Blainville's beaked whale, and the single spotted dolphin. Six necropsies were performed and three of the six necropsied whales (one Cuvier's beaked whale, one Blainville's beaked whale, and the spotted dolphin) were fresh enough to permit identification of pathologies by computerized tomography (CT). Tissues from the remaining three animals were in a state of advanced decomposition at the time of inspection.

Findings: The spotted dolphin demonstrated poor body condition and evidence of a systemic debilitating disease. In addition, since the dolphin stranding site was isolated from the acoustic activities of Navy ships, it was determined that the dolphin stranding was unrelated to the presence of Navy active sonar.

All five necropsied beaked whales were in good body condition and did not show any signs of external trauma or disease. In the two best preserved whale specimens, hemorrhage was associated with the brain and hearing structures. Specifically, subarachnoid hemorrhage within the temporal region of the brain and intracochlear hemorrhages were noted. Similar findings of bloody effusions around the ears of two other moderately decomposed whales were consistent with the same observations in the freshest animals. In addition, three of the whales had small hemorrhages in their acoustic fats, which are fat bodies used in sound production and reception (i.e., fats of the lower jaw and the melon). The best-preserved whale demonstrated acute hemorrhage within the kidney, inflammation of the lung and lymph nodes, and congestion and mild hemorrhage in multiple other organs. Other findings were consistent with stresses and injuries associated with the stranding process. These consisted of external scrapes, pulmonary edema and congestion.

Conclusions: The post-mortem analyses of stranded beaked whales lead to the conclusion that the immediate cause of death resulted from overheating, cardiovascular collapse and stresses associated with being stranded on land. However, the presence of subarachnoid and intracochlear hemorrhages were believed to have occurred prior to stranding and were hypothesized as being related to an acoustic event. Passive acoustic monitoring records demonstrated that no large scale acoustic activity besides the Navy sonar exercise occurred in the times surrounding the stranding event. The mechanism by which sonar could have caused the observed traumas or caused the animals to strand was undetermined. The spotted dolphin was in overall poor condition for examination, but showed indications of long-term disease. No analysis of baleen whales (minke whale) was conducted. Baleen whale stranding events have not been associated with either low-frequency or mid-frequency sonar use (ICES 2005a, 2005b).

2000 Madeira Island, Portugal Beaked Whale Strandings (May 10 – 14, 2000)

Description: Three Cuvier's beaked whales stranded on two islands in the Madeira Archipelago, Portugal, from May 10 – 14, 2000 (Cox et al. 2006). A joint NATO amphibious training exercise, named "Linked Seas 2000," which involved participants from 17 countries, took place in Portugal during May 2 – 15, 2000. The timing and location of the exercises overlapped with that of the stranding incident.

Findings: Two of the three whales were necropsied. Two heads were taken to be examined. One head was intact and examined grossly and by CT; the other was only grossly examined because it was partially flensed and had been seared from an attempt to dispose of the whale by fire (Ketten 2005).

No blunt trauma was observed in any of the whales. Consistent with prior CT scans of beaked whales stranded in the Bahamas 2000 incident, one whale demonstrated subarachnoid and peribullar hemorrhage and blood within one of the brain ventricles. Post-cranially, the freshest whale demonstrated renal congestion and hemorrhage, which was also consistent with findings in the freshest specimens in the Bahamas incident.

Conclusions: The pattern of injury to the brain and auditory system were similar to those observed in the Bahamas strandings, as were the kidney lesions and hemorrhage and congestion in the lungs (Ketten 2005). The similarities in pathology and stranding patterns between these two events suggested a similar causative mechanism. Although the details about whether or how sonar was used during "Linked Seas 2000" is unknown, the presence of naval activity within the region at the time of the strandings suggested a possible relationship to Navy activity.

2002 Canary Islands Beaked Whale Mass Stranding (24 September 2002)

Description: On September 24, 2002, 14 beaked whales stranded on Fuerteventura and Lanzaote Islands in the Canary Islands (Jepson et al. 2003). Seven of the 14 whales died on the beach and the 7 were returned to the ocean. Four beaked whales were found stranded dead over the next three days either on the coast or floating offshore (Fernández et al. 2005). At the time of the strandings, an international naval exercise (Neo-Tapon 2002) that involved numerous surface warships and several submarines was being conducted off the coast of the Canary Islands. Tactical mid-frequency active sonar was utilized during the exercises, and strandings began within hours of the onset of the use of mid-frequency sonar (Fernández et al. 2005).

Findings: Eight Cuvier's beaked whales, one Blainville's beaked whale, and on Gervais' beaked whale were necropsied; six of them within 12 hours of stranding (Fernández et al. 2005). The stomachs of the whales contained fresh and undigested prey contents. No pathogenic bacteria were isolated from the whales, although parasites were found in the kidneys of all of the animals. The head and neck lymph nodes were congested and hemorrhages were noted in multiple tissues and organs, including the kidney, brain, ears, and jaws. Widespread fat emboli were found throughout the carcasses, but no evidence of blunt trauma was observed in the whales. In addition, the parenchyma of several organs contained macroscopic intravascular bubbles and lesions, putatively associated with nitrogen off-gassing.

Conclusions: The association of NATO mid-frequency sonar use close in space and time to the beaked whale strandings, and the similarity between this stranding event and previous beaked whale mass strandings coincident with sonar use, suggests that a similar scenario and causative mechanism of stranding may be shared between the events. Beaked whales stranded in this event demonstrated brain and auditory system injuries, hemorrhages, and congestion in multiple organs, similar to the pathological findings of the Bahamas and Madeira stranding events. In addition, the necropsy results of Canary Islands stranding event lead to the hypothesis that the presence of disseminated and widespread gas bubbles and fat emboli were indicative of nitrogen bubble formation, similar to what might be expected in decompression sickness (Jepson et al. 2003; Fernández et al. 2005). Whereas gas emboli would develop from the nitrogen gas, fat emboli would enter the blood stream from ruptured fat cells (presumably where nitrogen bubble formation occurs) or through the coalescence of lipid bodies within the blood stream.

The possibility that the gas and fat emboli found by Fernández et al. (2005) was due to nitrogen bubble formation has been hypothesized to be related to either direct activation of the bubble by sonar signals or to a behavioral response in which the beaked whales flee to the surface following sonar exposure. The first hypothesis is related to rectified diffusion (Crum and Mao 1996), the process of increasing the size of a bubble by exposing it to a sound field. This process is facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard 1979). Deeper and longer dives of some marine mammals, such as those conducted by beaked whales, are theoretically predicted to induce greater levels of supersaturation (Houser et al. 2001). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness. It is unlikely that the short duration of sonar pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: stable bubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario the marine mammal would need to be in a gas-supersaturated state for a long enough period of time for bubbles to become of a problematic size. The second hypothesis speculates that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson et al. 2003; Fernández et al. 2005). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Tyack et al. (2006) showed that beaked whales often make rapid ascents from deep dives suggesting that it is unlikely that beaked whales would suffer from decompression sickness. Zimmer and Tyack (2007) speculated that if repetitive shallow dives that are used by beaked whales to avoid a predator or a sound source, they could accumulate high levels of nitrogen because they would be above the depth of lung collapse (above about 210 ft) and could lead to decompression sickness. There is no evidence that beaked whales dive in this manner in response to predators or sound sources and other marine mammals such as Antarctic and Galapagos fur seals, and pantropical spotted dolphins make repetitive shallow dives with no apparent decompression sickness (Kooyman and Trillmich, 1984; Kooyman et al., 1984; Baird et al., 2001).

Although theoretical predictions suggest the possibility for acoustically mediated bubble growth, there is considerable disagreement among scientists as to its likelihood (Piantadosi and Thalmann 2004). Sound exposure levels predicted to cause in vivo bubble formation within diving cetaceans have not been evaluated and are suspected as needing to be very high (Evans 2002; Crum et al. 2005). Moore and Early (2004) reported that in analysis of sperm whale bones spanning 111 years, gas embolism symptoms were observed indicating that sperm whales may be susceptible to decompression sickness due to natural diving behavior. Further, although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson et al. 2003), there is no conclusive evidence supporting this hypothesis and there is concern that at least some of the pathological findings (e.g., bubble emboli) are artifacts of the necropsy. Currently, stranding networks in the United States have agreed to adopt a set of necropsy guidelines to determine, in part, the possibility and frequency with which bubble emboli can be introduced into marine mammals during necropsy procedures (Arruda et al. 2007).

2006 Spain, Gulf of Vera Beaked Whale Mass Stranding (26-27 January 2006)

Description: The Spanish Cetacean Society reported an atypical mass stranding of four beaked whales that occurred January 26 to 28, 2006, on the southeast coast of Spain near Mojacar (Gulf of Vera) in the Western Mediterranean Sea. According to the report, two of the whales were discovered the evening of January 26 and were found to be still alive. Two other whales were discovered during the day on January 27, but had already died. A following report stated that the first three animals were located near the town of Mojacar and were examined by a team from the University of Las Palmas de Gran Canarias, with the help of the stranding network of Ecologistas en Acción Almería-PROMAR and others from the Spanish Cetacean Society. The fourth animal was found dead on the afternoon of May 27, a few kilometers north of the first three animals.

From January 25-26, 2006, a NATO surface ship group (seven ships including one U.S. ship under NATO operational command) conducted active sonar training against a Spanish submarine within 50 nm of the stranding site.

Findings: Veterinary pathologists necropsied the two male and two female beaked whales (*Z. cavirostris*).

Conclusions: According to the pathologists, a likely cause of this type of beaked whale mass stranding event may have been anthropogenic acoustic activities. However, no detailed pathological results confirming this supposition have been published to date, and no positive acoustic link was established as a direct cause of the stranding.

Even though no causal link can be made between the stranding event and naval exercises, certain conditions may have existed in the exercise area that, in their aggregate, may have contributed to the marine mammal strandings (Freitas 2004):

- Operations were conducted in areas of at least 1000 meters in depth near a shoreline where there is a rapid change in bathymetry on the order of 1000 – 6000 meters occurring a cross a relatively short horizontal distance (Freitas 2004).

- Multiple ships, in this instance, five MFA sonar equipped vessels, were operating in the same area over extended periods of time (20 hours) in close proximity.

- Exercises took place in an area surrounded by landmasses, or in an embayment. Operations involving multiple ships employing mid-frequency active sonar near land may produce sound directed towards a channel or embayment that may cut off the lines of egress for marine mammals (Freitas 2004)

2.4.3.2 Other Global Stranding Discussions

In the following sections, stranding events that have been linked to U.S. Navy activity in popular press are presented. As detailed in the individual case study conclusions, the U.S. Navy believes there is enough evidence available to refute allegations of impacts from mid-frequency sonar, or at least indicate that a substantial degree of uncertainty in time and space that preclude a meaningful scientific conclusion.

Case Studies of Stranding Events

2003 Washington State Harbor Porpoise Strandings (May 2 – June 2 2003)

Description: At 1040 hours on May 5, 2003, the USS SHOUP began the use of mid-frequency tactical active sonar as part of a naval exercise. At 1420, the USS SHOUP entered the Haro Strait and terminated active sonar use at 1438, thus limiting active sonar use within the strait to less than 20 minutes. Between May 2 and June 2, 2003, approximately 16 strandings involving 15 harbor porpoises (*Phocoena phocoena*) and one Dall's porpoise (*Phocoenoides dalli*) were reported to the Northwest Marine Mammal Stranding Network. A comprehensive review of all strandings and the events involving USS SHOUP on 5 May 2003 were presented in U.S. Department of Navy (2004). Given that the USS SHOUP was known to have operated sonar in the strait on May 5, and that supposed behavioral reactions of killer whales (*Orcinus orca*) had been putatively linked to these sonar operations (NMFS Office of Protected Resources, 2005), the NMFS undertook an analysis of whether sonar caused the strandings of the harbor porpoises.

Whole carcasses of ten of harbor porpoises and the head of an additional porpoise were collected for analysis. Necropsies were performed on ten of the harbor porpoises and six whole carcasses and two heads were selected for CT imaging. Gross examination, histopathology, age determination, blubber analysis, and various other analyses were conducted on each of the carcasses (Norman et al. 2004).

Findings: Post-mortem findings and analysis details are found in Norman et al. (2004). All of the carcasses suffered from some degree of freeze-thaw artifact that hampered gross and histological evaluations. At the time of necropsy, three of the porpoises were moderately fresh, whereas the remainder of the carcasses was considered to have moderate to advanced decomposition. None of the 11 harbor porpoises demonstrated signs of acoustic trauma. In contrast, a putative cause of death was determined for 5 of the porpoises; 2 animals had blunt trauma injuries and 3 animals had indication of disease processes (fibrous peritonitis, salmonellosis, and necrotizing pneumonia). A cause of death could not be determined in the remaining animals, which is consistent with expected percentage of marine mammal necropsies conducted within the northwest region. It is important to note, however, that these determinations were based only on the evidence from the necropsy so as not to be biased with regard to determinations of the potential presence or absence of acoustic trauma. The result was that other potential causal factors, such as one animal (Specimen 33NWR05005) found tangled in a fishing net, was unknown to the investigators in their determination regarding the likely cause of death.

Conclusions: The NMFS concluded from a retrospective analysis of stranding events that the number of harbor porpoise stranding events in the approximate month surrounding the USS SHOUP use of sonar was higher than expected based on annual strandings of harbor porpoises (Norman et al. 2004). In this regard, it is important to note that the number of strandings in the May-June timeframe in 2003 was also higher for the outer coast indicating a much wider phenemona than use of sonar by USS SHOUP in Puget Sound for one day in May. The conclusion by NMFS that the number of strandings in 2003 was higher is also different from that of The Whale Museum, which has documented and responded to harbor porpoise strandings since 1980 (Osborne 2003). According to The Whale Museum, the number of strandings as of May 15, 2003, was consistent with what was expected based on historical stranding records and was less than that occurring in certain years. For example, since 1992 the San Juan Stranding Network has documented an average of 5.8 porpoise strandings per year. In 1997 there were 12 strandings in the San Juan Islands with more than 30 strandings throughout the general Puget Sound area. Disregarding the discrepancy in the historical rate of porpoise strandings and its relation to the USS SHOUP, NMFS acknowledged that the intense level of media attention focused on the strandings likely resulted in an increased reporting effort by the public over that which is normally observed (Norman et al. 2004). NMFS also noted in its report that the "sample size is too small and biased to infer a specific relationship with respect to sonar usage and subsequent strandings."

Seven of the porpoises collected and analyzed died prior to SHOUP departing to sea on May 5, 2003. Of these seven, one, discovered on May 5, 2003, was in a state of moderate decomposition, indicating it died before May 5; the cause of death was determined to be due, most likely, to salmonella septicemia. Another porpoise, discovered at Port Angeles on May 6, 2003, was in a state of moderate decomposition, indicating that this porpoise also died prior to May 5. One stranded harbor porpoise discovered fresh on May 6 is the only animal that could potentially be linked in time to the USS SHOUP's May 5 active sonar use. Necropsy results for this porpoise found no evidence of acoustic trauma. The remaining eight strandings were discovered one to three weeks after the USS SHOUP's May 5 transit of the Haro Strait, making it difficult to causally link the sonar activities of the USS SHOUP to the timing of the strandings. Two of the eight porpoises died from blunt trauma injury and a third suffered from parasitic infestation, which possibly contributed to its death (Norman et al. 2004). For the remaining five porpoises, NMFS was unable to identify the causes of death.

The speculative association of the harbor porpoise strandings to the use of sonar by the USS SHOUP is inconsistent with prior stranding events linked to the use of mid-frequency sonar. Specifically, in prior events, the stranding of whales occurred over a short period of time (less than 36 hours), stranded individuals were spatially co-located, traumas in stranded animals were consistent between events, and active sonar was known or suspected to be in use. Although mid-frequency active sonar was used by the USS SHOUP, the distribution of harbor porpoise strandings by location and with respect to time surrounding the event do not support the suggestion that mid-frequency active sonar was a cause of harbor porpoise strandings. Rather, a complete lack of evidence of any acoustic trauma within the harbor porpoises, and the identification of probable causes of stranding or death in several animals, further supports the conclusion that harbor porpoise strandings were unrelated to the sonar activities of the USS SHOUP.

Additional allegations regarding USS SHOUP use of sonar having caused behavioral effects to Dall’s porpoise, orca, and a minke whale also arose in association with this event (see U.S. Department of Navy 2004 for a complete discussion).

Dall’s porpoise: Information regarding the observation of Dall’s porpoise on 5 May 2003 came from the operator of a whale watch boat at an unspecified location. This operator reported the Dall’s porpose were seen “going north” when the SHOUP was estimated by him to be 10 miles away. Potential reasons for the Dall’s movement include the pursuit of prey, the presence of harassing resident orca or predatory transient orca, vessel disturbance from one of many whale watch vessels, or multiple other unknowable reasons including the use of sonar by USS SHOUP. In short, there was nothing unusual in the observed behavior of the Dall’s porpoise on 5 May 2003 and no way to assess if the otherwise normal behavior was in reaction to the use of sonar by USS SHOUP, any other potential causal factor, or a combination of factors.

Orca: Observer opinions regarding orca J-Pod behaviors on 5 May 2003 were inconsistent, ranging from the orca being “at ease with the sound” or “resting” to their being “annoyed.” One witness reported observing “low rates of surface active behavior” on behalf of the orca J-Pod, which is in conflict with that of another observer who reported variable surface activity, tail slapping and spyhopping. Witnesses also expressed the opinion that the behaviors displayed by the orca on 5 May 2003 were “extremely unusual,” although those same behaviors are observed and reported regularly on the Orca Network Website, are behaviors listed in general references as being part of the normal repertoire of orca behaviors. Given the contradictory nature of the reports on the observed behavior of the J-Pod orca, it is impossible to determine if any unusual behaviors were present. In short, there is no way to assess if any unusual behaviors were present or if present they were in reaction to vessel disturbance from one of many nearby whale watch vessels, use of sonar by USS SHOUP, any other potential causal factor, or a combination of factors.

Minke whale: A minke whale was reported porpoising in Haro Strait on 5 May 2003, which is a rarely observed behavior. The cause of this behavior is indeterminate given multiple potential causal factors including but not limited to the presence of predatory Transient orca, possible interaction with whale watch boats, other vessels, or SHOUP’s use of sonar. The behavior of the minke whale was the only unusual behavior clearly present on 5 May 2003, however, no way to given the existing information if the unusual behavior observed was in reaction to the use of sonar by USS SHOUP, any other potential causal factor, or a combination of factors.

2004 Hawai'i Melon-Headed Whale Mass Stranding (July 3-4 2004)

Description: The majority of the following information is taken from the NMFS report on the stranding event (Southall et al. 2006) but is inclusive of additional and new information not presented in the NMFS report. On the morning of July 3, 2004, between 150-200 melon-headed whales (*Peponocephala electra*) entered Hanalei Bay, Kauai. Individuals attending a canoe blessing ceremony observed the animals entering the bay at approximately 7:00 a.m. The whales were reported entering the bay in a "wave as if they were chasing fish" (Braun 2006). At 6:45 a.m. on July 3, 2004, approximately 25 nm north of Hanalei Bay, active sonar was tested briefly prior to the start of an anti-submarine warfare exercise.

The whales stopped in the southwest portion of the bay, grouping tightly, and displayed spy-hopping and tail-slapping behavior. As people went into the water among the whales, the pod separated into as many as four groups, with individual animals moving among the clusters. This continued through most of the day, with the animals slowly moving south and then southeast within the bay. By about 3 p.m., police arrived and kept people from interacting with the animals. The Navy believes that the abnormal behavior by the whales during this time is likely the result of people and boats in the water with the whales rather than the result of sonar activities taking place 25 or more miles off the coast. At 4:45 p.m. on July 3, 2004, the RIMPAC Battle Watch Captain received a call from a National Marine Fisheries representative in Honolulu, Hawaii, reporting the sighting of as many as 200 melon-headed whales in Hanalei Bay. At 4:47 p.m. the Battle Watch Captain directed all ships in the area to cease active sonar transmissions.

At 7:20 p.m. on July 3, 2004, the whales were observed in a tight single pod 75 yards from the southeast side of the bay. The pod was circling in a group and displayed frequent tail slapping and whistle vocalizations and some spy hopping. No predators were observed in the bay and no animals were reported as having fresh injuries. The pod stayed in the bay through the night of July 3, 2004. On the morning of July 4, 2004, the whales were observed to still be in the bay and collected in a tight group. A decision was made at that time to attempt to herd the animals out of the bay. A 700-to-800-foot rope was constructed by weaving together beach morning glory vines. This vine rope was tied between two canoes and with the assistance of 30 to 40 kayaks, was used to herd the animals out of the bay. By approximately 11:30 a.m. on July 4, 2004, the pod was coaxed out of the bay.

A single neonate melon-headed whale was observed in the bay on the afternoon of July 4, after the whale pod had left the bay. The following morning on July 5, 2004, the neonate was found stranded on Lumahai Beach. It was pushed back into the water but was found stranded dead between 9 and 10 a.m. near the Hanalei pier. NMFS collected the carcass and had it shipped to California for necropsy, tissue collection, and diagnostic imaging.

Following the stranding event, NMFS undertook an investigation of possible causative factors of the stranding. This analysis included available information on environmental factors, biological factors, and an analysis of the potential for sonar involvement. The latter analysis included vessels that utilized mid-frequency active sonar on the afternoon and evening of July 2. These vessels were to the southeast of Kauai, on the opposite side of the island from Hanalei Bay.

Findings: NMFS concluded from the acoustic analysis that the melon-headed whales would have had to have been on the southeast side of Kauai on July 2 to have been exposed to sonar from naval vessels on that day (Southall et al. 2006). There was no indication whether the animals were in that region or whether they were elsewhere on July 2. NMFS concluded that the animals would have had to swim from 1.4-4.0 m/s for 6.5 to 17.5 hours after sonar transmissions ceased to reach Hanalei Bay by 7:00 a.m. on July 3. Sound transmissions by ships to the north of Hanalei Bay on July 3 were produced as part of exercises between 6:45 a.m. and 4:47 p.m.

Propagation analysis conducted by the 3rd Fleet estimated that the level of sound from these transmissions at the mouth of Hanalei Bay could have ranged from 138-149 dB re: 1 μPa.

NMFS was unable to determine any environmental factors (e.g., harmful algal blooms, weather conditions) that may have contributed to the stranding. However, additional analysis by Navy investigators found that a full moon occurred the evening before the stranding and was coupled with a squid run (Mobley 2007). One of the first observations of the whales entering the bay reported the pod came into the bay in a line "as if chasing fish" (Braun, 2005). . In addition, a group of 500-700 melon-headed whales were observed to come close to shore and interact with humans in Sasanhaya Bay, Rota, on the same morning as the whales entered Hanalei Bay (Jefferson et al. 2006). Previous records further indicated that, though the entrance of melon-headed whales into the shallows is rare, it is not unprecedented. A pod of melon-headed whales entered Hilo Bay in the 1870s in a manner similar to that which occurred at Hanalei Bay in 2004.

The necropsy of the melon-headed whale calf suggested that the animal died from a lack of nutrition, possibly following separation from its mother. The calf was estimated to be approximately one week old. Although the calf appeared not to have eaten for some time, it was not possible to determine whether the calf had ever nursed after it was born. The calf showed no signs of blunt trauma or viral disease and had no indications of acoustic injury.

Conclusions: Although it is not impossible, it is unlikely that the sound level from the sonar caused the melon-headed whales to enter Hanalei Bay. This conclusion is based on a number of factors:

1. The speculation that the whales may have been exposed to sonar the day before and then fled to the Hanalei Bay is not supported by reasonable expectation of animal behavior and swim speeds. The flight response of the animals would have had to persist for many hours following the cessation of sonar transmissions. Such responses have not been observed in marine mammals and no documentation of such persistent flight response after the cessation of a frightening stimulus has been observed in other mammals. The swim speeds, though feasible for the species, are highly unlikely to be maintained for the durations proposed, particularly since the pod was a mixed group containing both adults and neonates. Whereas adults may maintain a swim speed of 4.0 m/s for some time, it is improbable that a neonate could achieve the same for a period of many hours.

2. The area between the islands of Oahu and Kauai and the PMRF training range have been used in RIMPAC exercises for more than 20 years, and are used year-round for ASW training using mid frequency active sonar. Melon-headed whales inhabiting the waters around Kauai are likely not naive to the sound of sonar and there has never been another stranding event associated in time with ASW training at Kauai or in the Hawaiian Islands. Similarly, the waters surrounding Hawaii contain an abundance of marine mammals, many of which would have been exposed to the same sonar operations that were speculated to have affected the melon-headed whales. No other strandings were reported coincident with the RIMPAC exercises. This leaves it uncertain as to why melon-headed whales, and no other species of marine mammal, would respond to the sonar exposure by stranding.

3. At the nominal swim speed for melon-headed whales, the whales had to be within 1.5 to 2 nm of Hanalei Bay before sonar was activated on July 3. The whales were not in their open ocean habitat but had to be close to shore at 6:45 a.m. when the sonar was activated to have been observed inside Hanalei Bay from the beach by 7:00 a.m (Hanalei Bay is very large area). This observation suggests that other potential factors could be causative of the stranding event (see below).

4. The simultaneous movement of 500-700 melon-headed whales and Risso's dolphins into Sasanhaya Bay, Rota, in the Northern Marianas Islands on the same morning as the 2004 Hanalei stranding (Jefferson et al. 2006) suggests that there may be a common factor which prompted the melon-headed whales to approach the shoreline. A full moon occurred the evening before the stranding and a run of squid was reported concomitant with the lunar activity (Mobley et al. 2007). Thus, it is possible that the melon-headed whales were capitalizing on a lunar event that provided an opportunity for relatively easy prey capture (Mobley et al. 2007). A report of a pod entering Hilo Bay in the 1870s indicates that on at least one other occasion, melon-headed whales entered a bay in a manner similar to the occurrence at Hanalei Bay in July 2004. Thus, although melon-headed whales entering shallow embayments may be an infrequent event, and every such event might be considered anomalous, there is precedent for the occurrence.

5. The received noise sound levels at the bay were estimated to range from roughly 95 – 149 dB re: 1 μPa. Received levels as a function of time of day have not been reported, so it is not possible to determine when the presumed highest levels would have occurred and for how long. However, received levels in the upper range would have been audible by human participants in the bay. The statement by one interviewee that he heard "pings" that lasted an hour and that they were loud enough to hurt his ears is unreliable. Received levels necessary to cause pain over the duration stated would have been observed by most individuals in the water with the animals. No other such reports were obtained from people interacting with the animals in the water.

Although NMFS concluded that sonar use was a "plausible, if not likely, contributing factor in what may have been a confluence of events (Southall et al. 2006)," this conclusion was based primarily on the basis that there was an absence of any other compelling explanation. The authors of the NMFS report on the incident were unaware, at the time of publication, of the simultaneous event in Rota. In light of the simultaneous Rota event, the Hanalei stranding does not appear as anomalous as initially presented and the speculation that sonar was a causative factor is weakened. The Hanalei Bay incident does not share the characteristics observed with other mass strandings of whales coincident with sonar activity (e.g., specific traumas, species composition, etc.). In addition, the inability to conclusively link or exclude the impact of other environmental factors makes a causal link between sonar and the melon-headed whale strandings highly speculative at best.

1980- 2004 Beaked Whale Strandings in Japan (Brownell et al. 2004)

Description: Brownell et al. (2004) compare the historical occurrence of beaked whale strandings in Japan (where there are U.S. Naval bases), with strandings in New Zealand (which lacks a U.S. Naval base) and concluded the higher number of strandings in Japan may be related to the presence of the US. Navy vessels using mid-frequency sonar. While the dates for the strandings were well documented, the authors of the study did not attempt to correlate the dates of any navy activities or exercises with the dates of the strandings.

To fully investigate the allegation made by Brownell et al. (2004), the Center for Naval Analysis (CNA) in an internal Navy report, looked at the past U.S. Naval exercise schedules from 1980 to 2004 for the water around Japan in comparison to the dates for the strandings provided by Brownell et al. (2004). None of the strandings occurred during or soon (within weeks) after any U.S. Navy exercises. While the CNA analysis began by investigating the probabilistic nature of any co-occurrences, the strandings and sonar use were not correlated by time. Given there there there was no instance of co-occurrence in over 20 years of stranding data, it can be reasonably postulated that sonar use in Japan waters by U.S. Navy vessels did not lead to any of the strandings documented by Brownell et al. (2004).

2004 Alaska Beaked Whale Strandings (7-16 June 2004)

Description: In the timeframe between 17 June and 19 July 2004, five beaked whales were discovered at various locations along 1,600 miles of the Alaskan coastline and one was found floating (dead) at sea. Because the Navy exercise Alaska Shield/Northern Edge 2004 occurred within the approximate timeframe of these strandings, it has been alleged that sonar may have been the probable cause of these strandings.

The Alaska Shield/Northern Edge 2004 exercise consisted of a vessel tracking event followed by a vessel boarding search and seizure event. There was no ASW component to the exercise, no use of mid-frequency sonar, and no use of explosives in the water. There were no events in the Alaska Shield/Northern Edge exercise that could have caused in any of the strandings over this 33 day period covering 1,600 miles of coastline.

2005 North Carolina Marine Mammal Mass Stranding Event (January 15-16, 2005)

Description: On January 15 and 16, 2005, 36 marine mammals consisting of 33 short-finned pilot whales, 1 minke whale, and 2 dwarf sperm whales stranded alive on the beaches of North Carolina (Hohn et al., 2006a). The animals were scattered across a 111-km area from Cape Hatteras northward. Because of the live stranding of multiple species, the event was classified as a UME. It is the only stranding on record for the region in which multiple offshore species were observed to strand within a two- to three-day period

The U.S. Navy indicated that from January 12-14 some unit level training with mid-frequency active sonar was conducted by vessels that were 93 to 185 km from Oregon Inlet. An expeditionary strike group was also conducting exercises to the southeast, but the closest point of active sonar transmission to the inlet was 650 km away. The unit level operations were not unusual for the area or time of year and the vessels were not involved in antisubmarine warfare exercises. Marine mammal observers on board the vessels did not detect any marine mammals during the period of unit level training. No sonar transmissions were made on January 15-16.

The National Weather Service reported that a severe weather event moved through North Carolina on January 13 and 14. The event was caused by an intense cold front that moved into an unusually warm and moist air mass that had been persisting across the eastern United States for about a week. The weather caused flooding in the western part of the state, considerable wind damage in central regions of the state, and at least three tornadoes that were reported in the north central part of the state. Severe, sustained (one to four days) winter storms are common for this region.

Over a two-day period (January 16-17), two dwarf sperm whales, 27 pilot whales, and the minke whale were necropsied and tissue samples collected. Twenty-five of the stranded cetacean heads were examined; two pilot whale heads and the heads of the dwarf sperm whales were analyzed by CT.

Findings: The pilot whales and dwarf sperm whale were not emaciated, but the minke whale, which was believed to be a dependent calf, was emaciated. Many of the animals were on the beach for an extended period of time prior to necropsy and sampling, and many of the biochemical abnormalities noted in the animals were suspected of being related to the stranding and prolonged time on land. Lesions were observed in all of the organs, but there was no consistency across species. Musculoskeletal disease was observed in two pilot whales and cardiovascular disease was observed in one dwarf sperm whale and one pilot whale. Parasites were a common finding in the pilot whales and dwarf sperm whales but were considered consistent with the expected parasite load for wild odontocetes. None of the animals exhibited traumas similar to those observed in prior stranding events associated with mid-frequency sonar activity. Specifically, there was an absence of auditory system trauma and no evidence of distributed and widespread bubble lesions or fat emboli, as was previously observed (Fernández et al., 2005).

Sonar transmissions prior to the strandings were limited in nature and did not share the concentration identified in previous events associated with mid-frequency active sonar use (Evans and England, 2001). The operational/environmental conditions were also dissimilar (e.g., no constrictive channel and a limited number of ships and sonar transmissions). NMFS noted that environmental conditions were favorable for a shift from up-welling to down-welling conditions, which could have contributed to the event. However, other severe storm conditions existed in the days surrounding the strandings and the impact of these weather conditions on at-sea conditions is unknown. No harmful algal blooms were noted along the coastline.

Conclusions: All of the species involved in this stranding event are known to occasionally strand in this region. Although the cause of the stranding could not be determined, several whales had preexisting conditions that could have contributed to the stranding. Cause of death for many of the whales was likely due to the physiological stresses associated with being stranded. A consistent suite of injuries across species, which was consistent with prior strandings where sonar exposure is expected to be a causative mechanism, was not observed.

NMFS was unable to determine any causative role that sonar may have played in the stranding event. The acoustic modeling performed, as in the Hanalei Bay incident, was hampered by uncertainty regarding the location of the animals at the time of sonar transmissions. However, as in the Hanalei Bay incident, the response of the animals following the cessation of transmissions would imply a flight response that persisted for many hours after the sound source was no longer operational. In contrast, the presence of a severe weather event passing through North Carolina during January 13 and 14 is a possible, if not likely, contributing factor to the North Carolina UME of January 15. Hurricanes may have been responsible for mass strandings of pygmy killer whales in the British Virgin Islands and Gervais' beaked whales in North Carolina (Mignucci-Giannoni et al. 2000; Norman and Mead 2001).

2.4.3.3 Causal Associations for Stranding Events

Several stranding events have been associated with Navy sonar activities but relatively few of the total stranding events that have been recorded occurred spatially or temporally with Navy sonar activities. While sonar may be a contributing factor under certain rare conditions, the presence of sonar it is not a necessary condition for stranding events to occur.

A review of past stranding events associated with sonar suggest that the potential factors that may contribute to a stranding event are steep bathymetry changes, narrow channels, multiple sonar ships, surface ducting and the presence of beaked whales that may be more susceptible to sonar exposures. The most important factors appear to be the presence of a narrow channel (e.g. Bahamas and Madeira Island, Portugal) that may prevent animals from avoiding sonar exposure and multiple sonar ships within that channel. There are no narrow channels (less than 35 nm wide and 10 nm in length) in the SOCAL Range Complex and the ships would be spread out over a wider area allowing animals to move away from sonar activities if they choose. In addition, beaked whales may not be more susceptible to sonar but may favor habitats that are more conducive to sonar effects.

There have been no mass strandings in Southern California waters are attributed to Navy sonar. Given the large military presence and private and commercial vessel traffic in the Southern California waters, it is likely that a mass stranding event would be detected. Therefore, it is unlikely that the conditions that may have contributed to past stranding events involving Navy sonar would be present in the SOCAL Range Complex.

2.4.3.4 California Stranding Patterns

While major range events undergo name changes over the years, the equivalent of COMPTUEX and JTFEX have been conducted in Southern California, specifically SCIRC, since 1934. Sonar training activities have been conducted since World War II, and sonar systems assessed in the COMPTUEX/JTFEX EA/OEA (U.S. Navy 2006a) have been used since the 1970's (J. Marshall U.S. Navy, pers. comm.). Between 1982-2005, eight blue whales, 14 fin whales, seven humpback whales, two sperm whales, zero sei whales, and 12 Guadalupe fur seals (California Marine Mammal Stranding Network Database 2006), were reported as stranded in California. Known strandings also occurred in all months with no significant temporal trend (California Marine Mammal Stranding Network Database 2006). Beaked whales have also stranded in Southern California, however they were not considered mass stranding events nor were they correlated with sonar. Eleven beaked whales stranded between 1982-2005 from San Diego to Santa Barbara County [specifically, Blainville's, Hubb's (*M. carhubbsi*), Cuvier's, and Stejneger's (*M. stejnegeri*)] (California Marine Mammal Stranding Network Database 2006).

2.4.4 Stranding Section Conclusions

Marine mammal strandings have been a historic and ongoing occurrence attributed to a variety of causes. Over the last fifty years, increased awareness and reporting has lead to more information about species effected and raised concerns about anthropogenic sources of stranding. While there has been some marine mammal mortalities potentially associated with mid-frequency sonar effects to a small number of species (primarily limited numbers of certain species of beaked whales), the significance and actual causative reason for any impacts is still subject to continued investigation.

By comparison and as described previously, potential impacts to all species of cetaceans worldwide from fishery related mortality can be orders of magnitude more significant (100,000s of animals vice 10s of animals) (Culik, 2002; ICES, 2005b; Read et al., 2006). This does not negate the influence of any mortality or additional stressor to small, regionalized sub-populations which may be at greater risk from human related mortalities (fishing, vessel strike, sound) than populations with larger oceanic level distribution or migrations. ICES (2005a) noted, however, that taken in context of marine mammal populations in general, sonar is not major threat, or significant portion of the overall ocean noise budget.

In conclusion, a constructive framework and continued research based on sound scientific principles is needed in order to avoid speculation as to stranding causes, and to further our understanding of potential effects or lack of effects from military mid-frequency sonar (Bradshaw et al., 2005; ICES 2005b; Barlow and Gisiner, 2006; Cox et al. 2006).

3 ASSESSING ENVIRONMENTAL CONSEQUENCES

When analyzing the results of the sonar and underwater detonation exposure modeling to provide an estimate of effects, it is important to understand that there are limitations to the ecological data used in the model, and that the model results must be interpreted within the context of a given species' ecology.

3.1 ANALYTICAL FRAMEWORK FOR ASSESSING MARINE MAMMAL RESPONSE TO ACTIVE SONAR

As summarized by the National Academies of Science (NAS), the possibility that human-generated sound could harm marine mammals or significantly interfere with their "normal" activities is an issue of increasing concern (National Research Council [NRC] 2005). This section of the appendix for the EIS/OEIS evaluates the potential for the specific Navy acoustic sources used in the SOCAL Range Complex to result in harassment of marine mammals.

Marine mammals respond to various types of man-made sounds introduced in the ocean environment. Responses are typically subtle and can include shorter surfacings, shorter dives, fewer blows per surfacing, longer intervals between blows (breaths), ceasing or increasing vocalizations, shortening or lengthening vocalizations, and changing frequency or intensity of vocalizations (NRC 2005). However, it is not known how these responses relate to significant effects (e.g., long-term effects or population consequences) (NRC 2005). Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sound, 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 (NAS 2003; NRC 2005), there are many unknowns in assessing the effects and significance of marine mammals responses to sound exposures. For this reason, the Navy enlisted the expertise of National Marine Fisheries Service (NMFS) as the cooperating agency. Their input assisted the Navy in developing a conceptual analytical framework for evaluating what sound levels marine mammals might receive as a result of Navy training actions in SOCAL Range Complex, whether marine mammals might respond to these exposures, and whether that response might have a mode of action on the biology or ecology of marine mammals such that the response should be considered a potential harassment. From this framework of evaluating the potential for harassment incidents to occur, an assessment of whether acoustic sources might impact populations, stocks or species of marine mammals can be conducted.

The conceptual analytical framework (Figure 3-1) presents an overview of how the mid-frequency active sonar sources used during training are assessed to evaluate the potential for marine mammals to be exposed to an acoustic source, the potential for that exposure to result in a physiological effect or behavioral response by an animal, and the assessment of whether that response may result in a consequence that constitutes harassment in accordance with MMPA definitions.

The first step in the conceptual model is to estimate the potential for marine mammals to be exposed to a Navy acoustic source. Three questions are answered in this "acoustic modeling" step:

1. What action will occur? This requires identification of all acoustic sources that would be used in the exercises and the specific outputs of those sources. This information is provided in Chapter 3.

2. Where and when will the action occur? The place and season of the action are important to determine which marine mammal species are likely to be present. Species occurrence and

density data (Section 2.1 and 2.2 are used to determine the subset of marine mammals that may be present when an acoustic source is operational.

3. Predict the underwater acoustic environment that would be encountered. The acoustic environment here refers to environmental factors that influence the propagation of underwater sound. Acoustic parameters influenced by the place, season, and time are described in Section 4.2.

4. How many marine mammals are predicted to be exposed to sound from the acoustic sources? Sound propagation models are used to predict the received exposure level from an acoustic source, and these are coupled with species distribution and density data to estimate the accumulated received energy and maximum sound pressure level that might be received at a level that could be considered as potential harassment. Section 4 describes the acoustic modeling and Section 6.3 present the number of exposure incidents predicted by the modeling.

The next steps in the analytical framework evaluate whether the sound exposures predicted by the acoustic model might cause a response in a marine mammal, and if that response might be considered harassment of the animal. Harassment includes the concepts of potential injury (Level A Harassment) and behavioral disturbance (Level B harassment). The response assessment portion of the analytical framework examines the following question:

1. Which potential acoustic exposures might result in harassment of marine mammals?

The predicted acoustic exposures are first considered within the context of the species biology (e.g., can a marine mammal detect the sound, and is that mammal likely to respond to that sound?). Next, if a response is predicted, is that response potentially 'harassment' in accordance with MMPA harassment definitions? For example, if a response to the acoustic exposure has a mode of action that results in a consequence for an individual, such as interruption of feeding, that response or repeated occurrence of that response could be considered "abandonment or significant alteration of natural behavioral patterns," and therefore the exposure(s) would cause Level B harassment.

The following flow chart (Figure 3-1) is a representation of the general analytical framework utilized in applying the specific thresholds discussed in this section. The framework presented in the flow chart is organized from left to right and is compartmentalized according to the phenomena that occur within each. These include the physics of sound propagation (Physics), the potential physiological processes associated with sound exposure (Physiology), the potential behavioral processes that might be affected as a function of sound exposure (Behavior), and the immediate effects these changes may have on functions the animal is engaged in at the time of exposure (Life Function – Proximate). These compartmentalized effects are extended to longer term life functions (Life Function – Ultimate) and into population and species effects. Throughout the flow chart, dotted and solid lines are used to connect related events. Solid lines designate those effects that "will" happen; dotted lines designate those that "might" happen but must be considered (including those hypothesized to occur but for which there is no direct evidence).

Section 3.2 reviews the regulatory framework and premises for the Navy/NMFS marine mammal response analytical framework. Section 3.3 present the analysis by species/stock, presenting relevant information about the species biology and ecology to provide a context for assessing whether modeled exposures might result in incidental harassment. The potential for harassment incidents is then considered within the context of the affected marine mammal population, stock or species to assess potential population viability. Particular focus on recruitment and survival are provided to analyze whether the effects of the action can be considered to have negligible impact on species or stocks.

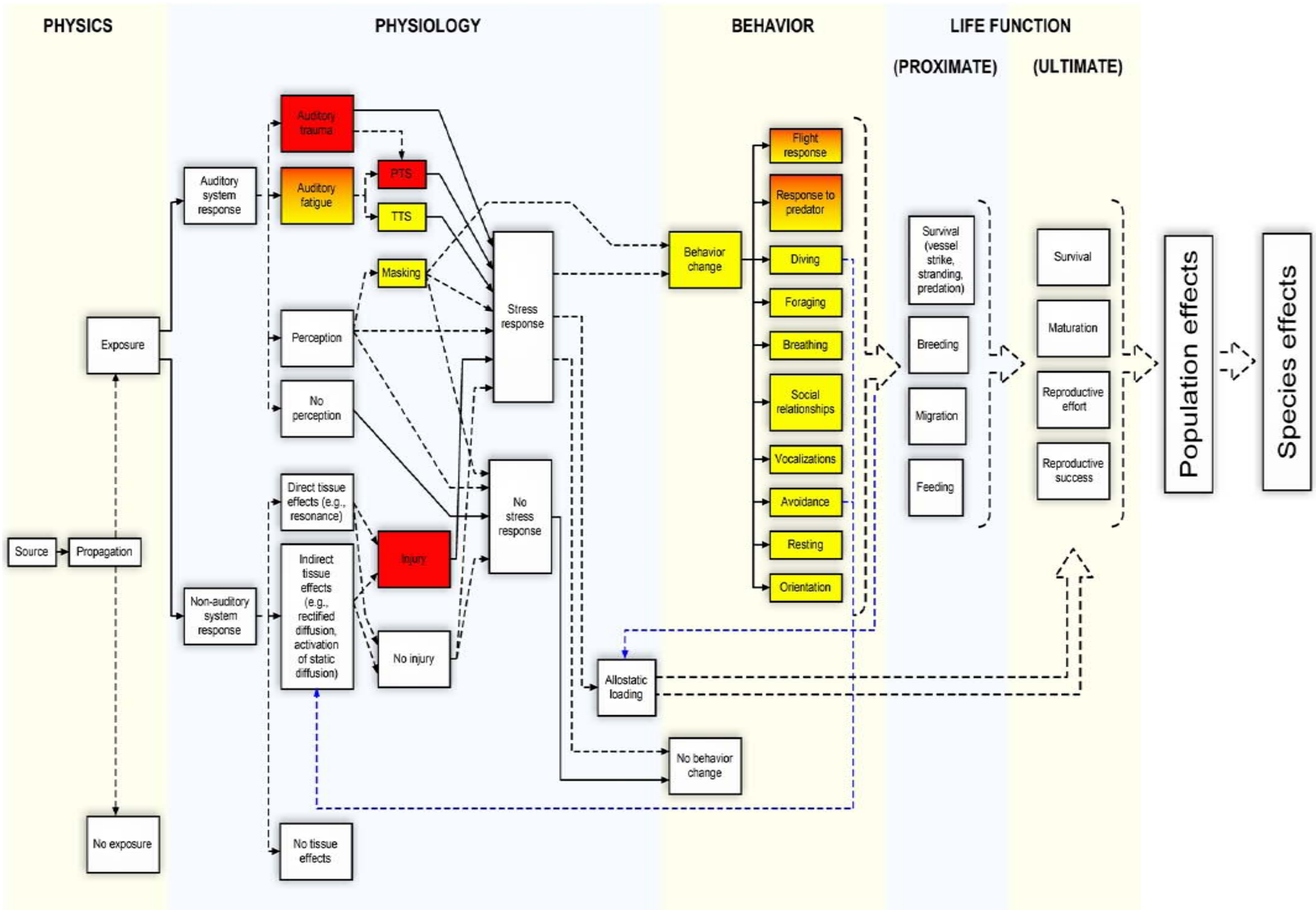


Figure 3-1. Conceptual model for assessing the effects of mid-frequency sonar exposures on marine mammals.

This page intentionally left blank

Some boxes contained within the flow chart are colored according to how they relate to the definitions of harassment under the Marine Mammal Protection Act (MMPA). Red boxes correspond to events that are injurious. By prior ruling and usage, these events would be considered as Level A harassment under the MMPA. Yellow boxes correspond to events that have the potential to qualify as Level B harassment under the MMPA. Based on prior ruling, the specific instance of TTS is considered as Level B harassment. Boxes that are shaded from red to yellow have the potential for injury and behavioral disturbance. The analytical framework outlined within the flow chart acknowledges that physiological responses must always precede behavioral responses (i.e., there can be no behavioral response without first some physiological effect of the sound) and an organization where each functional block only occurs once and all relevant inputs/outputs flow to/from a single instance.

Physiology

Potential impacts to the auditory system are assessed by considering the characteristics of the received sound (e.g., amplitude, frequency, duration) and the sensitivity of the exposed animals. Some of these assessments can be numerically based (e.g., TTS, permanent threshold shift [PTS], perception). Others will be necessarily qualitative, due to lack of information, or will need to be extrapolated from other species for which information exists. Potential physiological responses to the sound exposure are ranked in descending order, with the most severe impact (auditory trauma) occurring at the top and the least severe impact occurring at the bottom (the sound is not perceived).

1. Auditory trauma represents direct mechanical injury to hearing related structures, including tympanic membrane rupture, disarticulation of the middle ear ossicles, and trauma to the inner ear structures such as the organ of Corti and the associated hair cells. Auditory trauma is always injurious but could be temporary and not result in PTS. Auditory trauma is always assumed to result in a stress response.

2. Auditory fatigue refers to a loss of hearing sensitivity after sound stimulation. The loss of sensitivity persists after, sometimes long after, the cessation of the sound. The mechanisms responsible for auditory fatigue differ from auditory trauma and would primarily consist of metabolic exhaustion of the hair cells and cochlear tissues. The features of the exposure (e.g., amplitude, frequency, duration, temporal pattern) and the individual animal’s susceptibility would determine the severity of fatigue and whether the effects were temporary (TTS) or permanent (PTS). Auditory fatigue (PTS or TTS) is always assumed to result in a stress response.

3. Sounds with sufficient amplitude and duration to be detected among the background ambient noise are considered to be perceived. This category includes sounds from the threshold of audibility through the normal dynamic range of hearing (i.e., not capable of producing fatigue). To determine whether an animal perceives the sound, the received level, frequency, and duration of the sound are compared to what is known of the species’ hearing sensitivity.

Since audible sounds may interfere with an animal’s ability to detect other sounds at the same time, perceived sounds have the potential to result in auditory masking. Unlike auditory fatigue, which always results in a stress response because the sensory tissues are being stimulated beyond their normal physiological range, masking may or may not result in a stress response, depending on the degree and duration of the masking effect. Masking may also result in a unique circumstance where an animal’s ability to detect other sounds is compromised without the animal’s knowledge. This could conceivably result in sensory impairment and subsequent behavior change; in this case, the change in behavior is the *lack of a response* that would normally be made if sensory impairment did not occur. For this reason, masking also may lead directly to behavior change without first causing a stress response.

The features of perceived sound (e.g., amplitude, duration, temporal pattern) are also used to judge whether the sound exposure is capable of producing a stress response. Factors to consider in this decision include the probability of the animal being naïve or experienced with the sound (i.e., what are the known/unknown consequences of the exposure).

The received level is not of sufficient amplitude, frequency, and duration to be perceptible by the animal. By extension, this does not result in a stress response (not perceived).

Potential impacts to tissues other than those related to the auditory system are assessed by considering the characteristics of the sound (e.g., amplitude, frequency, duration) and the known or estimated response characteristics of nonauditory tissues. Some of these assessments can be numerically based (e.g., exposure required for rectified diffusion). Others will be necessarily qualitative, due to lack of information. Each of the potential responses may or may not result in a stress response.

1. Direct tissue effects – Direct tissue responses to sound stimulation may range from tissue shearing (injury) to mechanical vibration with no resulting injury. Any tissue injury would produce a stress response, whereas noninjurious stimulation may or may not.

2. Indirect tissue effects – Based on the amplitude, frequency, and duration of the sound, it must be assessed whether exposure is sufficient to indirectly affect tissues. For example, the hypothesis that rectified diffusion occurs is based on the idea that bubbles that naturally exist in biological tissues can be stimulated to grow by an acoustic field. Under this hypothesis, one of three things could happen: (1) bubbles grow to the extent that tissue hemorrhage occurs (injury); (2) bubbles develop to the extent that a complement immune response is triggered or nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs (a stress response without injury); or (3) the bubbles are cleared by the lung without negative consequence to the animal. The probability of rectified diffusion, or any other indirect tissue effect, will necessarily be based on what is known about the specific process involved. No tissue effects – The received sound is insufficient to cause either direct mechanical) or indirect effects to tissues. No stress response occurs.

The Stress Response

The acoustic source is considered a potential stressor if, by its action on the animal, via auditory or nonauditory means, it may produce a stress response in the animal. The term “stress” has taken on an ambiguous meaning in the scientific literature, but with respect to Figure 3-1 and the later discussions of allostasis and allostatic loading, the stress response will refer to an increase in energetic expenditure that results from exposure to the stressor and which is predominantly characterized by either the stimulation of the sympathetic nervous system (SNS) or the hypothalamic-pituitary-adrenal (HPA) axis (Reeder and Kramer 2005). The SNS response to a stressor is immediate and acute and is characterized by the release of the catecholamine neurohormones norepinephrine and epinephrine (i.e., adrenaline). These hormones produce elevations in the heart and respiration rate, increase awareness, and increase the availability of glucose and lipids for energy. The HPA response is ultimately defined by increases in the secretion of the glucocorticoid steroid hormones, predominantly cortisol in mammals. The amount of increase in circulating glucocorticoids above baseline may be an indicator of the overall severity of a stress response (Hennessy et al. 1979). Each component of the stress response is variable in time; e.g., adrenalines are released nearly immediately and are used or cleared by the system quickly, whereas cortisol levels may take long periods of time to return to baseline.

The presence and magnitude of a stress response in an animal depends on a number of factors. These include the animal’s life history stage (e.g., neonate, juvenile, adult), the environmental conditions, reproductive or developmental state, and experience with the stressor. Not only will these factors be subject to individual variation, but they will also vary within an individual over time. In considering potential stress responses of marine mammals to acoustic stressors, each of these should be considered. For example, is the acoustic stressor in an area where animals engage in breeding activity? Are animals in the region resident and likely to have experience with the stressor (i.e., repeated exposures)? Is the region a foraging ground or are the animals passing through as transients? What is the ratio of young (naïve) to old (experienced) animals in the population? It is unlikely that all such questions can be answered from empirical data; however, they should be addressed in any qualitative assessment of a potential stress response as based on the available literature.

The stress response may or may not result in a behavioral change**,** depending on the characteristics of the exposed animal. However, provided a stress response occurs, we assume that some contribution is made to the animal's allostatic load. Allostasis is the ability of an animal to maintain stability through change by adjusting its physiology in response to both predictable and unpredictable events (McEwen and Wingfield 2003). The same hormones associated with the stress response vary naturally throughout an animal's life, providing support for particular life history events (e.g., pregnancy) and predictable environmental conditions (e.g., seasonal changes). The allostatic load is the cumulative cost of allostasis incurred by an animal and is generally characterized with respect to an animal's energetic expenditure. Perturbations to an animal that may occur with the presence of a stressor, either biological (e.g., predator) or anthropogenic (e.g., construction), can contribute to the allostatic load (Wingfield, 2003). Additional costs are cumulative and additions to the allostatic load over time may contribute to reductions in the probability of achieving ultimate life history functions (e.g., survival, maturation, reproductive effort and success) by producing pathophysiological states. The contribution to the allostatic load from a stressor requires estimating the magnitude and duration of the stress response, as well as any secondary contributions that might result from a change in behavior.

If the acoustic source does not produce tissue effects, is not perceived by the animal, or does not produce a stress response by any other means, Figure 3-1 assumes that the exposure does not contribute to the allostatic load. Additionally, without a stress response or auditory masking, it is assumed that there can be no behavioral change. Conversely, any immediate effect of exposure that produces an injury (i.e., red boxes on the flow chart in Figure 3-1) is assumed to also produce a stress response and contribute to the allostatic load.

Behavior

Acute stress responses may or may not cause a behavioral reaction. However, all changes in behavior are expected to result from an acute stress response. This expectation is based on the idea that some sort of physiological trigger must exist to change any behavior that is already being performed. The exception to this rule is the case of masking. The presence of a masking sound may not produce a stress response, but may interfere with the animal's ability to detect and discriminate biologically relevant signals. The inability to detect and discriminate biologically relevant signals hinders the potential for normal behavioral responses to auditory cues and is thus considered a behavioral change.

Numerous behavioral changes can occur as a result of stress response, and Figure 3-1 lists only those that might be considered the most common types of response for a marine animal. For each potential behavioral change, the magnitude in the change and the severity of the response needs to be estimated. Certain conditions, such as stampeding (i.e., flight response) or a response to a predator, might have a probability of resulting in injury. For example, a flight response, if significant enough, could produce a stranding event. Under the MMPA, such an event would be considered a Level A harassment. Each altered behavior may also have the potential to disrupt biologically significant events (e.g., breeding or nursing) and may need to be qualified as Level B harassment. All behavioral disruptions have the potential to contribute to the allostatic load. This secondary potential is signified by the feedback from the collective behaviors to allostatic loading.

Special considerations are given to the potential for avoidance and disrupted diving patterns. Due to past incidents of beaked whale strandings associated with sonar operations, feedback paths are provided between avoidance and diving and indirect tissue effects. This feedback accounts for the hypothesis that variations in diving behavior and/or avoidance responses can possibly result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular bubble formation. Although hypothetical in nature, the potential process is currently popular and hotly debated.

Life Function

Proximate Life Functions

Proximate life history functions are the functions that the animal is engaged in at the time of acoustic exposure. The disruption of these functions, and the magnitude of the disruption, is something that must be considered in determining how the ultimate life history functions are affected. Consideration of the magnitude of the effect to each of the proximate life history functions is dependent upon the life stage of the animal. For example, an animal on a breeding ground which is sexually immature will suffer relatively little consequence to disruption ofbreeding behavior when compared to an actively displaying adult of prime reproductive age.

Ultimate Life Functions

The ultimate life functions are those that enable an animal to contribute to the population (or stock, or species, etc.). The impact to ultimate life functions will depend on the nature and magnitude of the perturbation to proximate life history functions. Depending on the severity of the response to the stressor, acute perturbations may have nominal to profound impacts on ultimate life functions. For example, unit-level use of sonar by a vessel transiting through an area that is utilized for foraging, but not for breeding, may disrupt feeding by exposed animals for a brief period of time. Because of the brevity of the perturbation, the impact to ultimate life functions may be negligible. By contrast, weekly training over a period of years may have a more substantial impact because the stressor is chronic. Assessment of the magnitude of the stress response from the chronic perturbation would require an understanding of how and whether animals acclimate to a specific, repeated stressor and whether chronic elevations in the stress response (e.g., cortisol levels) produce fitness deficits.

The proximate life functions are loosely ordered in decreasing severity of impact. Mortality (survival) has an immediate effect, in that no future reproductive success is feasible and there is no further addition to the population resulting from reproduction. Severe injuries may also lead to reduced survivorship (longevity) and prolonged alterations in behavior. The latter may further affect an animal’s overall reproductive success and reproductive effort. Disruptions of breeding have an immediate impact on reproductive effort and may impact reproductive success. The magnitude of the effect will depend on the duration of the disruption and the type of behavior change that was provoked. Disruptions to feeding and migration can affect all of the ultimate life functions; however, the impacts to reproductive effort and success are not likely to be as severe or immediate as those incurred by mortality and breeding disruptions.

3.2 REGULATORY FRAMEWORK

The MMPA prohibits the unauthorized harassment of marine mammals, and provides the regulatory processes for authorization for any such harassment that might occur incidental to an otherwise lawful activity.

The model for estimating potential acoustic effects from SOCAL Range Complex anti-submarine warfare (ASW) training activities on cetacean species makes use of the methodology that was developed in cooperation with the National Oceanic and Atmospheric Administration (NOAA) for the Navy's Draft Overseas Environmental Impact Statement/Environmental Impact Statement, Undersea Warfare Training Range (OEIS/EIS) (DON, 2005). Via response comment letter to Undersea Warfare Training Range (USWTR) received from NMFS dated January 30, 2006, NMFS concurred with the use of Energy Flux Density Level (EL) for the determination of physiological effects to marine mammals. Therefore, this methodology is used to estimate the annual exposure of marine mammals that may be considered Level A harassment or Level B harassment as a result of temporary, recoverable physiological effects.

In addition, the approach for estimating potential acoustic effects from training activities on marine mammal makes use of the comments received on previous Navy NEPA documents. NMFS and others who commented recommended the use of an alternate methodology to evaluate when sound exposures might result in behavioral effects without corresponding physiological effects. As a result of these comments, this analysis uses a dose function approach to evaluate the potential for behavioral effects. The dose-function is further explained in Section 3.18.

A number of Navy actions and NOAA rulings have helped to qualify possible events deemed as "harassment" under the MMPA. As stated previously, "harassment" under the MMPA includes both potential injury (Level A), and disruptions of natural behavioral patterns to a point where they are abandoned or significantly altered (Level B). NMFS also includes mortality as a possible outcome to consider in addition to Level A and Level B harassment. The acoustic effects analysis and exposure calculations are based on the following premises:

- Harassment that may result from Navy operations described in the SOCAL Range Complex EIS/OEIS is unintentional and incidental to those operations.

- This SOCAL Range Complex EIS/OEIS request uses an unambiguous definition of injury as defined in the RIMPAC OEA (DON 2006) and in previous rulings (NOAA 2001; 2002a): injury occurs when any biological tissue is destroyed or lost as a result of the action.

- Behavioral disruption might result in subsequent injury and injury may cause a subsequent behavioral disruption, so Level A and Level B (defined below) harassment categories can overlap and are not necessarily mutually exclusive. However, consistant with prior ruling (NOAA 2001; 2006b), this SOCAL Range Complex EIS/OEIS request assumes that Level A and B do not overlap so as to preclude circular definitions of harassment.

- An individual animal predicted to experience simultaneous multiple injuries, multiple disruptions, or both, is counted as a single take (see NOAA 2001; 2006b). An animal whose behavior is disrupted by an injury has already been counted as a Level A harassment and will not also be counted as a Level B harassment. Based on the consideration of two different acoustic modeling methodologies to assess the potential for sound exposures that might result in behavioral disturbance, it is possible that an animal could simultaneously experience multiple disruptions (e.g., a temporary threshold shift and a resultant stress response), may be counted as multiple Level B harassment incidents (i.e., a potential overlap of 5 percent). Although this approach overestimates the potential for behavioral disturbance incidents, it is considered conservative because the actual incidents of disturbance are expected to be much lower.

- The acoustic effects analysis is based on primary exposures only. Secondary, or indirect, effects, such as susceptibility to predation following injury and injury resulting from disrupted behavior, while possible, can only be reliably predicted in circumstances where the responses have been well documented. Consideration of secondary effects would result in much Level A harassment being considered Level B harassment, and vice versa, since much injury (Level A harassment) has the potential to disrupt behavior (Level B harassment), and much temporary physiological or behavioral disruption (Level B) could be conjectured to have the potential for injury (Level A). Consideration of secondary effects would lead to circular definitions of harassment.

3.3 INTEGRATION OF REGULATORY AND BIOLOGICAL FRAMEWORKS

This section presents a biological framework within which potential effects can be categorized and then related to the existing regulatory framework of injury (Level A) and behavioral disruption (Level B). The information presented in Sections 3.4 and 3.5 is used to develop specific numerical exposure thresholds and dose function exposure estimations. Exposure thresholds are combined with sound propagation models and species distribution data to estimate the potential exposures, as presented in Section 4.2.3.

3.4 PHYSIOLOGICAL AND BEHAVIORAL EFFECTS

Sound exposure may affect multiple biological traits of a marine animal; however, the MMPA as amended directs which traits should be used when determining effects. Effects that address injury are considered Level A harassment under MMPA. Effects that address behavioral disruption are considered Level B harassment under MMPA.

The biological framework proposed here is structured according to potential physiological and behavioral effects resulting from sound exposure. The range of effects may then be assessed to determine which qualify as injury or behavioral disturbance under MMPA regulations Physiology and behavior are chosen over other biological traits because:

- They are consistent with regulatory statements defining harassment by injury and harassment by disturbance.
- They are components of other biological traits that may be relevant.
- They are a more sensitive and immediate indicator of effect.

For example, ecology is not used as the basis of the framework because the ecology of an animal is dependent on the interaction of an animal with the environment. The animal's interaction with the environment is driven both by its physiological function and its behavior, and an ecological impact may not be observable over short periods of observation. Ecological information is considered in the analysis of the effects of individual species (see Section 3.3 and 3.4).

A "physiological effect" is defined here as one in which the "normal" physiological function of the animal is altered in response to sound exposure. Physiological function is any of a collection of processes ranging from biochemical reactions to mechanical interaction and operation of organs and tissues within an animal. A physiological effect may range from the most significant of impacts (i.e., mortality and serious injury) to lesser effects that would define the lower end of the physiological impact range, such as the non-injurious distortion of auditory tissues. This latter physiological effect is important to the integration of the biological and regulatory frameworks and will receive additional attention in later sections.

A "behavioral effect" is one in which the "normal" behavior or patterns of behavior of an animal are overtly disrupted in response to an acoustic exposure. Examples of behaviors of concern can be derived from the harassment definitions in the MMPA and the ESA.

In this EIS/OEIS the term “normal” is used to qualify distinctions between physiological and behavioral effects. Its use follows the convention of normal daily variation in physiological and behavioral function without the influence of anthropogenic acoustic sources. As a result, this EIS/OEIS uses the following definitions:

- A physiological effect is a variation in an animal’s respiratory, endocrine, hormonal, circulatory, neurological, or reproductive activity and processes, beyond the animal’s normal range of variability, in response to human activity or to an exposure to a stimulus such as active sonar.

- A behavioral effect is a variation in the pattern of an animal’s breathing, feeding, resting, migratory, intraspecific behavior (such as reproduction, mating, territorial, rearing, and agonistic behavior), and interspecific beyond the animal’s normal pattern of variability in response to human activity or to an exposure to a stimulus such as active sonar.

The definitions of physiological effect and behavioral effect used within this document should not be confused with more global definitions applied to the field of biology or to existing Federal law. It is reasonable to expect some physiological effects to result in subsequent behavioral effects. For example, a marine mammal that suffers a severe injury may be expected to alter diving or foraging to the degree that its variation in these behaviors is outside that which is considered normal for the species. If a physiological effect is accompanied by a behavioral effect, the overall effect is characterized as a physiological effect; physiological effects take precedence over behavioral effects with regard to their ordering. This approach provides the most conservative ordering of effects with respect to severity, provides a rational approach to dealing with the overlap of the definitions, and avoids circular arguments.

The severity of physiological effects generally decreases with decreasing sound exposure and/or increasing distance from the sound source. The same generalization does not consistently hold for behavioral effects because they do not depend solely on the received sound level. Behavioral responses also depend on an animal’s learned responses, innate response tendencies, motivational state, the pattern of the sound exposure, and the context in which the sound is presented. However, to provide a tractable approach to predicting acoustic effects that is relevant to the terms of behavioral disruption described in the MMPA, it is assumed here that the severities of behavioral effects also decrease with decreasing sound exposure and/or increasing distance from the sound source. Figure 3-2 shows the relationship between severity of effects, source distance, and exposure level, as defined in this EIS/OEIS.

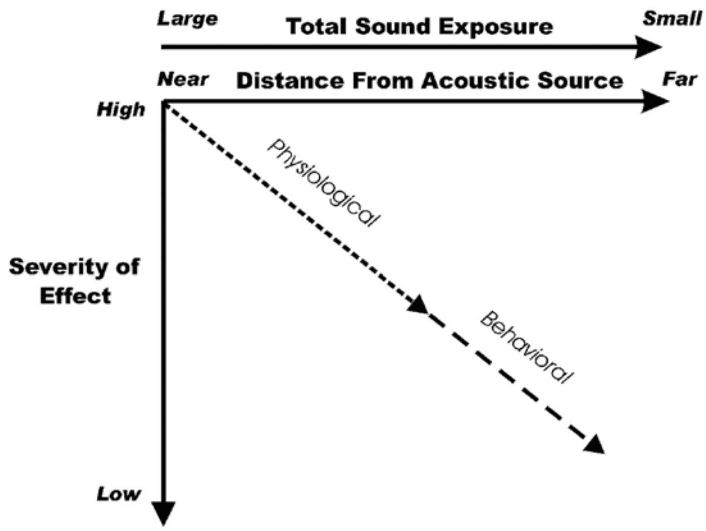


Figure 3-2. Relationship Between Severity of Effects, Source Distance, and Exposure Level.

3.5 MMPA Level A and Level B Harassment

Categorizing potential effects as either physiological or behavioral effects allows them to be related to the harassment definitions. For military readiness activities, Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild. Injury, as defined in the SOCAL Range Complex EIS/OEIS and previous regulatory rulings (NOAA 2001; 2002a), is the destruction or loss of biological tissue. The destruction or loss of biological tissue will result in an alteration of physiological function that exceeds the normal daily physiological variation of the intact tissue. For example, increased localized histamine production, edema, production of scar tissue, activation of clotting factors, white blood cell response, etc., may be expected following injury. Therefore, this EIS/OEIS assumes that all injury is qualified as a physiological effect and, to be consistent with prior actions and rulings (NOAA 2001), all injuries (slight to severe) are considered Level A harassment.

Public Law 108-136 (2004) amended the MMPA definitions of Level B harassment for military readiness activities, which applies to this action. For military readiness activities, Level B harassment is defined as “any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behaviors are abandoned or significantly altered.” Unlike Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause Level B harassment.

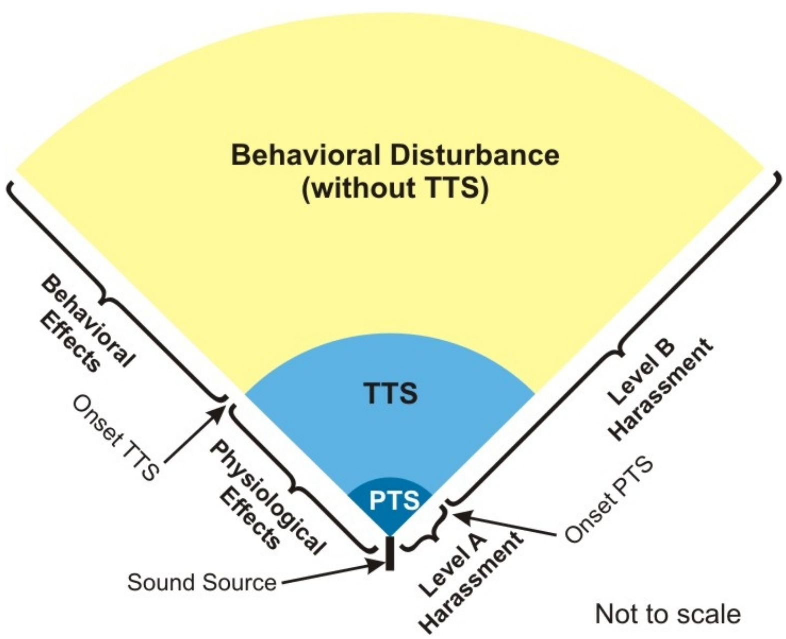
For example, some physiological effects can occur that are non-injurious but that can potentially disrupt the behavior of a marine mammal. These include temporary distortions in sensory tissue that alter physiological function, but that are fully recoverable without the requirement for tissue replacement or regeneration. For example, an animal that experiences a temporary reduction in hearing sensitivity suffers no injury to its auditory system, but may not perceive some sounds due to the reduction in sensitivity. As a result, the animal may not respond to sounds that would normally produce a behavioral reaction. This lack of response qualifies as a temporary disruption of normal behavioral patterns – the animal is impeded from responding in a normal manner to an acoustic stimulus.

The harassment status of slight behavior disruption has been addressed in workshops, previous actions, and rulings (NOAA 2001; DON 2001a). The conclusion is that a momentary behavioral reaction of an animal to a brief, time-isolated acoustic event does not qualify as Level B harassment. A more general conclusion, that Level B harassment occurs only when there is "a potential for a significant behavioral change or response in a biologically important behavior or activity," is found in recent rulings (NOAA, 2002a). Public Law 108-136 (2004) amended the definition of Level B harassment for military readiness activities, which applies to this action. For military readiness activities, Level B harassment is defined as "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns…to a point where such behaviors are abandoned or significantly altered."

Although the temporary lack of response discussed above may not result in abandonment or significant alteration of natural behavioral patterns, the acoustic effect inputs used in the acoustic model assume that temporary hearing impairment (slight to severe) is considered Level B harassment. Although modes of action are appropriately considered, as outlined in Figure 3-2, the conservative assumption used here is to consider all hearing impairment as harassment. As a result, the actual incidental harassment of marine mammals associated with this action may be less than predicted via the analytical framework.

3.6 MMPA EXPOSURE ZONES

Two acoustic modeling approaches are used to account for both physiological and behavioral effects to marine mammals. This subsection of harassment zones is specific to the modeling of total energy (EL), described in more detail in Section 4.2. When using a threshold of accumulated energy (EL) the volumes of ocean in which Level A and Level B harassment are predicted to occur are described as exposure zones. As a conservative estimate, all marine mammals predicted to be in a zone are considered exposed to accumulated sound levels that may result in harassment within the applicable Level A or Level B harassment categories. Figure 3-3- illustrates harassment zones extending from a hypothetical, directional sound source.



This figure is for illustrative purposes only and does not represent the sizes or shapes of the actual exposure zones.

Figure 3-3. Exposure Zones Extending from a Hypothetical, Directional Sound Source.

The Level A exposure zone extends from the source out to the distance and exposure at which the slightest amount of injury is predicted to occur. The acoustic exposure that produces the slightest degree of injury is therefore the threshold value defining the outermost limit of the Level A exposure zone. Use of the threshold associated with the onset of slight injury as the most distant point and least injurious exposure takes account of all more serious injuries by inclusion within the Level A harassment zone. The threshold used to define the outer limit of the Level A exposure zone is given in Figure 3-3.

The Level B exposure zone begins just beyond the point of slightest injury and extends outward from that point to include all animals that may possibly experience Level B harassment. Physiological effects extend beyond the range of slightest injury to a point where slight temporary distortion of the most sensitive tissue occurs, but without destruction or loss of that tissue (such as occurs with inner ear hair cells subjected to temporary threshold shift). The animals predicted to be in this zone are assumed to experience Level B harassment by virtue of temporary impairment of sensory function (altered physiological function) that can disrupt behavior. The criterion and threshold used to define the outer limit of the Level B exposure zone for the on-set of certain physiological effects are given in Figure 3-3. Due to the Level B exposure zone developed using accumulated energy, there is a partial overlap with the consideration of potential behavioral disturbance assessed using the dose function, which is a received sound pressure level, described in Section 3.19. This overlap is considered conservative in that it may ‘double-count’ potential exposures, and ensures both physiological and behavioral effects are sufficiently considered.

3.6.1 Auditory Tissues as Indicators of Physiological Effects

Exposure to continuous-type sound may cause a variety of physiological effects in mammals. For example, exposure to very high sound levels may affect the function of the visual system, vestibular system, and internal organs (Ward 1997). Exposure to high-intensity, continuous- type sounds of sufficient duration may cause injury to the lungs and intestines (e.g., Dalecki et al. 2002). Sudden, intense sounds may elicit a “startle” response and may be followed by an orienting reflex (Ward 1997; Jansen 1998). The primary physiological effects of sound, however, are on the auditory system (Ward 1997).

The mammalian auditory system consists of the outer ear, middle ear, inner ear, and central nervous system. Sound waves are transmitted through the middle ears to fluids within the inner ear except cetaceans. The inner ear contains delicate electromechanical hair cells that convert the fluid motions into neural impulses that are sent to the brain. The hair cells within the inner ear are the most vulnerable to over-stimulation by sound exposure (Yost 1994).

Very high sound levels may rupture the eardrum or damage the small bones in the middle ear (Yost 1994). Lower level exposures of sufficient duration may cause permanent or temporary hearing loss; such an effect is called a noise-induced threshold shift, or simply a threshold shift (TS) (Miller 1974). A TS may be either permanent, in which case it is called a permanent threshold shift (PTS), or temporary, in which case it is called a temporary threshold shift (TTS). Still lower levels of sound may result in auditory masking (described in Section 3.19), which may interfere with an animal’s ability to hear other concurrent sounds.

Because the tissues of the ear appear to be the most susceptible to the physiological effects of sound and TSs tend to occur at lower exposures than other more serious auditory effects, PTS and TTS are used here as the biological indicators of physiological effects. TTS is the first indication of physiological non-injurious change and is not physical injury. The remainder of this section is, therefore, focused on TSs, including PTSs and TTSs. Since masking (without a resulting TS) is not associated with abnormal physiological function, it is not considered a physiological effect in this EIS/OEIS, but rather a potential behavioral effect. Descriptions of other potential physiological effects, including acoustically mediated bubble growth and air cavity resonance, are described in the Section 3.19.

3.7 NOISE-INDUCED THRESHOLD SHIFTS

The amount of TS depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al. 1966; Ward 1997).

The magnitude of a TS normally decreases with the amount of time post-exposure (Miller 1974). The amount of TS just after exposure is called the initial TS. If the TS eventually returns to zero (the threshold returns to the pre-exposure value), the TS is a TTS. Since the amount of TTS depends on the time post-exposure, it is common to use a subscript to indicate the time in minutes after exposure (Quaranta et al. 1998). For example, TTS2 means a TTS measured two minutes after exposure. If the TS does not return to zero but leaves some finite amount of TS, then that remaining TS is a PTS. The distinction between PTS and TTS is based on whether there is a complete recovery of a TS following a sound exposure. Figure 3-4 shows two hypothetical TSs: one that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.

3.8 PTS, TTS, AND EXPOSURE ZONES

PTS is non-recoverable and, by definition, must result from the destruction of tissues within the auditory system. PTS therefore qualifies as an injury and is classified as Level A harassment under the wording of the MMPA. In the SOCAL Range Complex, the smallest amount of PTS (onset- PTS) is taken to be the indicator for the smallest degree of injury that can be measured. The acoustic exposure associated with onset-PTS is used to define the outer limit of the Level A exposure zone.

TTS is recoverable and, as in recent rulings (NOAA 2001; 2002a), is considered to result from the temporary, non-injurious distortion of hearing-related tissues. In the SOCAL Range Complex, the smallest measurable amount of TTS (onset-TTS) is taken as the best indicator for slight temporary sensory impairment. Because it is considered non-injurious, the acoustic exposure associated with onset-TTS is used to define the outer limit of the portion of the Level B exposure zone attributable to physiological effects. This follows from the concept that hearing loss potentially affects an animal’s ability to react normally to the sounds around it. Therefore, in the SOCAL Range Complex, the potential for TTS is considered as a Level B harassment that is mediated by physiological effects on the auditory system.

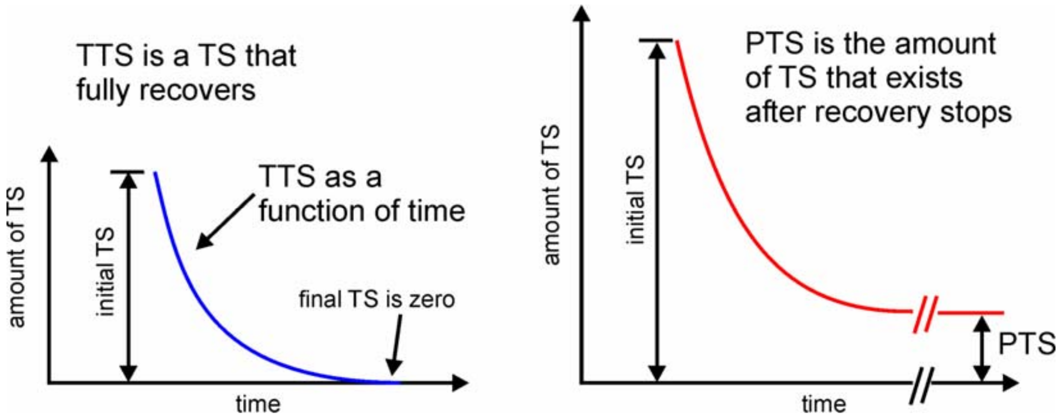


Figure 3-4. Hypothetical Temporary and Permanent Threshold Shifts

3.9 CRITERIA AND THRESHOLDS FOR PHYSIOLOGICAL EFFECTS (SENSORY IMPAIRMENT)

This section presents the effect criteria and thresholds for physiological effects of sound leading to injury and behavioral disturbance as a result of sensory impairment. Section 3.4 identified the tissues of the ear as being the most susceptible to physiological effects of underwater sound. PTS and TTS were determined to be the most appropriate biological indicators of physiological effects that equate to the onset of injury (Level A harassment) and behavioral disturbance (Level B harassment), respectively. This Section is, therefore, focused on criteria and thresholds to predict PTS and TTS in marine mammals.

Marine mammal ears are functionally and structurally similar to terrestrial mammal ears; however, there are important differences (Ketten 1998). The most appropriate information from which to develop PTS/TTS criteria for marine mammals would be experimental measurements of PTS and TTS from marine mammal species of interest. TTS data exist for several marine mammal species and may be used to develop meaningful TTS criteria and thresholds. Because of the ethical issues presented, PTS data do not exist for marine mammals and are unlikely to be obtained. Therefore, PTS criteria must be extrapolated using TTS criteria and estimates of the relationship between TTS and PTS.

This section begins with a review of the existing marine mammal TTS data. The review is followed by a discussion of the relationship between TTS and PTS. The specific criteria and thresholds for TTS and PTS used in this EIS/OEIS are then presented. This is followed by discussions of sound energy flux density level (EL), the relationship between EL and sound pressure level (SPL), and the use of SPL and EL in previous environmental compliance documents.

3.9.1 Energy Flux Density Level and Sound Pressure Level

Energy Flux Density Level (EL) is measure of the sound energy flow per unit area expressed in dB. EL is stated in dB re 1 µPa^2-s for underwater sound and dB re (20 µPa)^2-s for airborne sound.

Sound Pressure Level (SPL) is a measure of the root-mean square, or “effective,” sound pressure in decibels. SPL is expressed in dB re 1 µPa for underwater sound and dB re 20 µPa for airborne sound.

3.10 TTS IN MARINE MAMMALS

A number of investigators have measured TTS in marine mammals. These studies measured hearing thresholds in trained marine mammals before and after exposure to intense sounds. Some of the more important data obtained from these studies are onset-TTS levels – exposure levels sufficient to cause a just-measurable amount of TTS, often defined as 6 dB of TTS (for example, Schlundt et al. 2000). The existing cetacean and pinniped underwater TTS data are summarized in the following bullets.

- Schlundt et al. (2000) reported the results of TTS experiments conducted with bottlenose dolphins and white whales exposed to 1-second tones. This paper also includes a reanalysis of preliminary TTS data released in a technical report by Ridgway et al. (1997). At frequencies of 3, 10, and 20 kHz, SPLs necessary to induce measurable amounts (6 dB or more) of TTS were between 192 and 201 dB re 1 µPa (EL = 192 to 201 dB re 1 µPa^2-s). The mean exposure SPL and EL for onset-TTS were 195 dB re 1 µPa and 195 dB re 1 µPa^2-s, respectively. The sound exposure stimuli (tones) and relatively large number of test subjects (five dolphins and two white whales) make the Schlundt et al. (2000) data the most directly relevant TTS information for the scenarios described in the SOCAL Range Complex EIS/OEIS.

- Finneran et al. (2001, 2003, 2005) described TTS experiments conducted with bottlenose dolphins exposed to 3-kHz tones with durations of 1, 2, 4, and 8 seconds. Small amounts of TTS (3 to 6 dB) were observed in one dolphin after exposure to ELs between 190 and 204 dB re 1 µPa^2-s. These results were consistent with the data of Schlundt et al. (2000) and showed that the Schlundt et al. (2000) data were not significantly affected by the masking sound used. These results also confirmed that, for tones with different durations, the amount of TTS is best correlated with the exposure EL rather than the exposure SPL.

- Finneran et al. (2007) conducted TTS experiments with bottlenose dolphins exposed to intensed 20 kHz fatiquing tone. Behavioral and auditory evoked potentials (using sinusoidal amplitude modulated tones creating auditory steady state response [AASR]) were used to measure TTS. The fatiguing tone was either 16 (mean = 193 re 1µPa, SD = 0.8) or 64 seconds (185-186 re 1µPa) in duration. TTS ranged from 19-33db from behavioral measurements and 40-45dB from ASSR measurements.

- Nachtigall et al. (2003) measured TTS in a bottlenose dolphin exposed to octave-band sound centered at 7.5 kHz. Nachtigall et al. (2003a) reported TTSs of about 11 dB measured 10 to 15 minutes after exposure to 30 to 50 minutes of sound with SPL 179 dB re 1 µPa (EL about 213 dB re µPa^2-s). No TTS was observed after exposure to the same sound at 165 and 171 dB re 1 µPa. Nachtigall et al. (2003b) reported TTSs of around 4 to 8 dB 5 minutes after exposure to 30 to 50 minutes of sound with SPL 160 dB re 1 µPa (EL about 193 to 195 dB re 1 µPa^2-s). The difference in results was attributed to faster post-exposure threshold measurement—TTS may have recovered before being detected by Nachtigall et al. (2003a). These studies showed that, for long-duration exposures, lower sound pressures are required to induce TTS than are required for short-duration tones. These data also confirmed that, for the cetaceans studied, EL is the most appropriate predictor for onset-TTS.

- Finneran et al. (2000, 2002) conducted TTS experiments with dolphins and white whales exposed to impulsive sounds similar to those produced by distant underwater explosions and seismic water guns. These studies showed that, for very short-duration impulsive sounds, higher sound pressures were required to induce TTS than for longer-duration tones.

- Kastak et al. (1999, 2005) conducted TTS experiments with three species of pinnipeds, California sea lion, northern elephant seal and a Pacific harbor seal, exposed to continuous underwater sounds at levels of 80 and 95 dB Sensation Level (referenced to the animal's absolute auditory threshold at the center frequency) at 2.5 and 3.5 kHz for up to 50 minutes. Mean TTS shifts of up to 12.2 dB occurred with the harbor seals showing the largest shift of 28.1 dB. Increasing the sound duration had a greater effect on TTS than increasing the sound level from 80 to 95 dB.

Figure 3-5 shows the existing TTS data for cetaceans (dolphins and white whales). Individual exposures are shown in terms of SPL versus exposure duration (upper panel) and EL versus exposure duration (lower panel). Exposures that produced TTS are shown as filled symbols. Exposures that did not produce TTS are represented by open symbols. The squares and triangles represent impulsive test results from Finneran et al. 2000 and 2002, respectively. The circles show the 3-, 10-, and 20-kHz data from Schlundt et al. (2000) and the results of Finneran et al. (2003). The inverted triangle represents data from Nachtigall et al. (2003b).

Figure 3-5 illustrates that the effects of the different sound exposures depend on the SPL and duration. As the duration decreases, higher SPLs are required to cause TTS. In contrast, the ELs required for TTS do not show the same type of variation with exposure duration.

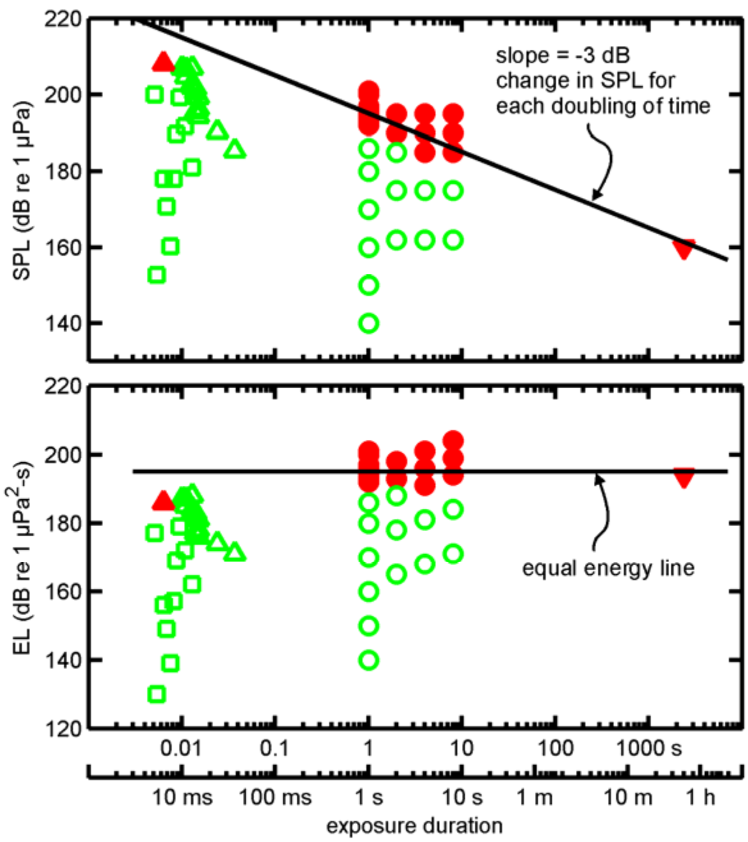


Figure 3-5. Existing TTS Data for Cetaceans.

Legend: Filled symbol: Exposure that produced TTS, Open symbol: Exposure that did not produce TTS, Squares: Impulsive test results from Finneran et al., 2000, Triangles: Impulsive test results from Finneran et al., 2002, Circles: 3, 10, and 20-kHz data from Schlundt et al. (2000) and results of Finneran et al. (2003), and Inverted triangle: Data from Nachtigall et al., 2003b.

The solid line in the upper panel of Figure 3-5 has a slope of -3 dB per doubling of time. This line passes through the point where the SPL is 195 dB re 1 µPa and the exposure duration is 1 second. Since EL = SPL + 10log10 (duration), doubling the duration increases the EL by 3 dB. Subtracting 3 dB from the SPL decreases the EL by 3 dB. The line with a slope of -3 dB per doubling of time, therefore, represents an equal energy line – all points on the line have the same EL, which is, in this case, 195 dB re 1 µPa^2-s. This line appears in the lower panel as a horizontal line at 195 dB re 1 µPa^2-s. The equal energy line at 195 dB re 1 µPa^2-s fits the tonal and sound data (the non-impulsive data) very well, despite differences in exposure duration, SPL, experimental methods, and subjects.

In summary, the existing cetacean TTS data show that, for the species studied and sounds (non-impulsive) of interest, the following is true:

- The growth and recovery of TTS are analogous to those in land mammals. This means that, as in land mammals, cetacean TSs depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al. 1965; Ward 1997).

- SPL by itself is not a good predictor of onset-TTS, since the amount of TTS depends on both SPL and duration.

- Exposure EL is correlated with the amount of TTS and is a good predictor for onset-TTS for single, continuous exposures with different durations. This agrees with human TTS data presented by Ward et al. (1958, 1959).

- An energy flux density level of 195 dB re 1 µPa^2-s is the most appropriate predictor for onset-TTS from a single, continuous exposure.

Relationship between TTS and PTS

Since marine mammal PTS data do not exist, onset-PTS levels for these animals must be estimated using TTS data and relationships between TTS and PTS. Much of the early human TTS work was directed towards relating TTS2 after 8 hours of sound exposure to the amount of PTS that would exist after years of similar daily exposures (e.g., Kryter et al. 1966). Although it is now acknowledged that susceptibility to PTS cannot be reliably predicted from TTS measurements, TTS data do provide insight into the amount of TS that may be induced without a PTS. Experimental studies of the growth of TTS may also be used to relate changes in exposure level to changes in the amount of TTS induced. Onset-PTS exposure levels may therefore be predicted by:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.

- Estimating the additional exposure, above the onset-TTS exposure, necessary to reach the maximum allowable amount of TTS that, again, may be induced without PTS. This is equivalent to estimating the growth rate of TTS – how much additional TTS is produced by an increase in exposure level.

Experimentally induced TTSs, from short duration sounds (1-8 seconds) in the range of 3.5-20 kHz, in marine mammals have generally been limited to around 2 to 10 dB, well below TSs that result in some PTS. Experiments with terrestrial mammals have used much larger TSs and provide more guidance on how high a TS may rise before some PTS results. Early human TTS studies reported complete recovery of TTSs as high as 50 dB after exposure to broadband sound (Ward, 1960; Ward et al. 1958, 1959). Ward et al. (1959) also reported slower recovery times when TTS2 approached and exceeded 50 dB, suggesting that 50 dB of TTS2 may represent a "critical" TTS. Miller et al. (1963) found PTS in cats after exposures that were only slightly longer in duration than those causing 40 dB of TTS. Kryter et al. (1966) stated: "A TTS2 that approaches or exceeds 40 dB can be taken as a signal that danger to hearing is imminent." These data indicate that TSs up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for TS to prevent PTS.

The small amounts of TTS produced in marine mammal studies also limit the applicability of these data to estimates of the growth rate of TTS. Fortunately, data do exist for the growth of TTS in terrestrial mammals. For moderate exposure durations (a few minutes to hours), TTS2 varies with the logarithm of exposure time (Ward et al. 1958, 1959; Quaranta et al. 1998). For shorter exposure durations the growth of TTS with exposure time appears to be less rapid (Miller 1974; Keeler 1976). For very long-duration exposures, increasing the exposure time may fail to produce any additional TTS, a condition known as asymptotic threshold shift (Saunders et al. 1977; Mills et al. 1979).

Ward et al. (1958, 1959) provided detailed information on the growth of TTS in humans. Ward et al. presented the amount of TTS measured after exposure to specific SPLs and durations of broadband sound. Since the relationship between EL, SPL, and duration is known, these same data could be presented in terms of the amount of TTS produced by exposures with different ELs.

Figure 3-6 shows results from Ward et al. (1958, 1959) plotted as the amount of TTS2 versus the exposure EL. The data in Figure 6-6(a) are from broadband (75 Hz to 10 kHz) sound exposures with durations of 12 to 102 minutes (Ward et al. 1958). The symbols represent mean TTS2 for 13 individuals exposed to continuous sound. The solid line is a linear regression fit to all but the two data points at the lowest exposure EL. The experimental data are fit well by the regression line (R2 = 0.95). These data are important for two reasons: (1) they confirm that the amount of TTS is correlated with the exposure EL; and (2) the slope of the line allows one to estimate the in additional amount of TTS produced by an increase in exposure. For example, the slope of the line in Figure 3-6(a) is approximately 1.5 dB TTS2 per dB of EL. This means that each additional dB of EL produces 1.5 dB of additional TTS2.

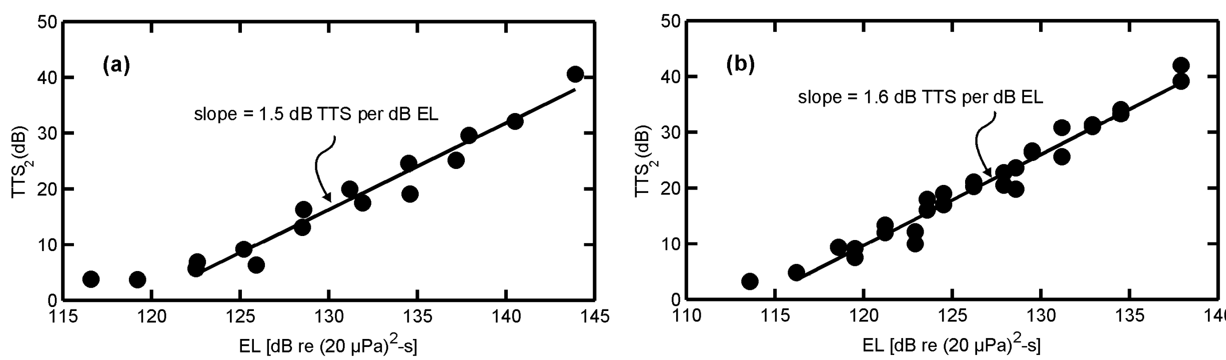


Figure 3-6. Growth of TTS versus the Exposure EL (from Ward et al. [1958, 1959])

The data in Figure 3-6(b) are from octave-band sound exposures (2.4 to 4.8 kHz) with durations of 12 to 102 minutes (Ward et al. 1959). The symbols represent mean TTS for 13 individuals exposed to continuous sound. The linear regression was fit to all but the two data points at the lowest exposure EL. The results are similar to those shown in Figure 3-6(a). The slope of the regression line fit to the mean TTS data was 1.6 dB TTS2/dB EL. A similar procedure was carried out for the remaining data from Ward et al. (1959), with comparable results. Regression lines fit to the TTS versus EL data had slopes ranging from 0.76 to 1.6 dB TTS2/dB EL, depending on the frequencies of the sound exposure and hearing test.

An estimate of 1.6 dB TTS2 per dB increase in exposure EL is the upper range of values from Ward et al. (1958, 1959) and gives the most conservative estimate – it predicts a larger amount of

TTS from the same exposure compared to the lines with smaller slopes. The difference between onset-TTS (6 dB) and the upper limit of TTS before PTS (40 dB) is 34 dB. To move from onset-TTS to onset-PTS, therefore, requires an increase in EL of 34 dB divided by 1.6 dB/dB, or approximately 21 dB. An estimate of 20 dB between exposures sufficient to cause onset-TTS and those capable of causing onset-PTS is a reasonable approximation.

To summarize:

- In the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated from marine mammal TTS data and PTS/TTS relationships observed in terrestrial mammals. This involves:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.

- Estimating the growth rate of TTS – how much additional TTS is produced by an increase in exposure level.

- A variety of terrestrial mammal data sources point toward 40 dB as a reasonable estimate of the largest amount of TS that may be induced without PTS. A conservative is that continuous-type exposures producing TSs of 40 dB or more always result in some amount of PTS.

- Data from Ward et al. (1958, 1959) reveal a linear relationship between TTS2 and exposure EL. A value of 1.6 dB TTS2 per dB increase in EL is a conservative estimate of how much additional TTS is produced by an increase in exposure level for continuous- type sounds.

- There is a 34 dB TS difference between onset-TTS (6 dB) and onset-PTS (40 dB). The additional exposure above onset-TTS that is required to reach PTS is therefore 34 dB divided by 1.6 dB/dB, or approximately 21 dB.

- Exposures with ELs 20 dB above those producing TTS may be assumed to produce a PTS. This number is used as a conservative simplification of the 21 dB number derived above.

For this specified action, sound exposure thresholds for modeling TTS and PTS exposures are as presented in Table 3-1.

Cetaceans predicted to receive a sound exposure with EL of 215 dB re 1 μPa^2-s or greater are assumed to experience PTS and are counted as Level A harassment. Cetaceans predicted to receive a sound exposure with EL greater than or equal to 195 dB re 1 μPa^2-s but less than 215 dB re 1 μPa^2-s are assumed to experience TTS and are counted as Level B harassment.

The TTS and PTS thresholds for pinnipeds vary with species. A threshold of 206 dB re 1 μPa^2-s for TTS and 226 dB re 1 μPa^2-s for PTS is used for otariids. Northern elephant seals are similar to otariids and use thresholds of TTS = 204 dB re 1 μPa^2-s, PTS = 224 dB re 1 μPa^2-s. A lower threshold is used for harbor seals (TTS = 183 dB re 1 μPa^2-s, PTS = 203 dB re 1 μPa^2-s).

Table 3-1. Summary of the Physiological Effects Thresholds for TTS and PTS for Cetaceans and Pinnipeds.

Physiological Effects			
Animal	**Criteria**	**Threshold (re 1μPa^2-s)**	**MMPA Effect**
Cetacean	TTS PTS	195 215	Level B Harassment Level A Harassment
Pinnipeds			
Northern Elephant Seal	TTS PTS	204 224	Level B Harassment Level A Harassment
Pacific Harbor Seal	TTS PTS	183 203	Level B Harassment Level A Harassment
California Sea Lion	TTS PTS	206 226	Level B Harassment Level A Harassment
Guadalupe Fur Seal	TTS PTS	206 226	Level B Harassment Level A Harassment
Northern Fur Seal	TTS PTS	206 226	Level B Harassment Level A Harassment

3.11 DERIVATION OF EFFECT THRESHOLD

Cetacean Threshold

The TTS threshold is primarily based on the cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The mean exposure EL required to produce onset-TTS in these tests was 195 dB re 1 μPa^2-s. This result is corroborated by the short-duration tone data of Finneran et al. (2001, 2003, 2005, 2003) and the long-duration sound data from Nachtigall et al. (2003a, b). Together, these data demonstrate that TTS in cetaceans is correlated with the received EL and that onset-TTS exposures are fit well by an equal-energy line passing through 195 dB re 1 μPa^2-s.

The PTS threshold is based on a 20 dB increase in exposure EL over that required for onset-TTS. The 20 dB value is based on estimates from terrestrial mammal data of PTS occurring at 40 dB or more of TS, and on TS growth occurring at a rate of 1.6 dB/dB increase in exposure EL. This is conservative because: (1) 40 dB of TS is actually an upper limit for TTS used to approximate onset-PTS, and (2) the 1.6 dB/dB growth rate is the highest observed in the data from Ward et al. (1958, 1959).

Pinniped Threshold

The TTS threshold for pinnipeds is based on TTS data from Kastak et al. (1999; 2005). Although their data is from continuous noise rather than short duration tones, pinniped TTS can be extrapolated using equal energy curves. Continuous sound at a lower intensity level can produce TTS similar to short duration but higher intensity sounds such as sonar pings.

3.12 USE OF EL FOR PHYSIOLOGICAL EFFECT THRESHOLDS

Effect thresholds are expressed in terms of total received EL. Energy flux density is a measure of the flow of sound energy through an area. Marine and terrestrial mammal data show that, for continuous-type sounds of interest, TTS and PTS are more closely related to the energy in the sound exposure than to the exposure SPL.

The EL for each individual ping is calculated from the following equation:

EL = SPL + 10log10(duration)

The EL includes both the ping SPL and duration. Longer-duration pings and/or higher-SPL pings will have a higher EL.

If an animal is exposed to multiple pings, the energy flux density in each individual ping is summed to calculate the total EL. Since mammalian TS data show less effect from intermittent exposures compared to continuous exposures with the same energy (Ward, 1997), basing the effect thresholds on the total received EL is a conservative approach for treating multiple pings; in reality, some recovery will occur between pings and lessen the effect of a particular exposure.

Therefore, estimates are conservative because recovery is not taken into account – intermittent exposures are considered comparable to continuous exposures.

The total EL depends on the SPL, duration, and number of pings received. The TTS and PTS thresholds do not imply any specific SPL, duration, or number of pings. The SPL and duration of each received ping are used to calculate the total EL and determine whether the received EL meets or exceeds the effect thresholds. For example, the TTS threshold would be reached through any of the following exposures:

- A single ping with SPL = 195 dB re 1 µPa and duration = 1 second.
- A single ping with SPL = 192 dB re 1 µPa and duration = 2 seconds.
- Two pings with SPL = 192 dB re 1 µPa and duration = 1 second.
- Two pings with SPL = 189 dB re 1 µPa and duration = 2 seconds.

Comparison to Surveillance Towed Array Sensor System Low Frequency (SURTASS LFA) Active Risk Functions

The physiological effect thresholds described in this EIS/OEIS should not be confused with criteria and thresholds used for the Navy's Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) sonar. SURTASS LFA features pings lasting many tens of seconds. The sonars of concern within the SOCAL Range Complex emit pings lasting a few seconds at most. SURTASS LFA risk functions were expressed in terms of the received "single ping equivalent" SPL. Physiological effect thresholds in this EIS/OEIS are expressed in terms of the total received EL. The SURTASS LFA risk function parameters cannot be directly compared to the effect thresholds used in this the SOCAL Range Complex EIS/OEIS. Comparisons must take into account the differences in ping duration, number of pings received, and method of accumulating effects over multiple pings.

3.13 PREVIOUS USE OF EL FOR PHYSIOLOGICAL EFFECTS

Energy measures have been used as a part of dual criteria for cetacean auditory effects in shock trials, which only involve impulsive-type sounds (DON 1997, 2001a). These actions used 192 dB re 1 μPa^2-s as a reference point to derive a TTS threshold in terms of EL. A second TTS threshold, based on peak pressure, was also used. If either threshold was exceeded, effect was assumed.

The 192 dB re 1 μPa^2-s reference point differs from the threshold of 195 dB re 1 μPa^2-s used in this SOCAL Range Complex EIS/OEIS. The 192 dB re 1 μPa^2-s value was based on the minimum observed by Ridgway et al. (1997) and Schlundt et al. (2000) during TTS measurements with bottlenose dolphins exposed to 1-second tones. At the time, no impulsive test data for marine mammals were available and the 1-second tonal data were considered to be the best available. The minimum value of the observed range of 192 to 201 dB re 1 μPa^2-s was used to protect against misinterpretation of the sparse data set available. The 192 dB re 1 μPa^2-s value was reduced to 182 dB re 1 μPa^2-s to accommodate the potential effects of pressure peaks in impulsive waveforms.

The additional data now available for onset-TTS in small cetaceans confirm the original range of values and increase confidence in it (Finneran et al. 2001, 2003; Nachtigall et al. 2003a, 2003b). The SOCAL Range Complex EIS/OEIS, therefore, uses the more complete data available and the mean value of the entire Schlundt et al. (2000) data set (195 dB re 1 μPa^2-s), instead of the minimum of 192 dB re 1 μPa^2-s. From the standpoint of statistical sampling and prediction theory, the mean is the most appropriate predictor—the "best unbiased estimator"—of the EL at which onset-TTS should occur; predicting the number of exposures in future actions relies (in part) on using the EL at which onset-TTS will most likely occur. When that EL is applied over many pings in each of many sonar exercises, that value will provide the most accurate prediction of the actual number of exposures by onset-TTS over all of those exercises. Use of the minimum value would overestimate the number of exposures because many animals counted would not have experienced onset-TTS. Further, there is no logical limiting minimum value of the distribution that would be obtained from continued successive testing. Continued testing and use of the minimum would produce more and more erroneous estimates.

3.14 CRITERIA AND THRESHOLDS FOR BEHAVIORAL EFFECTS

Section 3.4 categorized the potential effects of sound into physiological effects and behavioral effects. Criteria and thresholds for physiological effects are discussed in Section 3.4. This Section presents the effect criterion and threshold for behavioral effects of sound leading to behavioral disturbance without accompanying physiological effects. Since TTS is used as the biological indicator for a physiological effect leading to behavioral disturbance, the behavioral effects discussed in this section may be thought of as behavioral disturbance occurring at exposure levels below those causing TTS.

A large body of research on terrestrial animal and human response to airborne sound exists, but results from those studies are not readily extendible to the development of effect criteria and thresholds for marine mammals. For example, "annoyance" is one of several criteria used to define impact to humans from exposure to industrial sound sources. Comparable criteria cannot be developed for marine mammals because there is no acceptable method for determining whether a non-verbal animal is annoyed. Further, differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (e.g., human data tend to focus on 8-hour-long exposures) make extrapolation of human sound exposure standards inappropriate.

Behavioral observations of marine mammals exposed to anthropogenic sound sources exist, however, there are few observations and no controlled measurements of behavioral disruption of cetaceans caused by sound sources with frequencies, waveforms, durations, and repetition rates comparable to those employed by the tactical sonars to be used in the SOCAL Range Complex. At the present time there is no consensus on how to account for behavioral effects on marine mammals exposed to continuous-type sounds (NRC 2003).

3.15 HISTORY OF ASSESSING POTENTIAL HARASSMENT FROM BEHAVIORAL EFFECTS

The science of understanding the effects of sound on marine mammals is dynamic, and the Navy is committed to the use of the best available science for evaluating potential effects from training and testing activities. Navy LOA requests for USWTR mid-frequency active sonar training relied on behavioral observations of trained cetaceans exposed to intense underwater sound under controlled circumstances to develop a criterion and threshold for behavioral effects of sound based on energy flux density. These data are described in detail in Schlundt et al. (2000) and Finneran and Schlundt (2004). These data represented the best available data at the time those activities were proposed because they are based on controlled, tonal sound exposures within the tactical sonar frequency range and because the species studied are closely related to the majority of animals expected to be located within the proposed action area. The USWTR Draft EIS/OEIS provided analysis to the 190 dB re 1 μPa^2-s, which Navy believed to most accurately reflect scientifically-derived behavioral reactions from sound sources that are most similar to mid-frequency sonars. A full discussion of the scientific data and use of those data to derive the 190 dB re 1 μPa^2-s threshold is presented in the RIMPAC overseas environmental assessment (OEA) (DON 2006).

As described above, behavioral observations of trained cetaceans exposed to intense underwater sound under controlled circumstances are an important data set in evaluating and developing a criterion and threshold for behavioral effects of sound. These behavioral response data are an important foundation for the scientific basis of the Navy's prior threshold of onset behavioral effects because of the: (1) finer control over acoustic conditions; (2) greater quality and confidence in recorded sound exposures; and (3) the exposure stimuli closely match those of interest for the mid-frequency active sonar used proposed in SOCAL Range Complex. Since no comparable controlled exposure data for wild animals exist, or are likely to be obtained in the near-term, the relationship between the behavioral results reported by Finneran and Schlundt (2004) and wild animals is not known. Although experienced, trained subjects may tolerate higher sound levels than inexperienced animals; it is also possible that prior experiences and resultant expectations may have made some trained subjects less tolerant of sound exposures. However, in response to USWTR comments, potential differences between trained subjects and wild animals were considered by the Navy in conjunction with NMFS in the Navy's application for harassment authorization for RIMPAC 2006. At that time, NMFS recommended the Navy include analysis of this threshold based on NMFS' evaluation of behavioral observations of marine mammals under controlled conditions, plus NMFS' interpretation of two additional studies on reactions to vessel sound (Nowacek et al. 2004) and analysis for the U.S.S. SHOUP event (NMFS 2005). For that exercise, a conservative threshold for effect was derived compared to the regulatory definition of harassment, and the Navy agreed to the use of the 173 dB re 1 μPa^2-s threshold for the RIMPAC incidental harassment authorization (IHA) request.

Rationale for using energy flux density for evaluation of behavioral effects included:

- EL effect exposures account for both the exposure SPL and duration into account. Both SPL and duration of exposure affect behavioral responses to sound, so a behavioral effect threshold based on EL accounts for exposure duration.

- EL takes into account the effects of multiple pings. Effect thresholds based on SPL predict the same effect regardless of the number of received sounds. Previous actions using SPL-based criteria included implicit methods to account for multiple pings, such as the single-ping equivalent used in the surveillance towed array sensor system low frequency active (SURTASS LFA) (DON 2001b).

- EL allows a rational ordering of behavioral effects with physiological effects. The effect thresholds for physiological effects are stated in terms of EL because experimental data described above showed that the observed effects (TTS and PTS) are correlated best with the sound energy, not the SPL. Using EL for behavioral effects allows the behavioral and physiological effects to be placed on a single exposure scale, with behavioral effects occurring at lower exposures than physiological effects.

Subsequent to issuance of the RIMPAC IHA, additional public comments were received and considered. Based on this input, the Navy continued to coordinate with NMFS to determine whether an alternate approach to energy flux density could be used to evaluate when a marine mammal may behaviorally be affected by mid-frequency sonar sound exposures. Coordination between the Navy and NMFS produced the adoption of dose function for evaluation of behavioral effects. The dose function approach for evaluating behavioral effects is described in below, and fully considers the controlled, tonal sound exposure data in addition to comments received from the regulatory, scientific and the public regarding concerns with the use of EL for evaluating the effects of sound on wild animals.

3.16 RISK FUNCTION METHODOLOGY

Based on available evidence, marine animals are likely to exhibit any of a suite of potential behavioral responses or combinations of behavioral responses upon exposure to sonar transmissions. Potential behavioral responses include, but are not limited to: avoiding exposure or continued exposure; behavioral disturbance (including distress or disruption of social or foraging activity); habituation to the sound; becoming sensitized to the sound; or not responding to the sound.

Existing studies of behavioral effects of human-made sounds in marine environments remain inconclusive, partly because many of those studies have lacked adequate controls, applied only to certain kinds of exposures (which are often different from the exposures being analyzed in the study), and had limited ability to detect behavioral changes that may be significant to the biology of the animals that were being observed. These studies are further complicated by the wide variety of behavioral responses marine mammals exhibit and the fact that those responses can vary significantly by species, individuals, and the context of an exposure. In some circumstances, some individuals will continue normal behavioral activities in the presence of high levels of human-made noise. In other circumstances, the same individual or other individuals may avoid an acoustic source at much lower received levels (Richardson et al., 1995; Wartzok et al., 2003). These differences within and between individuals appear to result from a complex interaction of experience, motivation, and learning that are difficult to quantify and predict..

The National Marine Fisheries Service (NMFS) and other commentators recommended the use of an alternate methodology to evaluate when sound exposures might result in behavioral effects without corresponding physiological effects. Therefore, the Navy and NMFS have developed the Risk-Function approach to estimate potential behavioral effects from mid frequency active sonar. The behavioral response exposures presented in this chapter were estimated using the risk function methodology described below.

3.16.1 Applying the Risk Function Methodology

To assess the potential effects on marine mammals associated with active sonar used during training activities, the Navy together with NMFS, as a first step, investigated a series of mathematical models and methodologies that estimate the number of times individuals of the different species of marine mammals might be exposed to MFA sonar at different received levels. The Navy effects analyses assumed that the potential consequences of exposure to MFA sonar on individual animals would be a function of the received sound pressure level (decibels re 1 micropascal [dB re 1 μPa]). These analyses assume that MFA sonar poses no risk, that is, does not constitute harassment to marine mammals if they are exposed to sound pressure levels from the MFA sonar below a certain basement value.

The second step of the assessment procedure requires the Navy and NMFS to identify how marine mammals are likely to respond when they are exposed to active sonar. Marine mammals can experience a variety of responses to sound including sensory impairment (permanent and temporary threshold shifts and acoustic masking), physiological responses (particular stress responses), behavioral responses, social responses that might result in reducing the fitness of individual marine mammals and social responses that would not result in reducing the fitness of individual marine mammals.

Previously, the Navy and NMFS have used acoustic thresholds to identify the number of marine mammals that might experience hearing losses (temporary or permanent) or behavioral harassment upon being exposed to MFA sonar (see Figure 3.9.3, left panel). These acoustic thresholds have been represented by either sound exposure level (related to sound energy, abbreviated as SEL), sound pressure level (SPL), or other metrics such as peak pressure level and acoustic impulse (not considered for sonar in this DEIS/DOEIS). The general approach has been to apply these threshold functions so that a marine mammal is counted as behaviorally harassed or experiencing hearing loss when exposed to received sound levels above a certain threshold and not counted as behaviorally harassed or experiencing hearing loss when exposed to received levels below that threshold. For example, previous Navy EISs, environmental assessments, MMPA take authorization requests, and the MMPA incidental harassment authorization (IHA) for the Navy's 2006 Rim-of-the Pacific (RIMPAC) Major Exercise (FR 71.38710-38712, 2006) used 173 dB re 1 μPa^2-second (sec) as the energy threshold level (i.e., SEL) for Level B behavioral harassment for cetaceans. If the transmitted sonar accumulated energy received by a whale was above 195 dB re 1 μPa^2-sec, then the animal was considered to have experienced a temporary loss in the sensitivity of its hearing. The left panel in Figure 3-7 illustrates a typical step-function or threshold that might also relate a sonar exposure to the probability of a response. As this figure illustrates, past Navy/NMFS acoustic thresholds assumed that every marine mammal above a particular received level (for example, to the right of the red vertical line in the figure) would exhibit identical responses to a sonar exposure. This assumed that the responses of marine mammals would not be affected by differences in acoustic conditions; differences between species and populations: differences in gender, age, reproductive status, or social behavior; or the prior experience of the individuals.

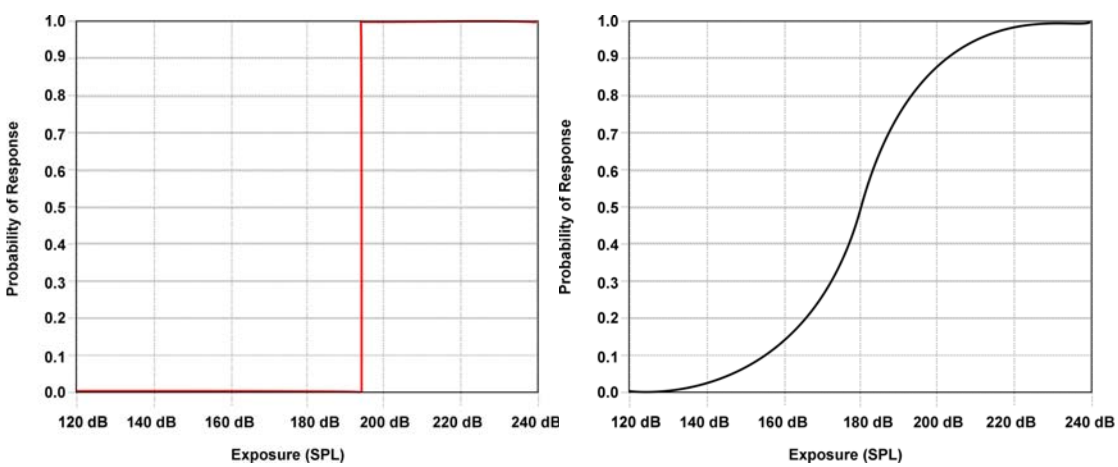


Figure 3-7. Typical Step Function (left) and Typical Risk Contimuum Function (right)

In this figure, for the typical step function (left panel) the probability of a response is depicted on the y-axis and received exposure on the x-axis. The right panel illustrates a typical risk continuum-function using the same axes. SPL is "Sound Pressure Level" in decibels referenced to 1 μPa root mean square (rms).

Both the Navy and NMFS agree that the studies of marine mammals in the wild and in experimental settings do not support these assumptions—different species of marine mammals and different individuals of the same species respond differently to sonar exposure. Additionally, there are specific geographic/bathymetric conditions that dictate the response of marine mammals to sonar that suggest that different populations may respond differently to sonar exposure. Further, studies of animal physiology suggest that gender, age, reproductive status, and social behavior, among other variables, probably affect how marine mammals respond to sonar exposures (Wartzok et al. 2003; Southall et al. 2007).

Over the past several years, the Navy and NMFS have worked on developing an MFA sonar acoustic risk function to replace the acoustic thresholds used in the past to estimate the probability of marine mammals being behaviorally harassed by received levels of MFA sonar. The Navy and NMFS will continue to use acoustic thresholds to estimate temporary or permanent threshold shifts using SEL as the appropriate metric. Unlike acoustic thresholds, acoustic risk continuum functions (which are also called “exposure-response functions,” “dose-response functions,” or “stress-response functions” in other risk assessment contexts) assume that the probability of a response depends first on the “dose” (in this case, the received level of sound) and that the probability of a response increases as the “dose” increases. It is important to note that the probabilities associated with acoustic risk functions do not represent an individual’s probability of responding. Rather, the probabilities identify the proportion of an exposed population that is likely to respond to an exposure.

The right panel in Figure 3-7 illustrates a typical acoustic risk function that might relate an exposure, as received SPL in dB re 1 μPa, to the probability of a response. As the exposure receive level increases in this figure, the probability of a response increases as well but the relationship between an exposure and a response is “linear” only in the center of the curve (that is, unit increases in exposure would produce unit increases in the probability of a response only in the center of a risk function curve). In the “tails” of an acoustic risk function curve, unit increases in exposure produce smaller increases in the probability of a response. Based on observations of various animals, including humans, the relationship represented by an acoustic risk function is a more robust predictor of the probable behavioral responses of marine mammals to sonar and other acoustic sources.

The Navy and NMFS have previously used the acoustic risk function to estimate the probable responses of marine mammals to acoustic exposures for other training and research programs. Examples of previous application include the Navy Final EISs on the SURTASS LFA sonar (DoN 2001); the North Pacific Acoustic Laboratory experiments conducted off the Island of Kauai (Office of Naval Research, 2001), and the Supplemental EIS for SURTASS LFA sonar (DoN 2007a).

The Navy and NMFS used two metrics to estimate the number of marine mammals that could be subject to Level B harassment (behavioral harassment and TTS) as defined by the MMPA, during training exercises. The agencies used acoustic risk functions with the metric of received SPL (dB re 1 μPa) to estimate the number of marine mammals that might be at risk for MMPA Level B behavioral harassment as a result of being exposed to MFA sonar. The agencies will continue to use acoustic thresholds (“step-functions”) with the metric of SEL (dB re 1 μPa^2-s) to estimate the number of marine mammals that might be “taken” through sensory impairment (i.e., Level A – PTS and Level B – TTS) as a result of being exposed to MFA sonar.

Although the Navy has not used acoustic risk functions in previous MFA sonar assessments of the potential effects of MFA sonar on marine mammals, risk functions are not new concepts for risk assessments. Common elements are contained in the process used for developing criteria for air, water, radiation, and ambient noise and for assessing the effects of sources of air, water, and noise pollution. The Environmental Protection Agency (EPA) uses dose-functions to develop water quality criteria and to regulate pesticide applications (U.S. EPA 1998); the Nuclear Regulatory Commission (NRC) uses dose-functions to estimate the consequences of radiation exposures (see NRC 1997 and 10 Code of Federal Regulations [C.F.R] § 20.1201); the Centers for Disease Control and Prevention (CDCP) and the Food and Drug Administration (FDA) use dose-functions as part of their assessment methods (for example, see CDCP 2003, U.S. FDA 2001); and the Occupational Safety and Health Administration (OSHA) uses dose-functions to assess the potential effects of noise and chemicals in occupational environments on the health of people working in those environments (for examples, see FR 61:56746-56856, 1996; FR 71:10099-10385, 2006).

3.16.2 Risk Function Adapted from Feller (1968)

The particular acoustic risk function developed by the Navy and NMFS estimates the probability of behavioral responses that NMFS would classify as harassment for the purposes of the MMPA given exposure to specific received levels of MFA sonar. The mathematical function is derived from a solution in Feller (1968) as defined in the SURTASS LFA Sonar Final OEIS/EIS (DoN 2001), and relied on in the Supplemental SURTASS LFA Sonar EIS (DoN 2007a) for the probability of MFA sonar risk for MMPA Level B behavioral harassment with input parameters modified by NMFS for MFA sonar for mysticetes, odontocetes, and pinnipeds.

In order to represent a probability of risk, the function should have a value near zero at very low exposures, and a value near one for very high exposures. One class of functions that satisfies this criterion is cumulative probability distributions, a type of cumulative distribution function. In selecting a particular functional expression for risk, several criteria were identified:

- The function must use parameters to focus discussion on areas of uncertainty;
- The function should contain a limited number of parameters;
- The function should be capable of accurately fitting experimental data; and
- The function should be reasonably convenient for algebraic manipulations.

As described in DoN(2001), the mathematical function below is adapted from a solution in Feller (1968).

$$R = \frac{1-\left(\frac{L-B}{K}\right)^{-A}}{1-\left(\frac{L-B}{K}\right)^{-2A}}$$

Where: R = risk (0 – 1.0);

L = Received Level (RL) in dB;

B = basement RL in dB; (120 dB);

K = the RL increment above basement in dB at which there is 50 percent risk;

A = risk transition sharpness parameter (10) (explained in 3.1.5.3).

In order to use this function, the values of the three parameters (B, K, and A) need to be established. The values used in this DEIS/DOEIS analysis are based on three sources of data: TTS experiments conducted at SSC and documented in Finneran, et al. (2001, 2003, and 2005; Finneran and Schlundt 2004); reconstruction of sound fields produced by the USS SHOUP associated with the behavioral responses of killer whales observed in Haro Strait and documented in Department of Commerce NMFS (2005); DoN (2004); and Fromm (2004a, 2004b); and observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components documented in Nowacek et al. (2004). The input parameters, as defined by NMFS, are based on very limited data that represent the best available science at this time.

3.16.3 Data Sources Used for Risk Function

There is widespread consensus that cetacean response to MFA sound signals needs to be better defined using controlled experiments. Navy is contributing to an ongoing behavioral response study in the Bahamas that is anticipated to provide some initial information on beaked whales, the species identified as the most sensitive to MFA sonar. NMFS is leading this international effort with scientists from various academic institutions and research organizations to conduct studies on how marine mammals respond to underwater sound exposures.

Until additional data is available, NMFS and the Navy have determined that the following three data sets are most applicable for the direct use in developing risk function parameters for MFA/HFA sonar. These data sets represent the only known data that specifically relate altered behavioral responses to exposure to MFA sound sources.

Data from SSC's Controlled Experiments: Most of the observations of the behavioral responses of toothed whales resulted from a series of controlled experiments, designed as acoustic experiments rather than behavioral experiments, on bottlenose dolphins and beluga whales conducted by researchers at SSC's facility in San Diego, California (Finneran et al. 2001, 2003, 2005; Finneran and Schlundt 2004; Schlundt et al. 2000). In experimental trials with marine mammals trained to perform tasks when prompted, scientists evaluated whether the marine mammals performed these tasks when exposed to mid-frequency tones. Altered behavior during experimental trials usually involved refusal of animals to return to the site of the sound stimulus. This refusal included what appeared to be deliberate attempts to avoid a sound exposure or to avoid the location of the exposure site during subsequent tests (Schlundt et al. 2000, Finneran et al. 2002). Bottlenose dolphins exposed to 1-sec intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 μPa rms, and beluga whales did so at received levels of 180 to 196 dB and above.

Finneran and Schlundt (2004) examined behavioral observations recorded by the trainers or test coordinators during the Schlundt et al. (2000) and Finneran et al. (2001, 2003, 2005) experiments featuring 1-second (sec) tones. These included observations from 193 exposure sessions (fatiguing stimulus level > 141 dB re 1μPa) conducted by Schlundt et al. (2000) and 21 exposure sessions conducted by Finneran et al. (2001, 2003, 2005). The observations were made during exposures to sound sources at 0.4 kHz, 3 kHz, 10 kHz, 20 kHz, and 75 kHz. The TTS experiments that supported Finneran and Schlundt (2004) are further explained below:

- Schlundt et al. (2000) provided a detailed summary of the behavioral responses of trained marine mammals during TTS tests conducted at SSC San Diego with 1-sec tones. Schlundt et al. (2000) reported eight individual TTS experiments. Fatiguing stimuli durations were 1-sec; exposure frequencies were 0.4 kHz, 3 kHz, 10 kHz, 20 kHz and 75 kHz. The experiments were conducted in San Diego Bay. Because of the variable ambient noise in the bay, low-level broadband masking noise was used to keep hearing thresholds consistent despite fluctuations in the ambient noise. Schlundt et al. (2000)

reported that “behavioral alterations,” or deviations from the behaviors the animals being tested had been trained to exhibit, occurred as the animals were exposed to increasing fatiguing stimulus levels.

- Finneran et al. (2001, 2003, 2005) conducted TTS experiments using tones at 3 kHz. The test method was similar to that of Schlundt et al. (2000) except the tests were conducted in a pool with very low ambient noise level (below 50 dB re 1 μPa/hertz [Hz]), and no masking noise was used. Two separate experiments were conducted using 1-sec tones. In the first, fatiguing sound levels were increased from 160 to 201 dB SPL. In the second experiment, fatiguing sound levels between 180 and 200 dB re 1 μPa were randomly presented.

<u>Data from Studies of Baleen (Mysticetes) Whale Responses</u>: The only mysticete data available resulted from a field experiments in which baleen whales (mysticetes) were exposed to a range frequency sound sources from 500 Hz to 4500 Hz (Nowacek et al. 2004). An alert stimulus, with a mid-frequency component, was the only portion of the study used to support the risk function input parameters.

- Nowacek et al. (2004) documented observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components. To assess risk factors involved in ship strikes, a multi-sensor acoustic tag was used to measure the responses of whales to passing ships and experimentally tested their responses to controlled sound exposures, which included recordings of ship noise, the social sounds of conspecifics and a signal designed to alert the whales. The alert signal was 18-minutes of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. The purposes of the alert signal were (a) to provoke an action from the whales via the auditory system with disharmonic signals that cover the whales estimated hearing range; (b) to maximize the signal to noise ratio (obtain the largest difference between background noise) and c) to provide localization cues for the whale. Five out of six whales reacted to the signal designed to elicit such behavior. Maximum received levels ranged from 133 to 148 dB re 1μPa.

<u>Observations of Killer Whales in Haro Strait in the Wild</u>: In May 2003, killer whales (*Orcinus orca*) were observed exhibiting behavioral responses while the USS SHOUP was engaged in MFA sonar operations in the Haro Strait in the vicinity of Puget Sound, Washington. Although these observations were made in an uncontrolled environment, the sound field that may have been associated with the sonar operations had to be estimated, and the behavioral observations were reported for groups of whales, not individual whales, the observations associated with the USS SHOUP provide the only data set available of the behavioral responses of wild, non-captive animal upon exposure to the AN/SQS-53 MFA sonar.

- NMFS (2005), DoN (2004), and Fromm (2004a, 2004b) documented reconstruction of sound fields produced by the USS SHOUP associated with the behavioral response of killer whales observed in Haro Strait. Observations from this reconstruction included an approximate closest approach time which was correlated to a reconstructed estimate of received level at an approximate whale location (which ranged from 150 to 180 dB), with a mean value of 169.3 dB.

3.16.4 Limitations of the Risk Function Data Sources

There are significant limitations and challenges to any risk function derived to estimate the probability of marine mammal behavioral responses; these are largely attributable to sparse data. Ultimately there should be multiple functions for different marine mammal taxonomic groups, but the current data are insufficient to support them. The goal is unquestionably that risk functions be based on empirical measurement.

The risk function presented here is based on three data sets that NMFS and Navy have determined are the best available science at this time. The Navy and NMFS acknowledge each of these data sets has limitations. However, this risk function, if informed by the limited available data relevant to the MFA sonar application, has the advantages of simplicity and the fact that there is precedent for its application and foundation in marine mammal research.

While NMFS considers all data sets as being weighted equally in the development of the risk function, the Navy believes the SSC San Diego data is the most rigorous and applicable for the following reasons:

- The data represents the only source of information where the researchers had complete control over and ability to quantify the noise exposure conditions.
- The altered behaviors were identifiable due to long term observations of the animals.
- The fatiguing noise consisted of tonal exposures with limited frequencies contained in the MFA sonar bandwidth.

However, the Navy and NMFS do agree that the following are limitations associated with the three data sets used as the basis of the risk function:

- The three data sets represent the responses of only four species: trained bottlenose dolphins and beluga whales, North Atlantic right whales in the wild and killer whales in the wild.
- None of the three data sets represent experiments designed for behavioral observations of animals exposed to MFA sonar.
- The behavioral responses of marine mammals that were observed in the wild (observations of killer whales in Haro Strait) are based on an estimated received level of sound exposure; they do not take into consideration (due to minimal or no supporting data):
    - Potential relationships between acoustic exposures and specific behavioral activities (e.g., feeding, reproduction, changes in diving behavior, etc.), variables such as bathymetry, or acoustic waveguides; or
    - Differences in individuals, populations, or species, or the prior experiences, reproductive state, hearing sensitivity, or age of the marine mammal.

<u>SSC San Diego Trained Bottlenose Dolphins and Beluga Data Set:</u>

- The animals were trained animals in captivity; therefore, they may be more or less sensitive than cetaceans found in the wild (Domjan, 1998).
- The tests were designed to measure TTS, not behavior.

- Because the tests were designed to measure TTS, the animals were exposed to much higher levels of sound than the baseline risk function (only two of the total 193 observations were at levels below 160 dB re 1 μPa^2-s).
- The animals were not exposed in the open ocean but in a shallow bay or pool.

North Atlantic Right Whales in the Wild Data Set:

- The observations of behavioral response were from exposure to alert stimuli that contained mid-frequency components but was not similar to a MFA sonar ping. The alert signal was 18 minutes of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. This 18-minute alert stimuli is in contrast to the average 1-sec ping every 30 sec in a comparatively very narrow frequency band used by military sonar.
- The purpose of the alert signal was, in part, to provoke an action from the whales through an auditory stimulus.

Killer Whales in the Wild Data Set:

- The observations of behavioral harassment were complicated by the fact that there were other sources of harassment in the vicinity (other vessels and their interaction with the animals during the observation).
- The observations were anecdotal and inconsistent. There were no controls during the observation period, with no way to assess the relative magnitude of the any observed response as opposed to baseline conditions.

3.16.5 Input Parameters for the Risk Function

The values of B, K, and A need to be specified in order to utilize the risk function defined in Section 3.9.7.4.2. The risk continuum function approximates the dose-response function in a manner analogous to pharmacological risk assessment (DoN 2001, Appendix A). In this case, the risk function is combined with the distribution of sound exposure levels to estimate aggregate impact on an exposed population.

3.16.5.1 Basement Value for Risk—The B Parameter

The B parameter defines the basement value for risk, below which the risk is so low that calculations are impractical. This 120 dB level is taken as the estimate received level (RL) below which the risk of significant change in a biologically important behavior approaches zero for the MFA sonar risk assessment. This level is based on a broad overview of the levels at which multiple species have been reported responding to a variety of sound sources, both mid-frequency and other, was recommended by the scientists, and has been used in other publications. The Navy recognizes that for actual risk of changes in behavior to be zero, the signal-to-noise ratio of the animal must also be zero. However, the present convention of ending the risk calculation at 120 dB for MFA sonar has a negligible impact on the subsequent calculations, because the risk function does not attain appreciable values at received levels that low.

3.16.5.2 The K Parameter

NMFS and the Navy used the mean of the following values to define the midpoint of the function: (1) the mean of the lowest received levels (185.3 dB) at which individuals responded with altered behavior to 3 kHz tones in the SSC data set; (2) the estimated mean received level value of 169.3 dB produced by the reconstruction of the USS SHOUP incident in which killer whales exposed to MFA sonar (range modeled possible received levels: 150 to 180 dB); and (3) the mean of the 5 maximum received levels at which Nowacek et al. (2004) observed significantly altered responses of right whales to the alert stimuli than to the control (no input signal) is 139.2 dB SPL. The arithmetic mean of these three mean values is 165 dB SPL. The value of K is the difference between the value of B (120 dB SPL) and the 50 percent value of 165 dB SPL; therefore, K=45.

3.16.5.3 Risk Transition—The A Parameter

The A parameter controls how rapidly risk transitions from low to high values with increasing receive level. As A increases, the slope of the risk function increases. For very large values of A, the risk function can approximate a threshold response or step function. NMFS has recommended that Navy use A=10 as the value for odontocetes, and pinnipeds (Figure 3.1.5.3-1) (NMFS 2008). This is the same value of A that was used for the SURTASS LFA sonar analysis. As stated in the SURTASS LFA Sonar Final OEIS/EIS (DoN 2001), the value of A=10 produces a curve that has a more gradual transition than the curves developed by the analyses of migratory gray whale studies (Malme et al., 1984). The choice of a more gradual slope than the empirical data was consistent with other decisions for the SURTASS LFA Sonar Final OEIS/EIS to make conservative assumptions when extrapolating from other data sets (see Subchapter 1.43 and Appendix D of the SURTASS LFA Sonar EIS [NMFS 2008]).

Based on NMFS' direction, the Navy will use a value of A=8 for mysticetes to allow for greater consideration of potential harassment at the lower received levels based on Nowacek et al., 2004 (Figure 3.1.5.3-2) (NMFS 2008).

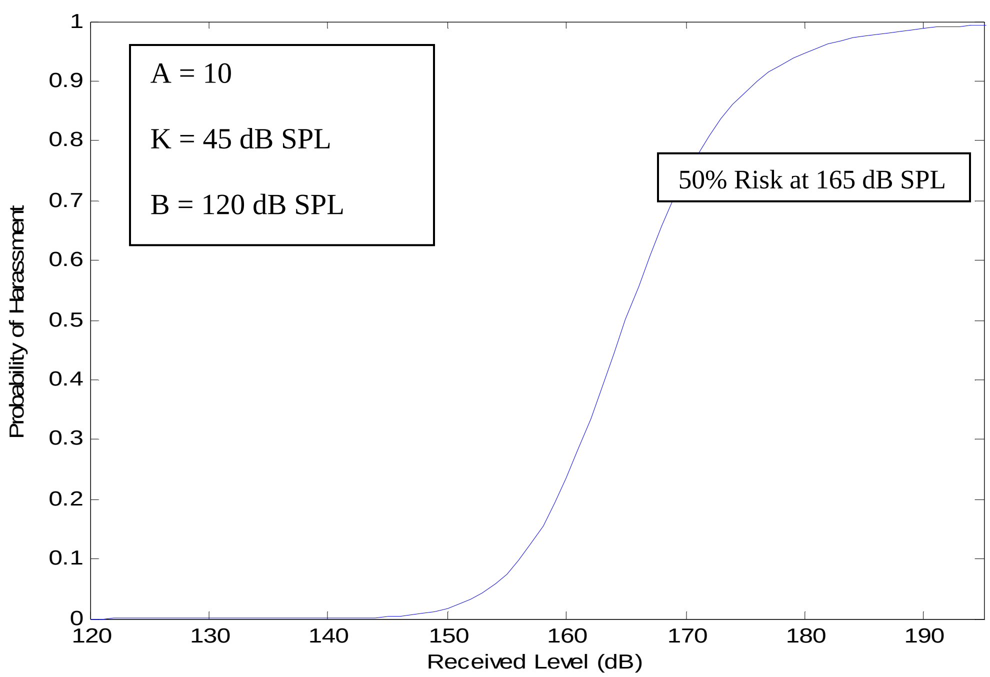


Figure 3-8. Risk Function Curve for Odontocetes (Toothed Whales) and Pinnipeds

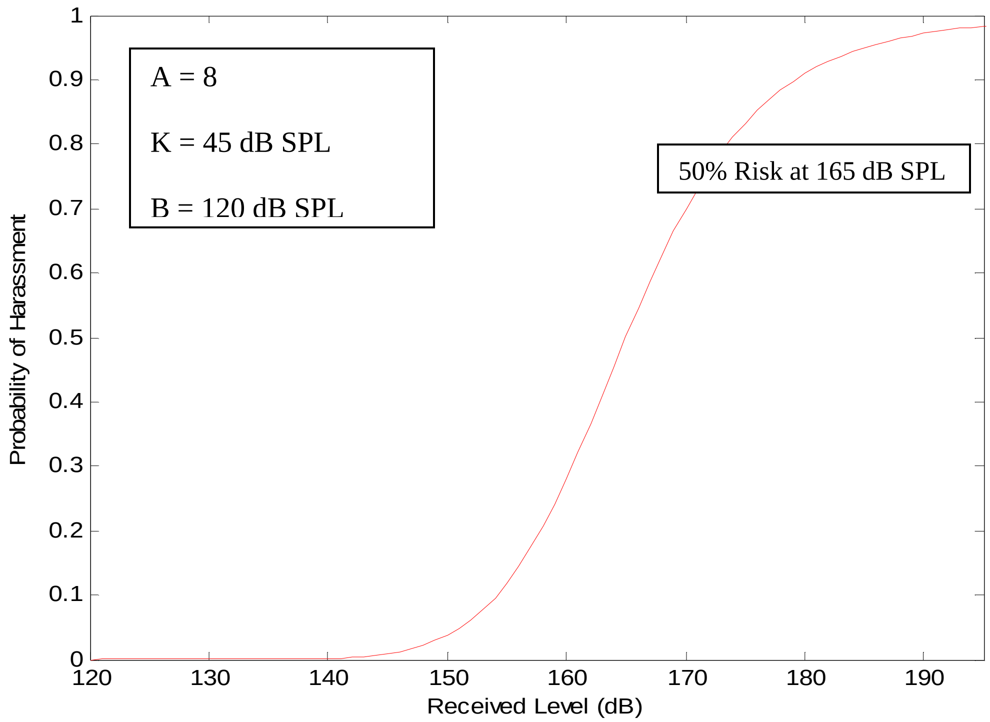


Figure 3-9. Risk Function Curve for Mysticetes (Baleen Whales)

3.16.6 Application of the Risk Function and Current Regulatory Scheme

The risk function is used to estimate the percentage of an exposed population that is likely to exhibit behaviors that would qualify as harassment (as that term is defined by the MMPA applicable to military readiness activities, such as the Navy's testing and training with mid- and high-frequency active sonar) at a given received level of sound. For example, at 165 dB SPL (dB re: 1µPa rms), the risk (or probability) of harassment is defined according to this function as 50 percent, and Navy/NMFS applies that by estimating that 50 percent of the individuals exposed at that received level are likely to respond by exhibiting behavior that NMFS would classify as behavioral harassment. The risk function is not applied to individual animals, only to exposed populations.

The data used to produce the risk function were compiled from four species that had been exposed to sound sources in a variety of different circumstances. As a result, the risk function represents a general relationship between acoustic exposures and behavioral responses that is then applied to specific circumstances. That is, the risk function represents a relationship that is deemed to be generally true, based on the limited, best-available science, but may not be true in specific circumstances. In particular, the risk function, as currently derived, treats the received level as the only variable that is relevant to a marine mammal's behavioral response. However, we know that many other variables—the marine mammal's gender, age, and prior experience; the activity it is engaged in during an exposure event, its distance from a sound source, the number of sound sources, and whether the sound sources are approaching or moving away from the animal—can be critically important in determining whether and how a marine mammal will respond to a sound source (Southall et al. 2007). The data that are currently available do not allow for incorporation of these other variables in the current risk functions; however, the risk function represents the best use of the data that are available.

As more specific and applicable data become available, NMFS can use these data to modify the outputs generated by the risk function to make them more realistic (and ultimately, data may exist to justify the use of additional, alternate, or multi-variate functions). As mentioned above, it is known that the distance from the sound source and whether it is perceived as approaching or moving away can affect the way an animal responds to a sound (Wartzok et al. 2003). Though there are data showing marine mammal responses to sound sources at that *received level*, NMFS does not currently have any data that describe the response of marine mammals to sounds at that *distance* (or to other contextual aspects of the exposure, such as the presence of higher frequency harmonics), much less data that compare responses to similar sound levels at varying distances. However, if data were to become available that suggested animals were less likely to respond (in a manner NMFS would classify as harassment) to certain levels beyond certain distances, or that they were more likely to respond at certain closer distances, Navy will re-evaluate the risk function to try to incorporate any additional variables into the "take" estimates.

Last, pursuant to the MMPA, an applicant is required to estimate the number of animals that will be "taken" by their activities. This estimate informs the analysis that NMFS must perform to determine whether the activity will have a "negligible impact" on the species or stock. Level B (behavioral) harassment occurs at the level of the individual(s) and does not assume any resulting population-level consequences, though there are known avenues through which behavioral disturbance of individuals can result in population-level effects. Alternately, a negligible impact finding is based on the lack of likely adverse effects to annual rates of recruitment or survival (i.e., population-level effects). An estimate of the number of Level B harassment takes, alone, is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be "taken" through harassment, NMFS must consider other factors, such as the nature of any responses (their intensity, duration, etc.), the context of any responses (critical reproductive time or location, migration, etc.), or any of the other variables mentioned in the first paragraph (if known), as well as the number and nature of estimated Level A takes, the number of estimated mortalities, and effects on habitat. For example, in the case of sonar usage in the SOCAL Range Complex, a portion of the animals that are likely to be "taken" through behavioral harassment are expected to be exposed at relatively low received levels (120-140 dB SPL) where the significance of those responses would be reduced because of the distance (25-65 nm) from a sound source. Alternatively, only a relatively very small portion (<5%) of the animals that are expected to be "taken" through behavioral harassment are expected to occur when animals are exposed to higher received levels, such as the onset of TTS (195 dB re 1 μPa^2-s) or higher. Since the modeling does not take into account the reduction of effects resulting from the Navy's standard mitigation, approximately 25% of all exposures are modeled as having occurred within the 1,000 yard mitigation safety zone where procedures are in place to reduce the received level of animals within this zone. Generally speaking, Navy and NMFS anticipate more severe effects from takes resulting from exposure to higher received levels (though this is in no way a strictly linear relationship throughout species, individuals, or circumstances) and less severe effects from takes resulting from exposure to lower received levels.

It is worth noting that Navy and NMFS would expect an animal exposed to the levels at the bottom of the risk function to exhibit behavioral responses that are less likely to adversely affect the longevity, survival, or reproductive success of the animals that might be exposed, based on received level, and the fact that the exposures will occur in the absence of some of the other contextual variables that would likely be associated with increased severity of effects, such as the proximity of the sound source(s) or the proximity of other vessels, aircraft, submarines, etc.

maneuvering in the vicinity of the exercise. NMFS will consider all available information (other variables, etc.), but all else being equal, takes that result from exposure to lower received levels and at greater distances from the exercises would be less likely to contribute to population level effects.

3.16.7 Navy Protocols For Acoustic Modeling Analysis of Marine Mammal Exposures

For this DEIS/DOEIS, the acoustic modeling results include additional analysis to account for the model's overestimation of potential effects. Specifically, the model overestimated effects because:

- Acoustic footprints for sonar sources near land are not reduced to account for the land mass where marine mammals would not occur..
- Acoustic footprints for sonar sources were added independently and, therefore, did not account for overlap they would have with other sonar systems used during the same active sonar activity. As a consequence, the area of the total acoustic footprint was larger than the actual acoustic footprint when multiple ships are operating together.
- Acoustic exposures do not reflect implementation of mitigation measures, such as reducing sonar source levels when marine mammals are present.
- Marine mammal densities were averaged across specific active sonar activity areas and, therefore, are evenly distributed without consideration for animal grouping or patchiness.
- Acoustic modeling did not account for limitations of the NMFS-defined refresh rate of 24 hours. This time period represents the amount of time in which individual marine mammals can be harasses no more than once.

Table 3-2 provides a summary of the modeling protocols used in the analysis for this DEIS/OEIS.

Table 3-2. Navy Protocols Providing for Modeling Quantification of Marine Mammal Exposures

Historical Data	Sonar Positional Reporting System (SPORTS)	Annual active sonar usage data will be obtained from the SPORTS database to determine the number of active sonar hours and the geographic location of those hours for modeling purposes.
Acoustic Parameters	AN/SQS-53 and AN/SQS-56	Model the AN/SQS-53 and the AN/SQS-56 active sonar sources separately to account for the differences in source level, frequency, and exposure effects.
	Submarine Sonar	Submarine active sonar use will be included in effects analysis calculations using the SPORTS database.
Post Modeling Analysis	Land Shadow	For sound sources within the acoustic footprint of land, subtract the land area from the marine mammal exposure calculation.
	Multiple Ships	Correction factors will be used to address overestimates of exposures to marine mammals resulting from multiple counting when there are more than one ship operating in the same vicinity.
	Multiple Exposures	The following refresh rates for SOCAL Range Complex training events will be included to account for multiple exposures: • Unit-level Training, Coordinated Events, and Maintenance – 4 hours • Integrated Anti-submarine Warfare (ASW) Course- – 16 hours • Major Exercises / Major Range Events– 12 hours • Sustainment Training Exercises – 12 hours.

3.17 OTHER EFFECTS CONSIDERED

3.18 STRESS

A possible stressor for marine mammals exposed to sound, including mid-frequency active sonar, is the effect on health and physiological stress (Review by Fair and Becker 2000). A stimulus may cause a number of behavioral and physiological responses such as an elevated heart rate, increases in endocrine and neurological function, and decreased immune function, particularly if the animal perceives the stimulus as life threatening (Seyle 1950; Moberg 2000; Sapolsky *et al*. 2005). The primary response to the stressor is to move away to avoid continued exposure. Next, the animal's physiological response to a stressor is to engage the autonomic nervous system with the classic "fight or flight" response. This includes changes in the cardiovascular system (increased heart rate), the gastrointestinal system (decrease digestion), the exocrine glands (increased hormone output), and the adrenal glands (increased nor-epinephrine). These physiological and hormonal responses are short lived and may not have significant long-term effects on an animal's health or fitness. Generally these short term responses are not detrimental to the animal except when the health of the animal is already compromised by disease, starvation or parasites; or the animal is chronically exposed to a stressor.

Exposure to chronic or high intensity sound sources can cause physiological stress. Acoustic exposures and physiological responses have been shown to cause stress responses (elevated respiration and increased heart rates) in humans (Jansen 1998). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper et al. (1998) reported on the physiological stress responses of osprey to low-level aircraft noise. Krausman et al. (2004) reported on the auditory (TTS) and physiology stress responses of Sonoran pronghorn antelope to military overflights. Smith et al. (2004a, 2004b) recorded sound-induced physiological stress responses in a hearing-specialist fish that was associated with TTS. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Most of these responses to sound sources or other stimuli have been studied extensively in terrestrial animals but are much more difficult to determine in marine mammals. Increases in heart rate are common reaction to acoustic disturbance in marine mammals (Miksis *et al*. 2001) as are small increases in the hormones norepinephrine, epinephrine, and dopamine (Romano *et al*. 2002; 2004). Increases in cortical steroids are more difficult to determine because blood collection procedures will also cause stress (Romano *et al*. 2002; 2004). A recent study, Chase Encirclement Stress Studies (CHESS), was conducted by NMFS on chronic stress effects in small odontocetes affected by the eastern tropical Pacific (ETP) tuna fishery (Forney et al. 2002). Analysis was conducted on blood constituents, immune function, reproductive parameters, heart rate and body temperature of small odontocetes that had been pursued and encircled by tuna fishing boats. Some effects were noted, including lower pregnancy rates, increases in norepinephrine, dopamine, ACTH and cortisol levels, heart lesions and an increase in fin and surface temperature when chased for over 75 minutes but with no change in core body temperature (Forney et al. 2002). These stress effects in small cetaceans that were actively pursued (sometimes for over 75 minutes) were relatively small and difficult to discern. It is unlikely that marine mammals exposed to mid-frequency active sonar would be exposed at long as the cetaceans in the CHESS study and would not be pursued by the Navy ships, therefore stress effects would be minimal from the short term exposure to sonar.

3.18.1 Acoustically Mediated Bubble Growth

One suggested cause of injury to marine mammals is by rectified diffusion (Crum and Mao 1996) the process of increasing the size of a bubble by exposing it to a sound field. This process is facilitated if the environment in which the ensonified bubbles exist is supersaturated with a gas, such as nitrogen which makes up approximately 78 percent of air (remainder of air is about 21 percent oxygen with some carbon dioxide). Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard 1979). Deeper and longer dives of some marine mammals (for example, beaked whales) are theoretically predicted to induce greater super saturation (Houser et al. 2001). Conversely, studies have shown that marine mammal lung structure (both pinnipeds and cetaceans) facilitates collapse of the lungs at depths deeper than approximately 162 ft (Kooyman et al. 1970). Collapse of the lungs would force air in to the non-air exchanging areas of the lungs (in to the bronchioles away from the alveoli) thus significantly decreasing nitrogen diffusion in to the body. Deep diving pinnipeds such as the northern elephant and Weddell seals (*Leptonychotes weddellii*) typically exhale before long deep dives, further reducing air volume in the lungs (Kooyman et al. 1970). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue super saturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness.

It is unlikely that the short duration of sonar pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested. Stable bubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario the marine mammal would need to be in a gas-supersaturated state for a long enough period of time and exposed to a continuous sound source for bubbles to become of a problematic size.

3.18.2 DecompressionSickness

Another hypothesis suggests that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson et al. 2003). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Cox et al. (2006), with experts in the field of marine mammal behavior, diving, physiology, respiration physiology, pathology, anatomy, and bio-acoustics considered this to be a plausible hypothesis but requires further investigation. Conversely Fahlman et al. (2006) suggested that diving bradycardia (reduction in heart rate and circulation to the tissues), lung collapse and slow ascent rates would reduce nitrogen uptake and thus reduce the risk of decompression sickness by 50 percent in models of marine mammals. Recent information on the diving profiles of Cuvier’s and Blaineville’s beaked whales in Hawaii (Baird et al. 2006) and in the Ligurian Sea in Italy (Tyack et al. 2006b) showed that while these species do dive deeply (regularly exceed depths of 2,624 ft) and for long periods (48-68 minutes), they have significantly slower ascent rates than descent rates. This fits well with Fahlman et al. (2006) model of deep and long duration divers that would have slower ascent rates to reduce nitrogen saturation and reduce the risk of decompression sickness. Therefore, if nitrogen saturation remains low, then a rapid ascent in response to sonar should not cause decompression sickness. Currently it is not known if beaked whales do rapidly ascend in response to sonar or other disturbances. It may be that deep diving animals would be better protected diving to depth to avoid predators, such as killer whales, rather than ascending to the surface where they may be more susceptible to predators.

Although theoretical predictions suggest the possibility for acoustically mediated bubble growth, there is considerable disagreement among scientists as to its likelihood (Piantadosi and Thalmann 2004; Evans and Miller 2003). To date, ELs predicted to cause in vivo bubble formation within diving cetaceans have not been evaluated (NOAA 2002b). Further, although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson et al. 2003), there is no conclusive evidence of this and complicating factors associated with introduction of gas in to the venous system during necropsy. Because evidence supporting it is debatable, no marine mammals addressed in this EIS/OEIS are given special treatment due to the possibility for acoustically mediated bubble growth. Beaked whales are, however, assessed differently from other species to account for factors that may have contributed to prior beaked whale strandings as set out in the previous section.

3.18.3 Resonance

Another suggested cause of injury in marine mammals is air cavity resonance due to sonar exposure. Resonance is a phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration—the particular frequency at which the object vibrates most readily. The size and geometry of an air cavity determine the frequency at which the cavity will resonate. Displacement of the cavity boundaries during resonance has been suggested as a cause of injury. Large displacements have the potential to tear tissues that surround the air space (for example, lung tissue).

Understanding resonant frequencies and the susceptibility of marine mammal air cavities to resonance is important in determining whether certain sonars have the potential to affect different cavities in different species. In 2002, NMFS convened a panel of government and private scientists to address this issue (NOAA 2002b). They modeled and evaluated the likelihood that Navy mid-frequency active sonar caused resonance effects in beaked whales that eventually led to their stranding (DOC and DON 2001). The conclusions of that group were that resonance in air-filled structures the frequencies at which resonance were predicted to occur were below the frequencies utilized by the sonar systems employed. Furthermore, air cavity vibrations due to the resonance effect were not considered to be of sufficient amplitude to cause tissue damage.

3.18.4 Likelihood of Prolonged Exposure

The proposed ASW activities within the SOCAL Range Complex would not result in prolonged exposure because the vessels are constantly moving, and the flow of the activity in the SOCAL Range Complex when ASW training occurs reduces the potential for prolonged exposure. The implementation of the mitigation measures described in Section 5 would further reduce the likelihood of any prolonged exposure.

3.18.5 Likelihood of Masking

Natural and artificial sounds can disrupt behavior by masking, or interfering with an animal's ability to hear other sounds. Masking occurs when the receipt of a sound is interfered with by a second sound at similar frequencies and at similar or higher levels. If the second sound were artificial, it could be potentially harassing if it disrupted hearing-related behavior such as communications or echolocation. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure.

Historically, principal masking concerns have been with prevailing background sound levels from natural and manmade sources (for example, Richardson et al. 1995). Dominant examples of the latter are the accumulated sound from merchant ships and sound of seismic surveys. Both cover a wide frequency band and are long in duration.

The proposed SOCAL Range Complex ASW areas are away from harbors but may include heavily traveled shipping lanes, although shipping lanes are a small portion of the overall range complex. The loudest mid-frequency underwater sounds in the Proposed Action area are those produced by hull-mounted mid-frequency active tactical sonar. The sonar signals are likely within the audible range of most cetaceans, but are very limited in the temporal and frequency domains. In particular, the pulse lengths are short, the duty cycle low, the total number of hours of operation per year small, and these hull-mounted mid-frequency active tactical sonars transmit within a narrow band of frequencies (typically less than one-third octave).

For the reasons outlined above, the chance of sonar operations causing masking effects is considered negligible.

3.18.6 Long-Term Effects

Navy activities are conducted in the same general areas throughout the SOCAL Range Complex, so marine mammal populations could be exposed to repeated activities over time. However, as described earlier, short-term non-injurious sound exposure levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. Application of this criterion assumes an effect even though it is highly unlikely that all behavioral disruptions or instances of TTS will result in long term significant impacts.

Long-term monitoring programs for the SOCAL Range Complex are being developed by the Navy to assess population trends and responses of marine mammals to Navy activities. Short-term monitoring programs for exercises (e.g., undersea warfare exercise (USWEX)) are being developed to assess mitigation measures and responses of marine mammals to Navy activities.

3.19 APPLICATION OF EXPOSURE THRESHOLDS TO OTHER SPECIES

Mysticetes

Information on auditory function in mysticetes is extremely lacking. Sensitivity to low-frequency sound by baleen whales has been inferred from observed vocalization frequencies, observed reactions to playback of sounds, and anatomical analyses of the auditory system. Baleen whales are estimated to hear from 15 Hz to 20 kHz, with good sensitivity from 20 Hz to 2 kHz (Ketten 1998). Filter-bank models of the humpback whale's ear have been developed from anatomical features of the humpback's ear and optimization techniques (Houser et al. 2001). The results suggest that humpbacks are sensitive to frequencies between 40 Hz and 16 kHz, but best sensitivity is likely to occur between 100 Hz and 8 kHz. However, absolute sensitivity has not been modeled for any baleen whale species. Furthermore, there is no indication of what sorts of sound exposure produce threshold shifts in these animals.

The criteria and thresholds for PTS and TTS developed for odontocetes for this activity are also used for mysticetes. This generalization is based on the assumption that the empirical data at hand are representative of both groups until data collection on mysticete species shows otherwise. For the frequencies of interest for this action, there is no evidence that the total amount of energy required to induce onset-TTS and onset-PTS in mysticetes is different than that required for odontocetes.

Beaked Whales

Recent beaked whale strandings have prompted inquiry into the relationship between high-amplitude continuous-type sound and the cause of those strandings. For example, in the stranding in the Bahamas in 2000, the Navy mid-frequency sonar was identified as the only contributory cause that could have lead to the stranding. The Bahamas exercise entailed multiple ships using mid-frequency sonar during transit of a long constricted channel. The Navy participated in an extensive investigation of the stranding with the NMFS. The "Joint Interim Report, Bahamas Marine Mammal Stranding Event of 15-16 March 2000" concluded that the variables to be considered in managing future risk from tactical mid-range sonar were "sound propagation characteristics (in this case a surface duct), unusual underwater bathymetry, intensive use of multiple sonar units, a constricted channel with limited egress avenues, and the presence of beaked whales that appear to be sensitive to the frequencies produced by these sonars." (DOC and DON 2001).

The Navy analyzed the known range of operational, biological, and environmental factors involved in the Bahamas stranding and focused on the interplay of these factors to reduce risks to beaked whales from ASW training operations. Mitigation measures based on the Bahamas investigation are presented in Chapter 5. The confluence of these factors do not occur in the SOCAL Range Complex. Although beaked whales are visually and acoustically detected in areas where sonar use routinely takes place, there has not been a stranding of beaked whales in the SOCAL Range Complex associated with the 30-year use history of the present sonar systems.

This history would suggest that the simple exposure of beaked whales to sonar is not enough to cause beaked whales to strand. Brownell et al (2004), have suggested that the high number of beaked whale strandings in Japan between 1980 and 2004 may be related to U.S. Navy sonar use in those waters given the presence of U.S. Naval Bases and exercises off Japan. The Center for Naval Analysis compiled the history of naval exercises taking place off Japan and found there to be no correlation in time for any of the stranding events presented in Brownell et al (2004). Like the situation in California, there are clearly beaked whales present in the waters off Japan (as evidenced by the strandings) however, there is no correlation in time to strandings and sonar use. Sonar did not causing the strandings provided by Brownell et al. (2004) and more importantly, this suggests sonar use in the presence of beaked whales over two decades has not resulted in strandings related to sonar use.

As suggested by the known presence of beaked whales in waters sonar use has historically taken place, it is likely that beaked whales have been occasionally exposed to sonar during the last 30 years of sonar use in Southern California and yet there is no indication of any adverse impact on beaked whales from exposure to sonar in Californian waters. Therefore, the continued use of sonar in the SOCAL Range Complex is not likely to result in effects to beaked whales.

3.19.1 Explosive Source Criteria

The criterion for mortality for marine mammals used in the CHURCHILL FEIS (DON, 2001) is "onset of severe lung injury." This is conservative in that it corresponds to a 1 percent chance of mortal injury, and yet any animal experiencing onset severe lung injury is counted as a lethal exposure.

- The threshold is stated in terms of the Goertner (1982) modified positive impulse with value "indexed to 31 psi-ms.'" Since the Goertner approach depends on propagation, source/animal depths, and animal mass in a complex way, the actual impulse value corresponding to the 31-psi-ms index is a complicated calculation. Again, to be conservative, CHURCHILL used the mass of a calf dolphin (at 12.2 kg), so that the threshold index is 30.5 psi-ms (Table 3.3).

Two criteria are used for injury: onset of slight lung hemorrhage and 50 percent eardrum rupture (tympanic membrane [TM] rupture). These criteria are considered indicative of the onset of injury (Table 3.3).

- The threshold for onset of slight lung injury is calculated for a small animal (a dolphin calf weighing 27 lb), and is given in terms of the "Goertner modified positive impulse," indexed to 13 psi-ms in the (DON, 2001a). This threshold is conservative since the positive impulse needed to cause injury is proportional to animal mass, and therefore, larger animals require a higher impulse to cause the onset of injury.

- The threshold for TM rupture corresponds to a 50 percent rate of rupture (i.e., 50 percent of animals exposed to the level are expected to suffer TM rupture); this is stated in terms of an EL value of 205 dB re 1 μPa^2-s. The criterion reflects the fact that TM rupture is not necessarily a serious or life-threatening injury, but is a useful index of possible injury that is well correlated with measures of permanent hearing impairment (e.g., Ketten, 1998 indicates a 30 percent incidence of permanent threshold shift [PTS] at the same threshold).

Two criteria are considered for non-injurious harassment temporary threshold shift (TTS), which is a temporary, recoverable, loss of hearing sensitivity (NMFS 2001; DON 2001a).

- The first criterion for TTS is 182 dB re 1 μPa^2-s maximum EL level in any 1/3-octave band at frequencies >100 hertz (Hz).

- A second criterion for estimating TTS threshold has also been developed. A threshold of 12 pounds per square inch (psi) peak pressure was developed for 10,000 pound charges as part of the CHURCHILL Final EIS (DON 2001a, [FR70/160, 19 Aug 05; FR 71/226, 24 Nov 06]). It was introduced to provide a more conservative safety zone for TTS when the explosive or the animal approaches the sea surface (for which case the explosive energy is reduced but the peak pressure is not). Navy policy is to use a 23 psi criterion for explosive charges less than 2,000 lb and the 12 psi criterion for explosive charges larger than 2,000 lb. This is below the level of onset of TTS for an odontocete (Finneran *et al*. 2002). All explosives modeled for the SOCAL Range Complex EIS/OEIS are less than 1,500 lbs.

Table 3-3. Effects Analysis Criteria for Underwater Detonations for Explosives < 2000 lbs Net Explosive Weight. Based on CHURCHILL FEIS (DON 2001) and Eglin Air Force Base IHA (NMFS 2005h) and LOA (NMFS 2006a).

	Criterion	Metric	Threshold	Comments	Source
Mortality & Injury	**Mortality** Onset of extensive lung hemorrhage	**Shock Wave** Goertner modified positive impulse	30.5 psi-msec	All marine mammals (dolphin calf)	Goertner 1982
	Slight Injury Onset of slight lung hemorrhage	**Shock Wave** Goertner modified positive impulse	13.0 psi-msec	All marine mammals (dolphin calf)	Goertner 1982
	Slight Injury 50% TM Rupture	**Shock Wave** Energy Flux Density (EFD) for *any single exposure*	205 dB re:1µPa^2-sec	All marine mammals	DoN 2001
Harassment	**Temporary Auditory Effects** TTS	**Noise Exposure** greatest EFD in any 1/3-octave band *over all exposures*	182 dB re:1µPa^2-sec	For odontocetes greatest EFD for frequencies ≥100 Hz and for mysticetes ≥10 Hz	NMFS 2005, NMFS 2006a
	Temporary Auditory Effects TTS	**Noise Exposure** Peak Pressure for *any single exposure*	23 psi-msec	All marine mammals	DoN 2001
	Behavioral Modification	**Noise Exposure** greatest EFD in any 1/3-octave band *over all exposures*	177 dB re:1µPa^2-sec	For odontocetes greatest EFD for frequencies ≥100 Hz and for mysticetes ≥10 Hz	NMFS

Notes:

Goertner, J.F. 1982. Prediction of underwater explosion safe ranges for sea mammals. Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, MD. NSWC/WOL TR-82-188. 25 pp.

DoN. 2001. USS Churchill Shock Trail FEIS- February 2001. Department of the Navy.

NMFS. 2005. Notice of Issuance of an Incidental Harassment Authorization, Incidental to Conducting the Precisions Strike Weapon (PSW) Testing and Training by Eglin Air Force Base in the Gulf of Mexico. Federal Register,70(160):48675-48691.

NMFS. 2006. Incidental Takes of Marine Mammals Incidental to Specified Activities; Naval Explosive Ordnance Disposal School Training Operations at Eglin Air Force Base, Florida, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Federal Register 71(199):60693-60697

NMFS. Briefed to NMFS for VAST-IMPASS; U.S. Air Force uses 176 dB for permit applications at Eglin Gulf Test and Training Range (EGTTR)

3.19.2 Shallow Water Underwater Detonations (Offshore of San Clemente Island)

Navy Special Warfare (NSW) incorporates VSW, bottom-laid explosives training into Basic Underwater Demolition/School (BUD/S) and Maritime Operations (MAROPs) training curriculums. Personnel training include small, single underwater explosive charges at Northwest Harbor (Figure 3-10) and Horse Beach Cove (Figure 3-11), and multiple charges at Northwest Harbor on San Clemente Island (SCI).

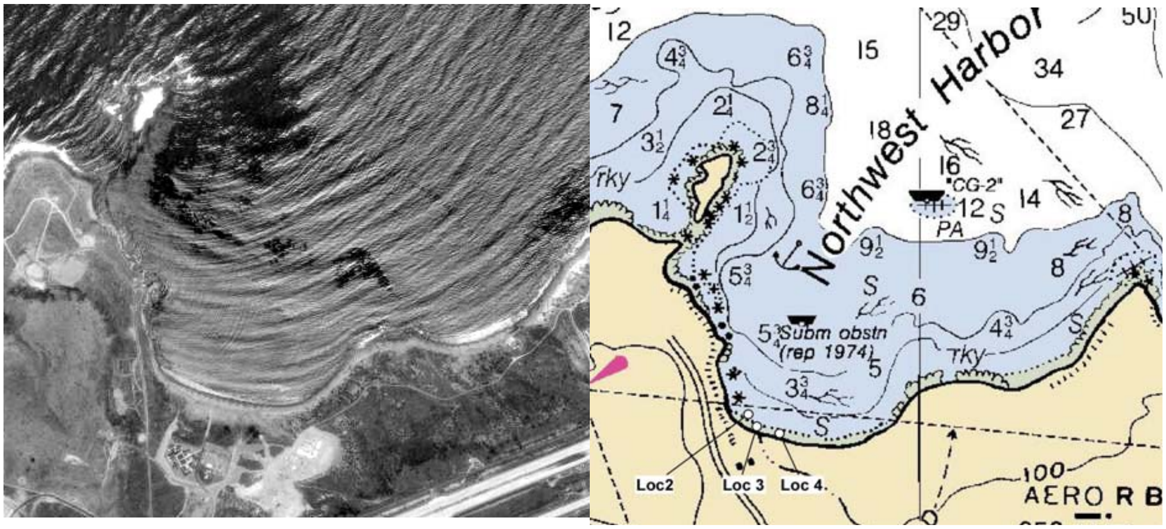


Figure 3-10. San Clemente Island, Northwest Harbor Aerial Photo and Chart Depths in fathoms at mean lower low water

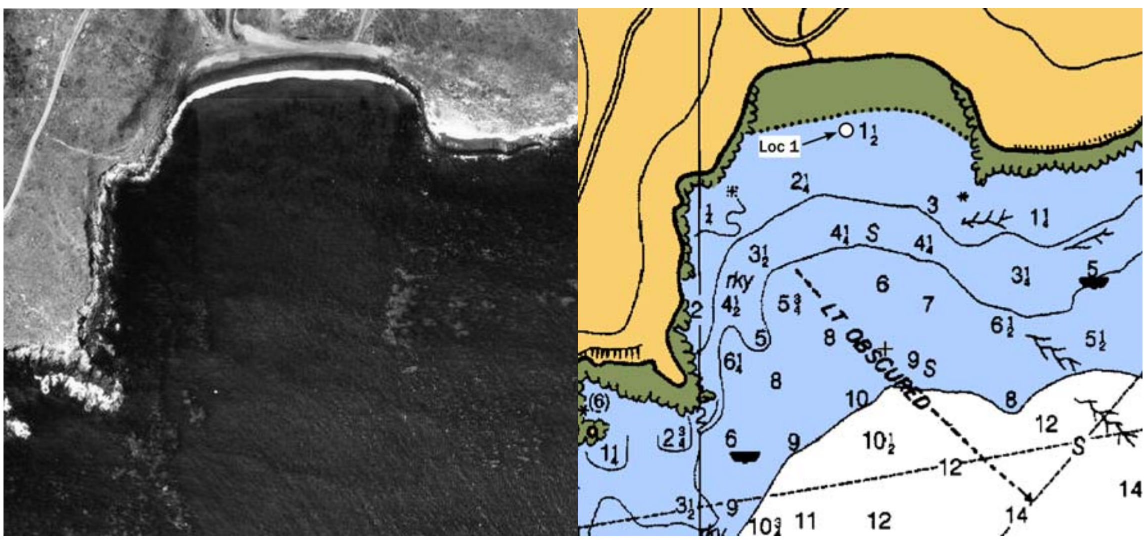


Figure 3-11. San Clemente Island, Horse Beach Cove, Aerial Photo and Chart Depths in fathoms at mean lower low water

These exercises are the culmination of theoretical and practical instruction for successive groups of Navy Special Warfare (NSW) personnel-in-training. The exercises are essential in that they provide NSW personnel with hands-on experience with the design, deployment, and detonation of underwater clearance devices of the general type and size that they are required to understand and utilize. The specific explosive elements and their arrangements have been selected to include the widest range of features, so that a trained operator can competently use similar forms or configurations as objectives require. That is, the explosive configurations used in the training exercises are not necessarily those that would be used in actual operations.

There are three underwater explosive exercises conducted in Northwest Harbor: the single charge (SC) exercise, the multiple-charge obstacle loading (OL) exercise, and the multiple-charge mat-weave (MW) exercise. Only SC exercises are conducted at Horse Beach Cove. Single charges of up to 20 lbs of C4 high-explosive are detonated in near-shore waters of 5 to 20 feet depth at Northwest Harbor and of 10-12 ft depth at Horse Beach Cove.

OL exercise is conducted up to 7 times a year at Northwest Harbor (Figure 3-12). The obstacles used in training are 8, 1 m^2 concrete blocks on the bottom in about 15 ft of water. They are arranged in an elongated pattern parallel to the shoreline. Onto each obstacle are attached 2 haversack charges of C4 explosive weighing 20 lbs each that is equivalent to about 27 lbs of TNT. All haversacks of all obstacles are cross-connected by detonation cord to effect coordinated detonation of C4.

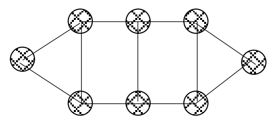


Figure 3-12. Obstacle Pattern

MW exercise is conducted up to 7 times a year at Northwest Harbor (Figure 3-11). Two MW devices or mats are used in training, and involves the detonation of two lattices of line-charge explosive in quick succession. Each mat is a square lattice arrangement of 2.75-in diameter line-charge high explosive with 10, 25-ft long segments arranged in a 5 x 5 cross-hatch pattern and tied together at their intersections (Figure 3-12 Square Mats). Each of the 10 line charges contains 50 lbs of PBX composite-explosive that is equivalent to about 67 lbs of TNT. The two 500-lb mats are placed side-by-side on the bottom at a depth of about 5 ft just off the shoreline. The explosive within each mat is detonated simultaneously – at the speed of the explosive – and the two mats are detonated sequentially with a time-separation of about 500 ms. By design, a mat directs a large proportion of its explosive force vertically – i e., down into the substrate and, incidentally, up into the air. MW exercises occur at the location labeled “Loc 3” on the chart in Figure 2 of the main text.

All scheduling, safety regulation enforcement, explosive handling, and explosive detonations are carried out by qualified NSW training personnel.

Mitigation Considerations and Precedence: The unusual physical topographies, the low numbers of protected species and the training routines at both sites combine with the unusual pressure-wave propagation characteristics of the Northwest Harbor, where multiple charges are used, to allow exceptionally reliable and effective mitigation procedures. Each of those characteristics will be described, but the exceptional reliability of visual detection of protected species at these sites allows for complete mitigation within a radius that extends out to the distance at which only the lowest degree of temporary auditory threshold shift (onset-TTS) would be expected to occur. That is, the procedures to be described will mitigate the potential for Level-A harassment by injury and Level-B harassment associated with TTS by not detonating explosives while protected species are in the area associated with those effects. That approach and the analysis used in this DEIS for underwater explosive effects on marine mammals and turtles are based on the criteria established in the FEIS for shock trial of the USS Winston S. Churchill (DoN, 2001) and the associated regulatory ruling (66 FR 22450, May 4, 2001). From those precedents, the distance at which onset-TTS, a Level-B harassment, would be expected to occur is taken be the greater of the distances at which either the peak-pressure has fallen to 12 psi or the energy in the 3rd octave-band of highest energy has fallen to 182 dB re 1 µPa^2 ·sec. For mysticetes, only energy occurring above 10 Hz was considered in the energy estimates and for odontocetes, only energy occurring above 100 Hz was considered.

Given effective mitigation to the distance associated with onset-TTS, more severe impacts – e. g., greater TTS and Level-A harassment by injury - and their associated pressure-wave metrics are not analyzed or described in this DEIS. Additionally, as in the cited precedence, detonations in the SC, OL, and MW exercises occur infrequently and are isolated in time from one another so that resultant behavioral disturbance or disruption, other than that caused by TTS, does not reach the degree associated with Level-B harassment. While the OL and MW exercises usually take place on separate days over a two-day period, they may occur several hours apart on the same day. There is an average of almost 2 months between successive occurrences of this pair of exercises.

As separate criteria for carnivora (sea lions) and chelonia (turtles) have not been established, the dual criterion for odontocetes is taken, as in the cited precedence, to be protective of those groups.

Recent suggested revisions to the cited precedence for large deep-water explosions are described below.

Topographic, Water, and Bottom Conditions: The locations of the training ranges at Northwest Harbor and Horse Beach Cove, when combined with existing training procedures, provide for reliable visual detection of protected species. Training is conducted in daylight hours in sea-states of 2 or less and the mitigation zones are always clearly visible from the shore. Unlike typical circular mitigation zones, pressure-wave propagation from the detonations and thus, the mitigation zones, are restricted to a relatively small area due to the confining sides of the harbor and cove. Those limiting sides shape each zone into a wedge shape of about 90 degrees from the point of detonations and less than that when viewed from the shore observer's position - i. e., both sites have narrow fields-of-search with visual angles less than 90 degrees. Additionally, both sites have beaches that slope up from the waterline with elevated on-shore positions that provide stable, unmoving elevated heights-of-eye for complete binocular-aided observation of the detonation areas and sea surface beyond 2000 ft seaward of the detonation locations. At both sites, visual observation from the shore is augmented by the observations of a safety boat operator moving through and beyond the mitigation area. Thus, marine mammals and turtles are easily detected when at the surface in the mitigation zone.

The shallow depths of the mitigation zones maximize the probability of animals being on the surface - re typical mitigation scenarios - and thus, the probability of their visual detection as well. Both wedge-shaped mitigation zones extend out from detonations in VSW depths of only 10-20 ft – the MW detonation is at an extremely shallow depth of 5 ft - and are no more than 50–60 ft in depth at their farthest extents. That is, the average depths of the zones are only about 30-35 ft and the highest blast pressures occur in the shallowest parts of the ranges near the charge locations where animal presence is most obvious. When combined with the low number of animals typically in these zones – described below - the few animals in or transiting through these shallow areas are not diving deeply or for extended periods of time as is typically assumed in mitigation areas over deeper water. For comparison, a typical at-sea mitigation zone over deep water has a circular surface area. There, point-charges in the upper column would have a hemispheric or cylindrical volume-of-effect - depending on charge-size and bottom-depth - with a circular surface visual-mitigation area of radius equal to the maximum horizontal extent of either the hemisphere or cylinder. The present wedge-shaped zones in VSW of similar radius have only

25% of that surface area over shallow volumes less than 1% as large as deeper-water hemispheric or cylindrical volumes. Thus, in the present relatively shallow volumes, marine animals will be at the surface much more frequently and, as a result, detected much more readily than in deeper water zones. Given these VSW characteristics, the percent detection or detection effectiveness for various species that are usually associated with deeper at-sea zones and other methods of observation do not apply nor do the detection probabilities associated with assessment surveys over deep water from ships or planes such as those described by Buckland et al. (1993) or Barlow (1995).

Bottom and water-column conditions also influence pressure-wave propagation. A study conducted during actual exercises at Naval Amphibious Base (NAB), Coronado, CA and Northwest Harbor during 2002 and 2003 (NSWC/Anteon Corp., Inc.; 2005) revealed considerable differences in pressure-wave propagation between the two sites - differences that are attributable to the different bottom and water-column conditions at those sites.

The NAB range is composed of clean sand along an open coast with, presumably, a hard substrate wherein propagation comes close to matching propagation-model predictions. At Horse Beach Cove, the bottom around the detonation location (Figure 3-11) and seaward has not been studied but, it appears to be composed of clean sands with some dense kelp extending out along the eastern side of the mitigation zone. As such, the pressure-wave propagation at Horse Beach Cove will be assumed to be similar to that of NAB along its main seaward axis – i. e., a line, roughly perpendicular to the shoreline that extends seaward from the detonation location.

The Northwest Harbor range, on the other hand, has heavily eroded hills on its West and South sides and is not subject to strong lateral wave-generated coastal currents suggesting a softer, silt-like substrate despite the clean sand on and near the beach. Additionally, moderate subsurface vegetation is distributed unevenly on the shore approaches. Beginning about 2200 ft offshore, dense surface-visible kelp occurs over considerable distances seaward along the main seaward axis and begins closer to the shore on either side of the main axis. In those conditions, blast pressures and energies, measured at various distances from the detonation, are substantially less than model predictions that assume a clean hard bottom.

The distribution of surface-visible kelp in Northwest Harbor varies due to storm-wave damage and recovery in different seasons but, subsurface kelp is, likely, present in the lower water column in most parts of the inner and outer harbor throughout the year. A depth sounder, that reported vegetation height and bottom depth, was deployed along a line from the SC exercise location 4 (Fig. 1, Chart) seaward. Bottom vegetation began about 300 ft seaward and moderate vegetation was found in the bottom 3rd of the water column out to about 600 ft seaward. Between 600 and 1000 ft seaward, vegetation was present that reached 2/3 of the way up to the surface. None of this vegetation was visible at the surface or when looking down from the surface. A similar examination of the water column along a line seaward of OL and MW locations 2 and 3 (Fig. 1, Chart) – not far to the west of the first line - indicated little or no vegetation out to about 1000 ft but, it is likely that subsurface kelp began at about that distance. Similar substantial attenuation of pressure-waves was observed out to 1000 ft along both of these axes indicating that the attenuation is not due solely to kelp in the column. However, such vegetation also deposits layers of organic matter over time just below the bottom and that could, along with a soft deeper substrate, contribute to the overall attenuation effects on propagation at Northwest Harbor.

In any case, some combination of vegetation and substrate create an acoustic sink-like condition that substantially attenuates the pressure waves created by near-shore detonations before they reach the inner limits of the denser surface-visible kelp at about 2200 ft. Additional relevant details of the study are given below in the description of pressure-wave propagation.

Finally, both Northwest Harbor and Horse Beach Cove are shallow bays that open to the ocean. These Bays undergo substantial, frequent water exchange with the ocean as a result of tidal volume flux and coastal circulation patterns. Water mixing within Northwest Harbor is substantial as evidenced by the absence of thermal and salinity layering in the sound velocity measurements that were made there. The same conditions likely exist at Horse Beach Cove as well. The water mixing within the bays that reduces layering effects also facilitates the rapid dilution of explosive by-products and the water exchange with the ocean transports those by-products from the sites and furthers their dilution.

Protected Species: Mysticetes and large odontocetes are rarely, if ever, present in the outer areas of Northwest Harbor that have dense kelp growth throughout the year and are not known to appear shoreward of the inner edge of the surface-visible kelp. Similarly, they are not known to appear in the shallow approaches to Horse Beach Cove. Were they to approach either area, even at considerable distance beyond the mitigation zones to be described, they would be immediately obvious to the shore or safety-boat observers. Neither Horse Beach Cove nor Northwest Harbor is known to be a preferred feeding site for small marine mammals and turtles are not known to feed in, nest near, or frequent either site. Thus, the principle concern is for protection of small odontocetes (dolphins, porpoises and small whales), carnivora (sea lions), and chelonia (turtles) that only occasionally visit these sites. It follows that the mitigation zones, to be described, are determined by estimates of the propagated peak-pressure and energy in the 3rd octave-band of highest energy above 100 Hz – i. e., in the range of hearing of small odontocetes.

Pressure-Wave Propagation in VSW: Measurements of the propagated pressures in live-fire tests during SC exercises at NAB and during SC, OL, and MW exercises at Northwest Harbor were conducted in 2002 and 2003 as part of a study to evaluate underwater explosive propagation models in very shallow water (VSW) (NSWC/Anteon Corp., Inc.; 2005). Details of the procedures, results, and conclusions may be found in that report. Results and conclusions relevant to the proposed action are described in this DEIS. The measurements made in those tests provide an in-place characterization of pressure propagation for all three training exercises as they are actually conducted at Northwest Harbor and a guide to expected explosive pressure propagation at Horse Beach Cove. That is, actual measurements, as opposed to model predictions, are used as the basis for determining mitigation ranges in the SC, OL, and MW exercises at Northwest Harbor. For the SC exercises in Horse Beach Cove, mitigation ranges are determined from the predictions of an explosive propagation model that, conservatively, assumes an unbounded homogeneous medium.

The propagation of pressure waves was found to be substantially different between Northwest Harbor and NAB – a clean hard sand range. For example, in SC exercises, measurements of propagated peak-peak pressures at about 1000 ft for 15 lb charges detonated in 15 ft of water – on and 2 ft off the bottom at both sites - produced peak-pressures that were only about ¼ as large at Northwest Harbor as those at NAB. Energies measured at similar distances for these same shots did not show substantial differences between sites. However, at Northwest Harbor, there was added extraneous noise in the recording system that added to the sums of energies calculated from that data (NSWC/Anteon Corp. Inc. 2005). That is, the actual energies in the water at Northwest Harbor were, likely, less than those at NAB.

The position of single charges - on and 2 ft off the bottom - had similar effects on propagated peak-pressures at both sites. That is, off-bottom positions produced consistently higher peak-pressures than on-bottom positions as measured at about 200, 500, and 1000 ft distances. Off-bottom 15 lb charges in 15 ft of water produced between 43 – 67 % greater peak-pressures than on-bottom charges. In an extremely shallow depth of 6 ft, the off-bottom placement of a 15 lb charge produced about 94% greater peak-pressure than a similar on-bottom charge as measured at about 190 ft distance. The SC exercises in the proposed action only use on-bottom positions and the MW exercise at Northwest Harbor uses on-bottom charge placement in about 5 ft of water (NSWC/Anteon Corp. Inc. 2005).

The data from both sites also show a trend that is not typically seen in explosions occurring in deeper water with the charges in the upper portion of the water column. For most of the SC detonations and both the OL and MW detonations, the deeper measuring gages at distance showed lower peak-pressures and energies. Usually, the highest pressures and energies are measured at the deepest depths due to bottom-reflected pressure waves, refraction etc. In the case of the multiple-explosive OL exercise, the deepest gages were at 79 and 66% of the water depth at about 800 and 1800 ft distances, respectively. These gages measured about half the peak-pressure and less than half of the total energy between 100 Hz and 40 KHz than were recorded by the gages in the upper half of the column. In the MW exercise, the effect was not seen at about 1000 ft distance, but a similar trend was seen at about 2300 ft. While the data are suggestive of a general trend for VSW detonations and VSW propagation, the deepest gages in many cases did not extend down close enough to the bottom and thus, such a general conclusion cannot be drawn (NSWC/Anteon Corp. Inc.; 2005).

Measurements made during the OL and MW exercises demonstrated an important finding with regard to multiple-charge detonations. In those exercises, the propagated pressure-waves are substantially smaller than would be expected for single charges with weights equal to the aggregate weights of the individual charges. Aggregation of multiple charge-weights is often done in the absence of empirical data or applicable models. Further, the differences are much greater than can be accounted for by the sound attenuating properties of Northwest Harbor. For the OL exercise with 16, 20-lb charges of C4, measurements at about 800 ft distance show received peak-pressures less than would be expected from a single 20-lb charge of C4. It was concluded that the OL detonations are too small, too fast, too far apart, and too separated in time for their propagated pressure waves to overlap – i. e., to sum with - each other to any substantial degree. Further, the essentially random distribution of charges on the eight obstacles make the obtained results representative of propagated pressure-waves in past and future OL exercises at that site. For the MW exercise, the measured peak-pressures at about 1000 ft were those that would be expected from only a few pounds of TNT at that distance. In the MW exercise, the complicated geometry of long linear charges, arranged in a lattice, provides an explanation for the obtained results – results that also are representative of past and future MW exercises. Details of these results and conclusions may be found in the Discussion section of Appendix E in NSWC/Anteon Corp., Inc. (2005).

Mitigation Zones at Northwest Harbor and Horse Beach Cove: Measurements during SC exercises at Northwest Harbor produced empirical data for more accurately determining mitigation zones for SC exercises there. Previously, a broader zone has been used for SC exercises. The peak-pressures (unfiltered) and energies – between 100 Hz and 41 KHz - in 3rd octave-bands of highest energies were measured seaward of a 15 lb single charge of C4 lying on the bottom in 15 ft of water. These values were measured during - and are representative of - CS exercises conducted there (NSWC/Anteon Report 2005, Shot 5236, Table 4, Figure 17). At about 1000 ft seaward, the peak-pressure varied from only 2-4 psi (unfiltered) at different depths and the energies between 100 Hz and 41 KHz in the 3rd octave-bands of highest energies varied from about 174-182 dB re 1 $\mu Pa^2 \cdot sec$ at different depths. As explained in the NSWC/Anteon Report (2005), these energy values contain extraneous noise added into the values. That is, the stated energy values are more than the actual energy in the water. A 20 lb single charge of C4 would be expected to have about 2 psi more peak-pressure and about 2 dB more energy at that distance. From these measurements, the range at which the criterion for onset-TTS would be expected to occur in small odontocetes and thus, the mitigation range for SC exercises with charge-weights of

20 lbs or less of C4 on the bottom at Northwest Harbor, is determined to be 1100 ft from the detonation site.

The mitigation range for SC exercises at Horse Beach Cove is determined from model predictions. As the pressure-wave propagation at Horse Beach Cove was not measured, it is considered to be equivalent to NAB's clean hard sand bottom - a conservative assumption. Predictions made by the Reflection and Refraction in Multi-Layered Ocean/Ocean Bottoms with Shear Wave Effects (REFMS) model were found to be unstable across the distances considered under the conditions of VSW with bottom or near bottom charge placement, reflective bottom, and a non-refractive water column – i. e., equal sound velocity at all depths - (NSWC/Anteon Corp. Inc.; 2005; Results and Discussion – Model Validation). The source of instability in the REFMS predictions is due, most likely, to the VSW where the ratio of depth to range is very small – a known problem for the REFMS predictive ray-tracing but, refraction and placement conditions may contribute as well. REFMS was developed for large explosives in deep water and has been validated there, but is in need of added development for reliable application in VSW conditions. The peak-pressures and 3rd octave-band energies for the minimum refraction and maximum reflection VSW bottom at NAB were just as well predicted by a simpler model that assumes "iso-velocity" throughout the column and with no boundaries – conservative assumptions. In iso-velocity conditions, peak pressure follows a power law over distance as do the dominant frequency and energy at that frequency. Predictions of that iso-velocity model for detonations in an unbounded (equivalent to an off-bottom charge), homogeneous medium or a free acoustic field appear in Figure 3-13.

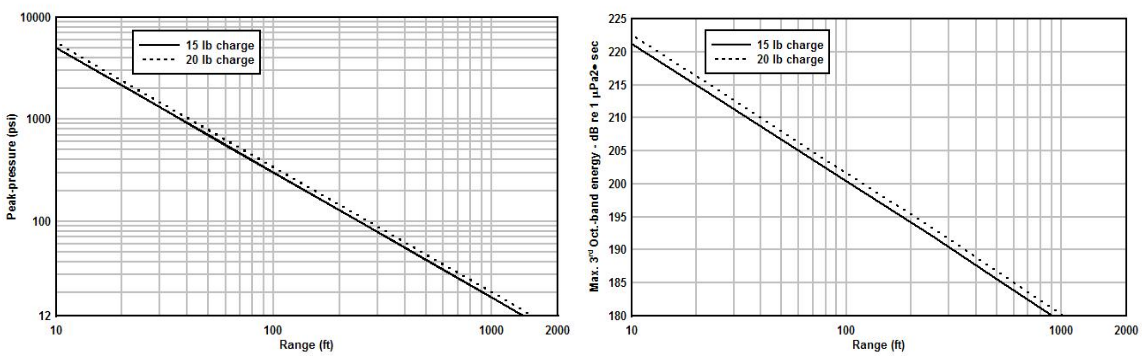


Figure 3-13. Iso-velocity predictions of peak pressure and energy in the 3rd octave-band of highest energy above 100 Hz as a function of range for 15 and 20 lb charges of C4 explosive.

From Figure 3-13, it is determined that the mitigation range for SC exercises with charge-weights of 20 lbs or less of C4 on the bottom at Horse Beach Cove is determined to be 1300 ft from the detonation site.

The mitigation range for the OL and MW exercises at Northwest Harbor are determined from empirical data collected during actual exercises (NSWC/Anteon Corp., Inc.; 2005; Appendix E). In both exercises, high peak-pressures and long signal durations were expected at the farthest range, so amplifier gains were reduced and recording periods were lengthened, accordingly. However, in the OL exercise, peak-pressures of only 4-10 psi (unfiltered) were recorded at three different water depths at 1779 ft distance along the main seaward axis. In the MW exercise, peak-pressures of only 3-5 psi (unfiltered) were recorded at three different depths at 2332 ft distance. In both exercises, the relatively high extraneous noise level in the recording – mentioned above - and unexpectedly low received signal pressure produced a low signal-to-noise ratio that, when coupled with the longer recording and integration periods, prevented accurate calculations of 3^{rd} octave-band energies. That is, noise spikes above 100 Hz could influence the calculation of individual octave-band energies. Instead, the data were band-pass filtered – with a low cutoff of 100 Hz to accommodate small odontocete hearing sensitivity and a high cutoff of 40 KHz to remove extraneous noise above that frequency – and total energies, instead of 3^{rd} octave-band energies, were reported. Thus, in the OL exercise, total energies of 181-187 dB re 1 μPa^2 ·sec were recorded at the three different water depths at 1779 ft distance. In the MW exercise, total energies of 180-185 dB re 1 μPa^2 ·sec were recorded at different depths at 2332 ft distance.

In addition to energy in the water, these total energy values incorporate some noise that remained in the pass-band after filtering. These totals can be related to maximum 3^{rd} octave-band energies by comparison with results obtained in the SC exercises. In two SC exercises with bottom charges, one at NAB and one at Northwest Harbor, the total energy and the energy in the 3^{rd} octave band of highest energy were considered for each pressure gage in both exercises. The mean difference, across all gages, between total energy and maximum 3^{rd} octave-band energy was 6.6 dB with a standard deviation of 2.0 dB. That is, the total energies given above indicate that the probable maximum 3^{rd} octave band energy was at or below the onset-TTS energy criterion at 1780 ft distance in the OL exercise and below that criterion at 2332 ft distance for the MW exercise. Considering the added noise, the actual energies – total and probable maximum 3^{rd} octave-band - were somewhat less. Thus, it is determined that the mitigation range for OL and MW exercises with charge-types and charge-weights described at Northwest Harbor is determined to be 2000 ft from the detonation site.

The total energy values, described above for these exercises, are not comparable with recently suggested revisions to the impulse criteria for onset-TTS resulting from exposure to very large single charges in very deep water. That suggested criterion uses a peak-pressure of 23 psi as a "limiting" value and 183 dB re 1 μPa^2 ·sec received, C-weighted energy flux density level. C-weighting has somewhat different filter characteristics than band-pass filtering and, for "mid-frequency" cetacea, the C-weighting has low and high-frequency cutoffs of 150 Hz and 160 KHz. For perspective, a mid-depth pressure gage at 1779 ft distance in the OL exercise recorded 9 psi peak-pressure and 187 dB re 1 μPa^2 ·sec total energy with 100 Hz and 40 KHz band-pass filtering. Using band-pass filtering between 150 Hz and 40 KHz as a conservative approximation to mid-frequency C-weighting – with 40 KHz used to remove high frequency noise as before - that gage's total energy at 1780 ft distance would be 183 dB re 1 μPa^2 ·sec. That value would include additional noise in the pass-band as before. Beyond that perspective, there are substantial differences between the very deep water, large charge scenario of the suggested revised criteria and the present one with its single and multiple relatively small explosives laid on the bottom in very shallow water. Different blast conditions, configurations, and charge-weight produce substantially different waveforms at a distance and therefore, likely differ considerably in their effects on auditory tissue. For these reasons, the previously described dual-criterion is used in this DEIS. It is the dual-criterion previously used in DON (2001) and approved in CFR (2001).

4 MODELING ACOUSTIC AND EXPLOSIVE EFFECTS

The methodology for analyzing potential impacts from sonar and explosives is presented in in this section, which defines the model process in detail, describes how the impact threshold derived from Navy-NMFS consultations are derived, and discusses relative potential impact based on species biology.

The Navy acoustic exposure model process uses a number of inter-related software tools to assess potential exposure of marine mammals to Navy generated underwater sound including sonar and explosions. For sonar, these tools estimate potential impact volumes and areas over a range of thresholds for sonar specific operating modes. Results are based upon extensive pre-computations over the range of acoustic environments that might be encountered in the operating area.

The process includes four steps used to calculate potential exposures:

- Identify unique acoustic environments that encompass the operating area. Parameters include depth and seafloor geography, bottom characteristics and sediment type, wind and surface roughness, sound velocity profile, surface duct, sound channel, and convergence zones.

- Compute transmission loss (TL) data appropriate for each sensor type in each of these acoustic environments. Propagation can be complex depending on a number of environmental parameters listed in step one, as well as sonar operating parameters such as directivity, source level, ping rate, and ping length, and for explosives the amount of explosive material detonated. The Navy standard CASS-GRAB acoustic propagation model is used to resolve these complexities for underwater propagation prediction.

- Use that TL to estimate the total sound energy received at each point in the acoustic environment.

- Apply this energy to predicted animal density for that area to estimate potential acoustic exposure, with animals distributed in 3-D based on best available science on animal dive profiles.

Modeling of the effects of mid-frequency sonar and underwater detonations was conducted using methods described in the following sections.

The primary potential impact to marine mammals from underwater acoustics is Level B harassment from noise. For explosions, in the absence of any mitigation or monitoring measures, there is a very small chance that a marine mammal could be injured or killed when exposed to the energy generated from an explosive force on the sea floor. Analysis of noise impacts to cetaceans is based on criteria and thresholds initially presented in U.S. Navy Environmental Impact Statements for ship shock trials of the Seawolf submarine and the Winston Churchill (DDG 81), and subsequently adopted by NMFS.

Non-lethal injurious impacts (Level A Harassment) are defined in those documents as tympanic membrane (TM) rupture and the onset of slight lung injury. The threshold for Level A Harassment corresponds to a 50-percent rate of TM rupture, which can be stated in terms of an energy flux density (EFD) value of 205 dB re 1 µPa^2-s. TM rupture is well-correlated with permanent hearing impairment. Ketten (1998) indicates a 30-percent incidence of permanent threshold shift (PTS) at the same threshold.

The criteria for onset of slight lung injury were established using partial impulse because the impulse of an underwater blast wave was the parameter that governed damage during a study using mammals, not peak pressure or energy (Yelverton 1981). Goertner (1982) determined a way to calculate impulse values for injury at greater depths, known as the Goertner "modified" impulse pressure. Those values are valid only near the surface because as hydrostatic pressure increases with depth, organs like the lung, filled with air, compress. Therefore the "modified" impulse pressure thresholds vary from the shallow depth starting point as a function of depth.

The shallow depth starting points for calculation of the "modified" impulse pressures are mass-dependent values derived from empirical data for underwater blast injury (Yelverton 1981). During the calculations, the lowest impulse and body mass for which slight, and then extensive, lung injury found during a previous study (Yelverton et al 1973) were used to determine the positive impulse that may cause lung injury. The Goertner model is sensitive to mammal weight; such that smaller masses have lower thresholds for positive impulse so injury and harassment will be predicted at greater distances from the source for them. Impulse thresholds of 13.0 and 31.0 psi-msec, found to cause slight and extensive injury in a dolphin calf, were used as thresholds in the analysis contained in this document.

Level B (non-injurious) Harassment includes temporary (auditory) threshold shift (TTS), a slight, recoverable loss of hearing sensitivity. One criterion used for TTS is 182 dB re 1 μPa^2-s maximum EFD level in any 1/3-octave band above 100 Hz for toothed whales (e.g., dolphins). A second criterion, 23 psi, has recently been established by NMFS to provide a more conservative range for TTS when the explosive or animal approaches the sea surface, in which case explosive energy is reduced, but the peak pressure is 1 μPa^2-s is not. NMFS applies the more conservative of these two. Table A-1 lists the thresholds for explosives.

Table 4-1. Explosive Source Thresholds

Threshold Type (Explosives)	Threshold Level
Level A – 50% Eardrum rupture (peak one-third octave energy)	205 dB
Temporary Threshold Shift (TTS) (peak one-third octave energy)	182 dB
Temporary Threshold Shift (TTS) (peak pressure)	23 psi
Level A – Slight lung injury (positive impulse)	13 psi-ms
Fatality – 1% Mortal lung injury (positive impulse)	31 psi-ms

For non-explosive sound sources, Level B Harassment includes behavioral modifications resulting from repeated noise exposures (below TTS) to the same animals over a relatively short period of time. Cetaceans exposed to ELs of 195 dB re 1 μPa^2-s up to 215 dB re 1 μPa^2-s are assumed to experience TTS. At 215 dB re 1 μPa^2-s, cetaceans are assumed to experience PTS. Unlike cetaceans, the TTS and PTS thresholds used for pinnipeds vary with species. Otariids have thresholds of 206 dB re 1 μPa^2-s for TTS and 226 dB re 1 μPa^2-s for PTS. Northern elephant seals are similar to otariids (TTS = 204 dB re 1 μPa^2-s, PTS = 224 dB re 1 μPa^2-s) but are lower for harbor seals (TTS = 183 dB re 1 μPa^2-s, PTS = 203 dB re 1 μPa^2-s).

A certain proportion of marine mammals are expected to experience behavioral disturbance at different received sound pressure levels and are counted as Level B harassment exposures. The details of this “sub-TTS” theory and calculation are described in the Dose Response section. Table 4-2 lists the thresholds for sonar.

Table 4-2. Sonar Source Thresholds For Cetaceans and Pinnipeds

Physiological Effects			
Animal	**Criteria**	**Threshold (re 1μPa^2-s)**	**MMPA Effect**
Cetacean	TTS	195	Level B Harassment
	PTS	215	Level A Harassment
Pinnipeds			
Northern Elephant Seal	TTS	204	Level B Harassment
	PTS	224	Level A Harassment
Pacific Harbor Seal	TTS	183	Level B Harassment
	PTS	203	Level A Harassment
California Sea Lion	TTS	206	Level B Harassment
	PTS	226	Level A Harassment
Guadalupe Fur Seal	TTS	226	Level B Harassment
	PTS	206	Level A Harassment
Northern Fur Seal	TTS	206	Level B Harassment
	PTS	226	Level A Harassment

The sound sources will be located in an area that is inhabited by species listed as threatened or endangered under the Endangered Species Act (ESA, 16 USC §§ 1531-1543). Operation of the sound sources, that is, transmission of acoustic signals in the water column, could potentially cause harm or harassment to listed species.

"Harm" defined under ESA regulations is "…an act which actually kills or injures…" (50 CFR 222.102) listed species. "Harassment" is an "intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (50 CFR 17.3).

Level A harassment criteria and thresholds under MMPA are appropriate to apply as "harm" criteria and thresholds under ESA. Analysis that predicts Level A harassment under MMPA will occur as a result of the proposed action would correspond to harm to listed species under ESA. Level B harassment criteria and thresholds under MMPA are appropriate to apply as harassment criteria and thresholds under ESA.

If a federal agency determines that its proposed action "may affect" a listed species, it is required to consult, either formally or informally, with the appropriate regulator. There is no permit issuance under ESA, rather consultation among the cognizant federal agencies under § 7 of the ESA. Such consultations would likely be concluded favorably, subject to requirements that the activity will not appreciably reduce the likelihood of the species' survival and recovery and impacts are minimized and mitigated. The Navy will initiate formal interagency consultation by submitting a Biological Assessment to NMFS, detailing the proposed action's potential effects on listed species and their designated critical habitats. Consultation would conclude with NMFS' issuance of a Biological Opinion that addresses the issues of whether the project can be expected to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

4.1 ACOUSTIC SOURCES

The Southern California (SOCAL) acoustic sources are categorized as either broadband (producing sound over a wide frequency band) or narrowband (producing sound over a frequency band that that is small in comparison to the center frequency). In general, the narrowband sources in this exercise are ASW sonars and the broadband sources are explosives. This delineation of source types has a couple of implications. First, the transmission loss used to determine the impact ranges of narrowband ASW sonars can be adequately characterized by model estimates at a single frequency. Broadband explosives, on the other hand, produce significant acoustic energy across several frequency decades of bandwidth. Propagation loss is sufficiently sensitive to frequency as to require model estimates at several frequencies over such a wide band.

Second, the types of sources have different sets of harassment metrics and thresholds. Energy metrics are defined for both types. However, explosives are impulsive sources that produce a shock wave that dictates additional pressure-related metrics (peak pressure and positive impulse). Detailed descriptions of both types of sources are provided in the following subsections.

4.1.1 Sonars

To estimate impacts from mid- and high-frequency sonar, five types of narrowband sonars representative of those used in operations in the SOCAL Range Complex were modeled. Exposure estimates are calculated for each sonar according to the manner in which it operates. For example, the SQS-53C is a hull-mounted, surface ship sonar that operates for many hours at a time, so it is most useful to calculate and report SQS-53C exposures per hour of operation. The SQS-56C is a hull-mounted, surface ship sonar (not as powerfull as the SQS-53C) that operates for many hours at a time, so it is most useful to calculate and report SQS-56C exposures per hour of operation. The AQS-22 is a helicopter-deployed sonar, which is lowered into the water, pings a number of times, and then moves to a new location. For the AQS-22, it is most helpful to calculate and report exposures per dip. Table 4-3 presents the deploying platform, frequency class, and the reporting metric for each sonar.

Table 4-3. Active Sonars Employed in SOCAL Range

Sonar	Description	Frequency Class	Exposures Reported
MK-48	Torpedo sonar	High frequency	Per torpedo
AN/SQS-53C	Surface ship sonar	Mid-frequency	Per hour
AN/SQS-56C	Surface ship sonar	Mid-frequency	Per hour
AN/SSQ-62	Sonobuoy sonar	Mid-frequency	Per sonobuoy
AN/AQS-22	Helicopter-dipping sonar	Mid-frequency	Per dip

Note that MK-48 source described here is the active pinger on the torpedo; the explosive source of the detonating torpedo is described in the next subsection.

The acoustic modeling that is necessary to support the exposure estimates for each of these sonars relies upon a generalized description of the manner of the sonar’s operating modes. This description includes the following:

- "Effective" energy source level – The total energy across the band of the source, scaled by the pulse length (10 $\log_{10}$ [pulse length]), and corrected for source beam width so that it reflects the energy in the direction of the main lobe. The beam pattern correction consists of two terms:
  - Horizontal directivity correction: 10 $\log_{10}$ (360 / horizontal beam width)
  - Vertical directivity correction: 10 $\log_{10}$ (2 / [sin(θ_1) – sin(θ_2)]), where θ_1 and θ_2 are the 3-dB down points on the main lobe.
- Source depth – Depth of the source in meters.
- Nominal frequency – Typically the center band of the source emission. These are frequencies that have been reported in open literature and are used to avoid classification issues. Differences between these nominal values and actual source frequencies are small enough to be of little consequence to the output impact volumes.
- Source directivity – The source beam is modeled as the product of a horizontal beam pattern and a vertical beam pattern. Two parameters define the horizontal beam pattern:
  - Horizontal beam width – Width of the source beam (degrees) in the horizontal plane (assumed constant for all horizontal steer directions).
  - Horizontal steer direction – Direction in the horizontal in which the beam is steered relative to the direction in which the platform is heading

  The horizontal beam is rectangular with constant response across the width of the beam and with flat, 20-dB down sidelobes. (Note that steer directions ϕ, $-\phi$, $180^o - \phi$, and $180^o + \phi$ all produce equal impact volumes.)

  Similarly, two parameters define the vertical beam pattern:
  - Vertical beam width – Width of the source beam (degrees) in the vertical plane measured at the 3-dB down point. (The width is that of the beam steered towards broadside and not the width of the beam at the specified vertical steer direction.)
  - Vertical steer direction – Direction in the vertical plane that the beam is steered relative to the horizontal (upward looking angles are positive).

  To avoid sharp transitions that a rectangular beam might introduce, the power response at vertical angle θ is

  $$\max \{ \sin^2 [n(\theta_s - \theta)] / [n \sin (\theta_s - \theta)]^2,\ 0.01 \}$$

  where $n = 180^o / \theta_w$ is the number of half-wavelength-spaced elements in a line array that produces a main lobe with a beam width of θ_w. θ_s is the vertical beam steer direction.
- Ping spacing – Distance between pings. For most sources this is generally just the product of the speed of advance of the platform and the repetition rate of the sonar. Animal motion is generally of no consequence as long as the source motion is greater than the speed of the animal (nominally, three knots). For stationary (or nearly stationary) sources, the "average" speed of the animal is used in place of the platform speed. The attendant assumption is that the animals are all moving in the same constant direction.

These parameters are defined for each of the active sonars (including two operating modes for the 53C) in Table 4-4.

Table 4-4. Source Description of SOCAL Mid- and High-Frequency Active Sonars

Sonar	Source Depth	Center Freq	Source Level	Emission Spacing	Vertical Directivity	Horizontal Directivity
AN/SQS-53C Search Mode	7 m	3.5 kHz	235 dB	154 m	Omni	240° Forward-looking
AN/SQS-53C Kingfisher Mode	7 m	3.5 kHz	236 dB	4.6 m	20° Width 42° D/E	120° Forward-looking
SQS-56C	27 m	6.8 to 8.2 kHz	225 dB	128.6 m	13 °	30 °
AN/SSQ-62	27 m	8 kHz	201 dB	450 m	Omni	Omni
AN/AQS-22	27 m	4.1 kHz	217 dB	15 m	Omni	Omni

4.1.2 Explosives

Explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. Three source parameters influence the effect of an explosive: the weight of the explosive warhead, the type of explosive material, and the detonation depth. The net explosive weight (or NEW) accounts for the first two parameters. The NEW of an explosive is the weight of only the explosive material in a given round, referenced to the explosive power of TNT.

The detonation depth of an explosive is particularly important due to a propagation effect known as surface-image interference increasingly. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface-reflection scattering loss). For the SOCAL Range there are two types of explosive sources: demolition charges and munitions (Mk-48 torpedo, Maverick and Harpoon missiles, Mk-82 and Mk-83 bombs, 5” rounds and 76 mm rounds). Demolition charges are typically modeled as detonating near the middle of the water column. The Mk-48 detonates immediately below the hull of its target (nominally 50 feet). A source depth of two meters is used for bombs and missiles that do not strike their target. For the gunnery rounds, a source depth of one foot is used. The NEW for these sources are as follows:

- Demolition charge – 20 pounds,
- Mk-48 – 851 pounds,
- Maverick – 78.5 pounds,
- Harpoon – 448 pounds,
- Mk-82 – 238 pounds,
- Mk-83 – 574 pounds,
- 5” rounds – 9.54 pounds, and
- 76 mm rounds – 1.6 pounds.

The exposures expected to result from these sources are computed on a per in-water explosive basis. The cumulative effect of a series of explosives can often be derived by simple addition if the detonations are spaced widely in time or space, allowing for sufficient animal movements as to ensure a different population of animals is considered for each detonation.

The cases in which simple addition of the exposures estimates may not be appropriate are addressed by the modeling of a "representative" sinking exercise (SINKEX). In a SINKEX, a decommissioned surface ship is towed to a specified deep-water location and there used as a target for a variety of weapons. Although no two SINKEXs are ever the same, a representative case derived from past exercises is described in the *Programmatic SINKEX Overseas Environmental Assessment (March 2006)* for the Western North Atlantic.

In a SINKEX, weapons are typically fired in order of decreasing range from the source with weapons fired until the target is sunk. A torpedo is used after all munitions have been expended if the target is still afloat. Since the target may sink at any time during the exercise, the actual number of weapons used can vary widely. In the representative case, however, all of the ordnances are assumed expended; this represents the worst case of maximum exposure.

The sequence of weapons firing for the representative SINKEX is described in Table 4-5. Guided weapons are nearly 100% accurate and are modeled as hitting the target (that is, no underwater acoustic effect) in all but two cases: (1) the Maverick is modeled as a miss to represent the occasional miss, and (2) the MK-48 torpedo intentionally detonates in the water column immediately below the hull of the target. Unguided weapons are more frequently off-target and are modeled according to the statistical hit/miss ratios. Note that these hit/miss ratios are artificially low in order to demonstrate a worst-case scenario; they should not be taken as indicative of weapon or platform reliability.

Table 4-5. Representative SINKEX Weapons Firing Sequence

Time (Local)	Event Description
0900	Range Control Officer receives reports that the exercise area is clear of non-participant ship traffic, marine mammals, and sea turtles.
0909	Hellfire missile fired, hits target.
0915	2 HARM missiles fired, both hit target (5 minutes apart).
0930	1 Penguin missile fired, hits target.
0940	3 Maverick missiles fired, 2 hit target, 1 misses (5 minutes apart).
1145	1 SM-1 fired, hits target.
1147	1 SM-2 fired, hits target.
1205	5 Harpoon missiles fired, all hit target (1 minute apart).
1300-1335	7 live and 3 inert MK 82 bombs dropped – 7 hit target, 2 live and 1 inert miss target (4 minutes apart).
1355-1410	4 MK 83 bombs dropped – 3 hit target, 1 misses target (5 minutes apart).
1500	Surface gunfire commences – 400 5-inch rounds fired (one every 6 seconds), 280 hit target, 120 miss target.
1700	MK 48 Torpedo fired, hits, and sinks target.

4.2 ENVIRONMENTAL PROVINCES

Propagation loss ultimately determines the extent of the Zone of Influence (ZOI) for a particular source activity. In turn, propagation loss as a function of range responds to a number of environmental parameters:

- water depth
- sound speed variability throughout the water column
- bottom geo-acoustic properties, and
- wind speed

Due to the importance that propagation loss plays in Anti-Submarine Warfare (ASW), the Navy has over the last four to five decades invested heavily in measuring and modeling these environmental parameters. The result of this effort is the following collection of global databases of these environmental parameters, most of which are accepted as standards for all Navy modeling efforts.

- Water depth – Digital Bathymetry Data Base Variable Resolution (DBDBV)
- Sound speed – Generalized Digital Environmental Model (GDEM)
- Bottom loss – Low-Frequency Bottom Loss (LFBL), Sediment Thickness Database, and High-Frequency Bottom Loss (HFBL), and
- Wind speed – U.S. Navy Marine Climatic Atlas of the World

This section provides a discussion of the relative impact of these various environmental parameters. These examples then are used as guidance for determining environmental provinces (that is, regions in which the environmental parameters are relatively homogenous and can be represented by a single set of environmental parameters) within the SOCAL Range.

4.2.1 Impact of Environmental Parameters

Within a typical operating area, the environmental parameter that tends to vary the most is bathymetry. It is not unusual for water depths to vary by an order of magnitude or more, resulting in significant impacts upon the Zone of Influence (ZOI) calculations. Bottom loss can also vary considerably over typical operating areas but its impact upon ZOI calculations tends to be limited to waters on the continental shelf and the upper portion of the slope. Generally, the primary propagation paths in deep water, from the source to most of the ZOI volume, do not involve any interaction with bottom. In shallow water, particularly if the sound velocity profile directs all propagation paths to interact with the bottom, bottom loss variability can play a larger role.

The spatial variability of the sound speed field is generally small over operating areas of typical size. The presence of a strong oceanographic front is a noteworthy exception to this rule. To a lesser extent, variability in the depth and strength of a surface duct can be of some importance. In the mid-latitudes, seasonal variation often provides the most significant variation in the sound speed field. For this reason, both summer and winter profiles are modeled for each selected environment.

4.2.2 Environmental Provincing Methodology

The underwater acoustic environment can be quite variable over ranges in excess of ten kilometers. For ASW applications, ranges of interest are often sufficiently large as to warrant the modeling of the spatial variability of the environment. In the propagation loss calculations, each of the environmental parameters is allowed to vary (either continuously or discretely) along the path from acoustic source to receiver. In such applications, each propagation loss calculation is conditioned upon the particular locations of the source and receiver.

On the other hand, the range of interest for marine animal harassment by most Naval activities is more limited. This reduces the importance of the exact location of source and marine animal and makes the modeling required more manageable in scope.

In lieu of trying to model every environmental profile that can be encountered in an operating area, this effort utilizes a limited set of representative environments. Each environment is characterized by a fixed water depth, sound velocity profile, and bottom loss type. The operating area is then partitioned into homogeneous regions (or provinces) and the most appropriately representative environment is assigned to each. This process is aided by some initial provincing of the individual environmental parameters. The Navy-standard high-frequency bottom loss database in its native form is globally partitioned into nine classes. Low-frequency bottom loss is likewise provinced in its native form, although it is not considered in the process of selecting environmental provinces. Only the broadband sources produce acoustic energy at the frequencies of interest for low-frequency bottom loss (typically less than 1 kHz); even for those sources the low-frequency acoustic energy is secondary to the energy above 1 kHz. The Navy-standard sound velocity profiles database is also available as a provinced subset. Only the Navy-standard bathymetry database varies continuously over the world's oceans. However, even this environmental parameter is easily provinced by selecting a finite set of water depth intervals. For this analysis "octave-spaced" intervals (10, 20, 50, 100, 200, 500, 1000, 2000, and 5000 m) provide an adequate sampling of water depth dependence.

Zone of influence volumes are then computed using propagation loss estimates derived for the representative environments. Finally, a weighted average of the ZOI volumes is taken over all representative environments; the weighting factor is proportional to the geographic area spanned by the environmental province.

The selection of representative environments is subjective. However, the uncertainty introduced by this subjectivity can be mitigated by selecting more environments and by selecting the environments that occur most frequently over the operating area of interest.

As discussed in the previous subsection, ZOI estimates are most sensitive to water depth. Unless otherwise warranted, at least one representative environment is selected in each bathymetry province. Within a bathymetry province, additional representative environments are selected as needed to meet the following requirements.

- In shallow water (less than 1,000 meters), bottom interactions occur at shorter ranges and more frequently; thus significant variations in bottom loss need to be represented.
- Surface ducts provide an efficient propagation channel that can greatly influence ZOI estimates. Variations in the mixed layer depth need to be accounted for if the water is deep enough to support the full extent of the surface duct.

Depending upon the size and complexity of the operating area, the number of environmental problems tends to range for 5 - 20.

4.2.3 Description of Environmental Provinces

The SOCAL Range is located in an area south of 34^{o} N, off the west coast of the US and Mexico. The range encompasses most of Warning Area W-291 and additional near-coastal areas to the north. For this analysis, eight areas within this range have been identified as representative. Seven of these areas are quasi-rectangular regions as described below and depicted in Figure 4-1.

- Area 1: Immediately east of San Nicolas Island; boundary vertices are

- 119^{o} 6' W 33^{o} 40' N
- 118^{o} 51' W 33^{o} 29' N
- 119^{o} 10' W 33^{o} 3' N
- 119^{o} 25' W 33^{o} 14' N

- Area 2: Between San Clemente and Santa Catalina Islands; boundary vertices are:
  - 118^{o} 40' W 33^{o} 29' N
  - 118^{o} 4' W 32^{o} 2' N
  - 118^{o} 15' W 32^{o} 48' N
  - 118^{o} 51' W 33^{o} 15' N
- Area 3: Off-shore area immediately west of MCB Camp Pendleton; boundary vertices are:
  - 117^{o} 44' W 33^{o} 29' N
  - 117^{o} 19' W 33^{o} 4' N
  - 117^{o} 31' W 32^{o} 52' N
  - 117^{o} 56' W 33^{o} 17' N

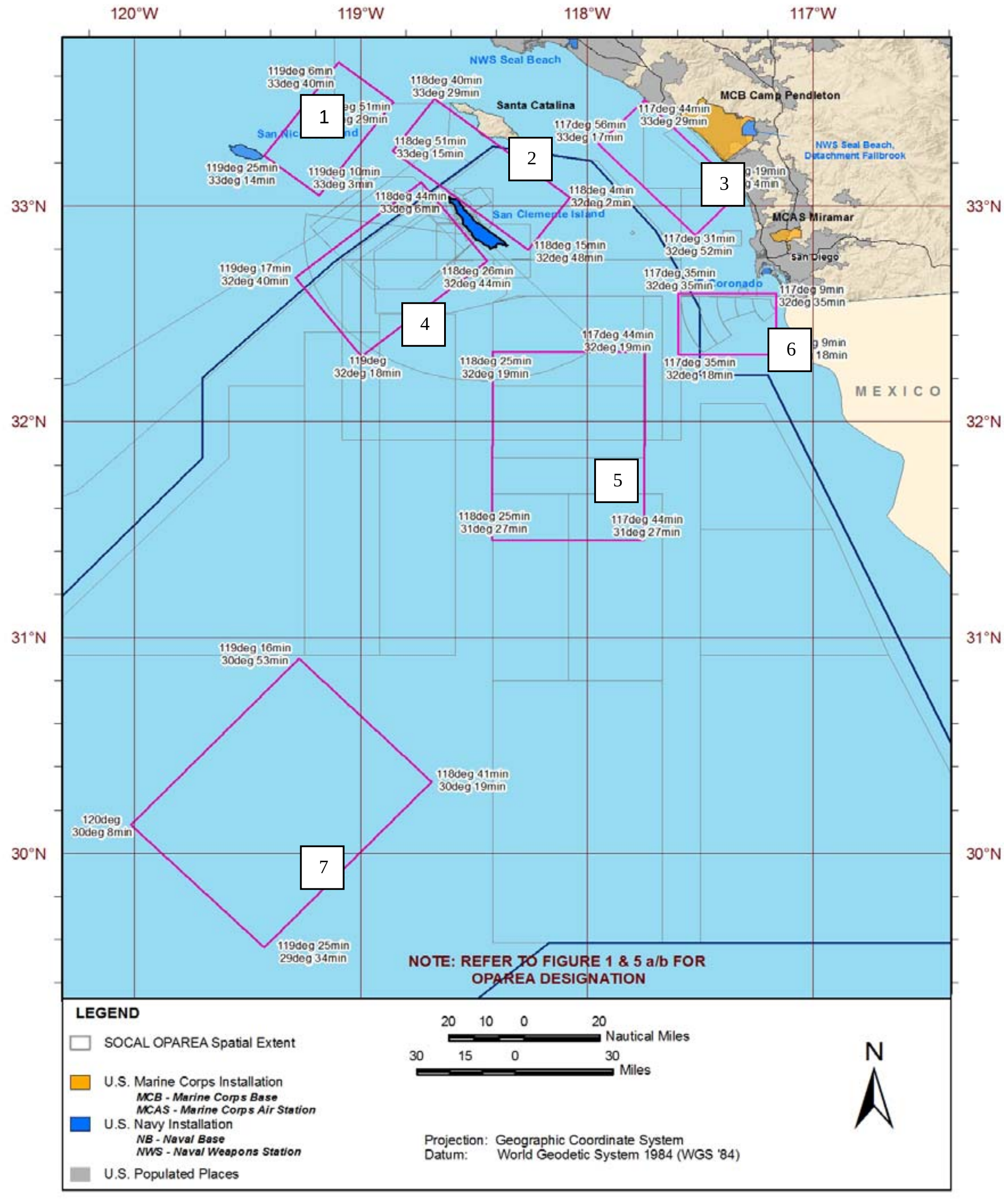


Figure 4-1. Representative Areas in SOCAL Range

-

Area 4: Area immediately south and west of San Clemente Island; boundary vertices are:

- 118° 44’ W 33° 6’ N
- 118° 26’ W 32° 44’ N
- 119° W 32° 18’ N
- 119° 17’ W 32° 40’ N

• Area 5: Area 25 n.m. south and east of San Clemente Island; boundary vertices are:

- 118° 25’ W 32° 19’ N
- 117° 44’ W 32° 19’ N
- 117° 44’ W 31° 27’ N
- 118° 25’ W 31° 27’ N

• Area 6: Off-shore area immediately west of NB Coronado; boundary vertices are:

- 117° 35’ W 32° 35’ N
- 117° 9’ W 32° 35’ N
- 117° 9’ W 32° 18’ N
- 117° 35’ W 32° 18’ N

• Area 7: Deep-water area near the middle of W-291; boundary vertices are:

- 119° 16’ W 30° 53’ N
- 118° 41’ W 30° 19’ N
- 119° 25’ W 29° 34’ N
- 120° W 30° 8’ N

The final region, Area 8, includes all areas outside the previous seven areas that are within the quasi-rectangular region bounded in latitude by 29° N and 34° N, and in longitude by 120° 30’ W and 116° 30’ W.

The acoustic sonars described in subsection 4.2 are, for the most part, deployed throughout all eight areas. The lone exception is Area 6 which is restricted to only the helicopter dipping sonar The explosive sources, other than demolition charges, are primarily limited by the SINKEX restrictions (at least 50 n.m. from land in water depths greater than 1000 fathoms) to the southern portion of Area 5, all of Area 7, and parts of Area 8. The use of demolition charges is limited to the north shore of SCI (Northwest Harbor).

This subsection describes the representative environmental provinces selected for the SOCAL Range. For all of these provinces, the average wind speed, winter and summer, is 11 knots.

The SOCAL Range contains a total of 13 distinct environmental provinces. These represent various combinations of nine bathymetry provinces, one Sound Velocity Profile (SVP) province, and three High-Frequency Bottom Loss (HFBL) classes.

The bathymetry provinces represent depths ranging from 10 meters to typical deep-water depths (slightly more than 5,000 meters). Nearly half of the range is characterized as deep-water (depths of 2,000 meters or more). The second most prevalent water depth regime, covering more than 40% of the range, is representative of waters along the continental slope. The remaining water depths (200 meters and less) provide only small contributions (less than 10%) to the analysis. The distribution of the bathymetry provinces over the SOCAL Range is provided in Table 4-6.

Table 4-6. Distribution of Bathymetry Provinces in SOCAL Range

Province Depth (m)	Frequency of Occurrence
10	Demolition Charges Only
20	0.33 %
50	1.17 %
100	1.74 %
200	3.28 %
500	9.92 %
1000	33.66 %
2000	17.03 %
5000	32.54 %

A single SVP province (45) describes the entire SOCAL Range. The seasonal variation is likewise of limited dynamic range, as might be expect given that the range is located in temperate waters. The surface sound speed of the winter profile is about ten m/s slower than the summer profile as depicted in Figure 4-2. Both seasons exhibit a shallow and relatively weak surface duct.

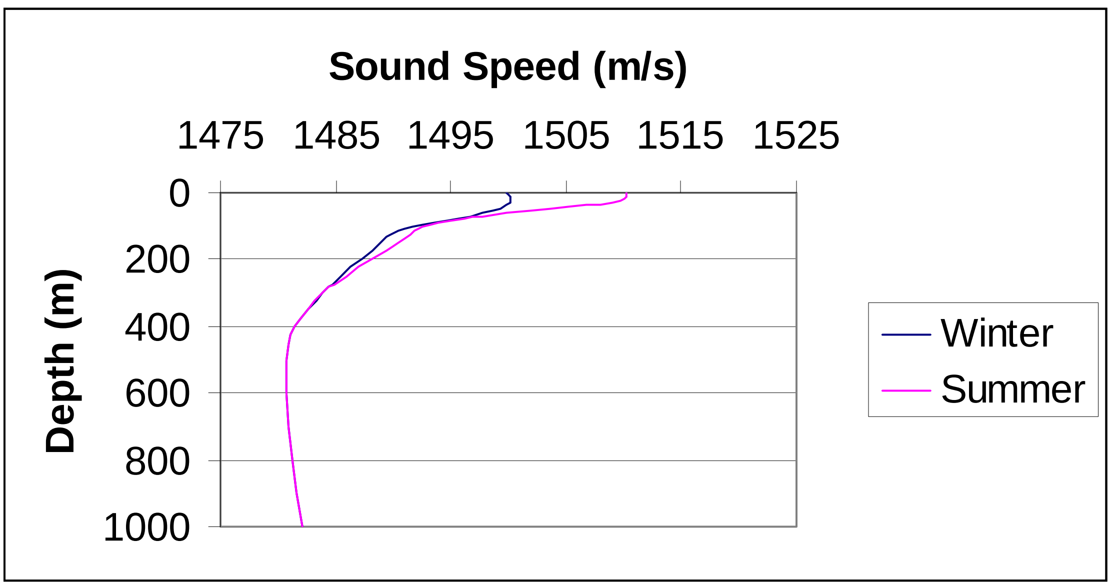


Figure 4-2. Winter and Summer SVPs in SOCAL Range

The three HFBL classes represented in the SOCAL Range are either low-loss bottoms (class 2, typically in shallow water) or high-loss bottoms (classes 7 or 8, predominately in intermediate to deep water). This partitioning by water depth leads to a distribution that is more than 90 % high-loss bottoms as indicated in Table 4-7.

Table 4-7. Distribution of High-Frequency Bottom Loss Classes in SOCAL Range

HFBL Class	Frequency of Occurrence
2	6.22 %
7	16.65 %
8	77.13 %

The logic for consolidating the environmental provinces focuses upon water depth, using the sound speed profile (in deep water) and the HFBL class (in shallow water) as secondary differentiating factors. The first consideration was to ensure that all six bathymetry provinces are represented. Then within each bathymetry province further partitioning of provinces proceeded as follows:

- The three shallowest bathymetry provinces are each represented by one environmental province. In each case, the bathymetry province is dominated (in some cases almost exclusively) by a single HFBL class, so that the secondary differentiating environmental parameter is of no consequence.
- The 100-, 200-, and 500-meter bathymetry provinces each have two environmental provinces, differing in HFBL class only (one has a low-loss bottom, the other a high-loss bottom). Since the frequency of occurrence of the secondary province is not overwhelmed by the dominant province, both are included in the analysis to ensure thoroughness.
- The 1000- and 2000-meter bathymetry provinces each contain two environmental provinces that feature different HFBL classes. However, in both cases the dominant province in the pair occurs more than a hundred times more frequently rendering the secondary province of no consequence in this analysis.
- The 5000-meter bathymetry province consists of three environmental provinces that differ only in HFBL class. One of the three provinces occurs so infrequently in comparison to the other two that it is excluded from this analysis.

The resulting thirteen environmental provinces used in the SOCAL Range acoustic modeling are described in Table 4-8.

Table 4-8. Distribution of Environmental Provinces in SOCAL Range

Environmental Province	Water Depth	SVP Province	HFBL Class	LFBL Province	Sediment Thickness	Frequency of Occurrence
1	20 m	45	2	0	0.2 secs	0.44 %
2	50 m	45	2	0	0.2 secs	1.05 %
3	100 m	45	2	0	0.2 secs	1.13 %
4	200 m	45	2	0	0.2 secs	0.90 %
5	200 m	45	8	– 49*	0.2 secs	0.66 %
6	500 m	45	2	0	0.2 secs	1.02 %
7	500 m	45	8	– 49*	0.2 secs	6.06 %
8	1000 m	45	8	– 49*	0.2 secs	22.34 %
9	2000 m	45	8	13	0.18 secs	27.58 %
10	5000 m	45	7	13	0.11 secs	24.40 %
11	5000 m	45	8	13	0.11 secs	13.66 %
12	100 m	45	8	– 49*	0.2 secs	0.36 %
13	10 m	45	2	0	0.2 secs	Demolition Charges Only

* Negative province numbers indicate shallow water provinces

The percentages given in the preceding table indicate the frequency of occurrence of each environmental province across all eight areas in the SOCAL Range as described in Figure 4-1. The distribution of the environments within each of the eight individual areas in provided in Table 4-9.

Table 4-9. Distribution of Environmental Provinces within SOCAL Areas

Environmental Province	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8
1	1.33%	1.00%	0.00%	0.09%	0.00%	7.44%	0.00%	0.45%
2	3.55%	2.19%	0.84%	1.54%	0.00%	7.89%	0.00%	1.05%
3	0.00%	0.66%	2.95%	1.30%	0.00%	4.57%	0.00%	1.13%
4	0.00%	0.80%	4.70%	5.37%	0.00%	4.49%	0.00%	0.90%
5	14.58%	2.73%	1.15%	4.71%	0.18%	1.07%	0.00%	0.66%
6	0.00%	2.69%	10.06%	5.10%	0.00%	2.27%	0.00%	1.02%
7	31.20%	10.87%	43.13%	13.20%	3.53%	15.44%	0.00%	6.06%
8	37.23%	54.90%	36.69%	51.81%	43.57%	48.97%	0.00%	22.34%
9	6.45%	21.64%	0.00%	12.62%	52.72%	7.86%	6.82%	27.58%
10	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	47.68%	24.40%
11	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	45.50%	13.66%
12	5.66%	2.52%	0.48%	4.26%	0.00%	0.00%	0.00%	0.36%
13	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.39%

Finally, the SINKEX areas are limited to regions that are more than 50 n.m. from land and deeper than 1000 fathoms. This includes part of Area 5, all of Area 7 and part of Area 8. The distribution of environmental provinces in these three areas is provided in Table 4-10.

Table 4-10. Distribution of Environmental Provinces within SINKEX Areas

Environmental Province	Area 5	Area 7	Area 8	All Areas
9	100.00 %	6.82 %	29.74 %	26.53 %
10	0.00 %	47.68 %	42.17 %	43.10 %
11	0.00 %	45.50 %	28.09 %	30.37 %

4.3 IMPACT VOLUMES AND IMPACT RANGES

Many naval actions include the potential to injure or harass marine animals in the neighboring waters through noise emissions. The number of animals exposed to potential harassment in any such action is dictated by the propagation field and the characteristics of the noise source.

The impact volume associated with a particular activity is defined as the volume of water in which some acoustic metric exceeds a specified threshold. The product of this impact volume with a volumetric animal density yields the expected value of the number of animals exposed to that acoustic metric at a level that exceeds the threshold. The acoustic metric can either be an energy term (energy flux density, either in a limited frequency band or across the full band) or a pressure term (such as peak pressure or positive impulse). The thresholds associated with each of these metrics define the levels at which half of the animals exposed will experience some degree of harassment (ranging from behavioral change to mortality).

Impact volume is particularly relevant when trying to estimate the effect of repeated source emissions separated in either time or space. Impact range, which is defined as the maximum range at which a particular threshold is exceeded for a single source emission, defines the range to which marine mammal activity is monitored in order to meet mitigation requirements.

With the exception of explosive sources, the sole relevant measure of potential harm to the marine wildlife due to sonar operations is the accumulated (summed over all source emissions) energy flux density received by the animal over the duration of the activity. Harassment measures for explosive sources include energy flux density and pressure-related metrics (peak pressure and positive impulse).

Regardless of the type of source, estimating the number of animals that may be injured or otherwise harassed in a particular environment entails the following steps.

- Each source emission is modeled according to the particular operating mode of the sonar. The "effective" energy source level is computed by integrating over the bandwidth of the source, scaling by the pulse length, and adjusting for gains due to source directivity. The location of the source at the time of each emission must also be specified.
- For the relevant environmental acoustic parameters, transmission loss (TL) estimates are computed, sampling the water column over the appropriate depth and range intervals. TL data are sampled at the typical depth(s) of the source and at the nominal center frequency of the source. If the source is relatively broadband, an average over several frequency samples is required.
- The accumulated energy within the waters that the source is "operating" is sampled over a volumetric grid. At each grid point, the received energy from each source

emission is modeled as the effective energy source level reduced by the appropriate propagation loss from the location of the source at the time of the emission to that grid point and summed. For the peak pressure or positive impulse, the appropriate metric is similarly modeled for each emission. The maximum value of that metric, over all emissions, is stored at each grid point.

- The impact volume for a given threshold is estimated by summing the incremental volumes represented by each grid point for which the appropriate metric exceeds that threshold.
- Finally, the number of exposures is estimated as the “product” (scalar or vector, depending upon whether an animal density depth profile is available) of the impact volume and the animal densities.

This section describes in detail the process of computing impact volumes (that is, the first four steps described above). This discussion is presented in two parts: active sonars and explosive sources. The relevant assumptions associated with this approach and the limitations that are implied are also presented. The final step, computing the number of exposures is discussed in subsection 4.5.

4.3.1 Computing Impact Volumes for Active Sonars

This section provides a detailed description of the approach taken to compute impact volumes for active sonars. Included in this discussion are:

- Identification of the underwater propagation model used to compute transmission loss data, a listing of the source-related inputs to that model, and a description of the output parameters that are passed to the energy accumulation algorithm.
- Definitions of the parameters describing each sonar type.
- Description of the algorithms and sampling rates associated with the energy accumulation algorithm.

Transmission Loss Calculations

Transmission loss (TL) data are pre-computed for each of two seasons in each of the environmental provinces described in the previous subsection using the GRAB propagation loss model (Keenan, 2000). The TL output consists of a parametric description of each significant eigenray (or propagation path) from source to animal. The description of each eigenray includes the departure angle from the source (used to model the source vertical directivity later in this process), the propagation time from the source to the animal (used to make corrections to absorption loss for minor differences in frequency and to incorporate a surface-image interference correction at low frequencies), and the transmission loss suffered along the eigenray path.

The frequency and source depth TL inputs are specified in Table 4-11.

Table 4-11. TL Frequency and Source Depth by Sonar Type

SONAR	FREQUENCY	SOURCE DEPTH
MK-48	> 10 kHz	27 m
AN/SQS-53C	3.5 kHz	7 m
AN/SQS-56C	6.8 to 8.2 kHz	7 m
AN/AQS-22	4.1 kHz	27 m
AN/ASQ-62	8 kHz	27 m

The eigenray data for a single GRAB model run are sampled at uniform increments in range out to a maximum range for a specific "animal" (or "target" in GRAB terminology) depth. Multiple GRAB runs are made to sample the animal depth dependence. The depth and range sampling parameters are summarized in Table 4-12. Note that some of the low-power sources do not require TL data to large maximum ranges.

Table 4-12. TL Depth and Range Sampling Parameters by Sonar Type

SONAR	RANGE STEP	MAXIMUM RANGE	ANIMAL DEPTH
MK-48	10 m	10 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
AN/SQS-53C	10 m	200 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
AN/AQS-22	10 m	10 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
AN/ASQ-62	5 m	5 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps

In a few cases, most notably the AN/SQS-53C for thresholds below approximately 180 dB, TL data may be required by the energy summation algorithm at ranges greater than covered by the pre-computed GRAB data. In these cases, TL is extrapolated to the required range using a simple cylindrical spreading loss law in addition to the appropriate absorption loss. This extrapolation leads to a conservative (or under) estimate of transmission loss at the greater ranges.

Although GRAB provides the option of including the effect of source directivity in its eigenray output, this capability is not exercised. By preserving data at the eigenray level, this allows source directivity to be applied later in the process and results in fewer TL calculations.

The other important feature that storing eigenray data supports is the ability to model the effects of surface-image interference that persist over range. However, this is primarily important at frequencies lower than those associated with the sonars considered in this subsection. A detailed description of the modeling of surface-image interference is presented in the subsection on explosive sources.

Energy Summation

The summation of energy flux density over multiple pings in a range-independent environment is a trivial exercise for the most part. A volumetric grid that covers the waters in and around the area of sonar operation is initialized. The source then begins its set of pings. For the first ping, the TL from the source to each grid point is determined (summing the appropriate eigenrays after they have been modified by the vertical beam pattern), the "effective" energy source level is reduced by that TL, and the result is added to the accumulated energy flux density at that grid point. After each grid point has been updated, the accumulated energy at grid points in each depth layer is compared to the specified threshold. If the accumulated energy exceeds that threshold, then the incremental volume represented by that grid point is added to the impact volume for that depth layer. Once all grid points have been processed, the resulting sum of the incremental volumes represents the impact volume for one ping.

The source is then moved along one of the axes in the horizontal plane by the specified ping separation range and the second ping is processed in a similar fashion. Again, once all grid points have been processed, the resulting sum of the incremental volumes represents the impact volume for two pings. This procedure continues until the maximum number of pings specified has been reached.

Defining the volumetric grid over which energy is accumulated is the trickiest aspect of this procedure. The volume must be large enough to contain all volumetric cells for which the accumulated energy is likely to exceed the threshold but not so large as to make the energy accumulation computationally unmanageable.

Determining the size of the volumetric grid begins with an iterative process to determine the lateral extent to be considered. Unless otherwise noted, throughout this process the source is treated as omni directional and the only animal depth that is considered is the TL target depth that is closest to the source depth (placing source and receiver at the same depth is generally an optimal TL geometry).

The first step is to determine the impact range (R_{MAX}) for a single ping. The impact range in this case is the maximum range at which the effective energy source level reduced by the transmission loss is greater than the threshold. Next, the source is moved along a straight-line track and energy flux density is accumulated at a point that has a CPA range of R_{MAX} at the mid-point of the source track. That total energy flux density summed over all pings is then compared to the prescribed threshold. If it is greater than the threshold (which, for the first R_{MAX}, it must be) then R_{MAX} is increased by ten percent, the accumulation process is repeated, and the total energy is again compared to the threshold. This continues until R_{MAX} grows large enough to ensure that the accumulated energy flux density at that lateral range is less than the threshold. The lateral range dimension of the volumetric grid is then set at twice R_{MAX}, with the grid centered along the source track. In the direction of advance for the source, the volumetric grid extends of the interval from [–R_{MAX}, 3 R_{MAX}] with the first source position located at zero in this dimension. Note that the source motion in this direction is limited to the interval [0, 2 R_{MAX}]. Once the source reaches 2 R_{MAX} in this direction, the incremental volume contributions have approximately reached their asymptotic limit and further pings add essentially the same amount. This geometry is demonstrated in Figure 4-3.

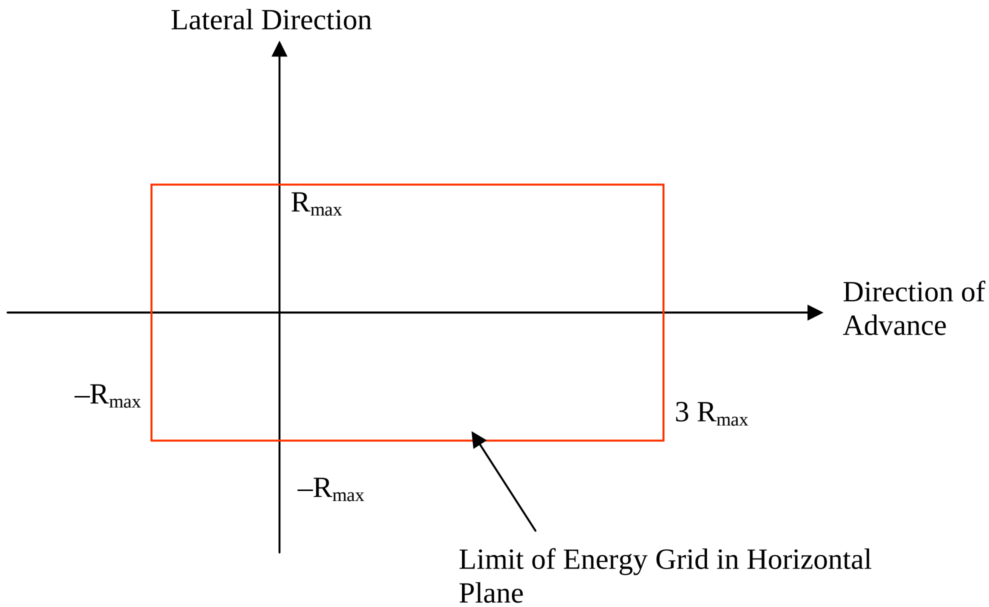


Figure 4-3. Horizontal Plane of Volumetric Grid for Omni Directional Source

If the source is directive in the horizontal plane, then the lateral dimension of the grid may be reduced and the position of the source track adjusted accordingly. For example, if the main lobe of the horizontal source beam is limited to the starboard side of the source platform, then the port side of the track is reduced substantially as demonstrated in the following figure.

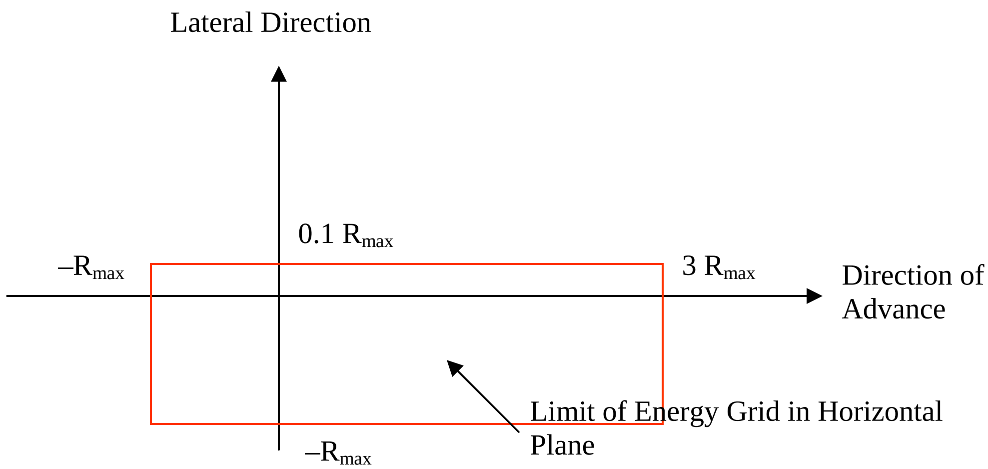


Figure 4-4. Horizontal Plane of Volumetric Grid for Starboard Beam Source

Once the extent of the grid is established, the grid sampling can be defined. In both dimensions of the horizontal plane the sampling rate is approximately $R_{MAX}/100$. The round-off error associated with this sampling rate is roughly equivalent to the error in a numerical integration to determine the area of a circle with a radius of R_{MAX} with a partitioning rate of $R_{MAX}/100$ (approximately one percent). The depth-sampling rate of the grid is comparable to the sampling rates in the horizontal plane but discretized to match an actual TL sampling depth. The depth-sampling rate is also limited to no more than ten meters to ensure that significant TL variability over depth is captured.

Impact Volume per Hour of Sonar Operation

The impact volume for a sonar moving relative to the animal population increases with each additional ping. The rate at which the impact volume increases varies with a number of parameters but eventually approaches some asymptotic limit. Beyond that point the increase in impact volume becomes essentially linear as depicted in Figure 4-5.

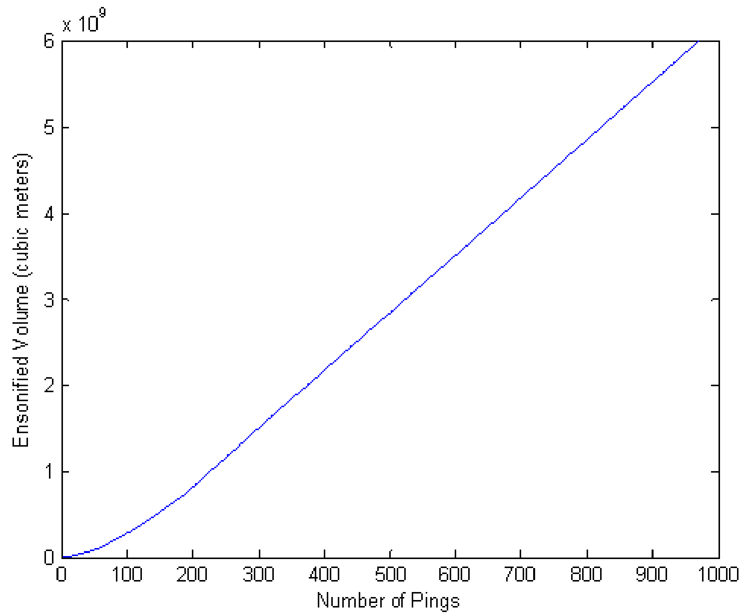


Figure 4-5. 53C Impact Volume by Ping

The slope of the asymptotic limit of the impact volume a given depth is the impact volume added per ping. This number multiplied by the number of pings in an hour gives the hourly impact volume for the given depth increment. Completing this calculation for all depths in a province, for a given source, gives the hourly impact volume vector, v_n, which contains the hourly impact volumes by depth for province n. Figure 4-6 provides an example of an hourly impact volume vector for a particular environment.

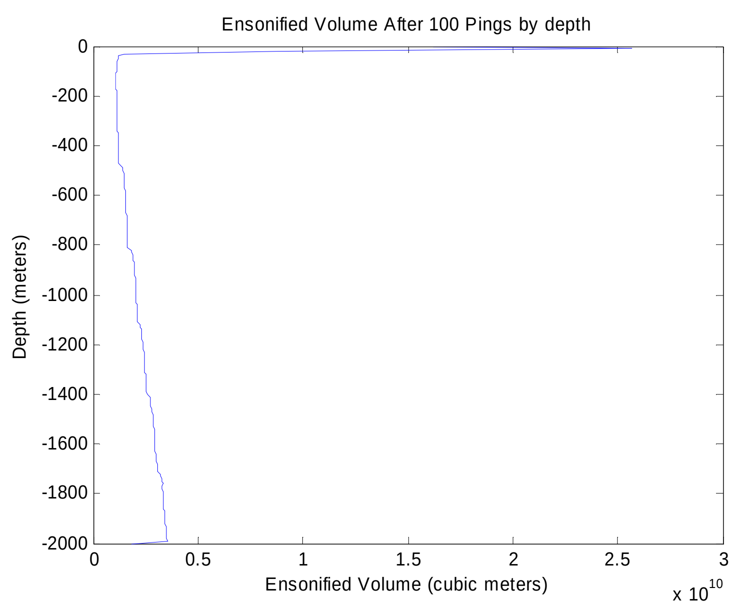


Figure 4-6. Example of an Impact Volume Vector

4.3.2 Computing Impact Volumes for Explosive Sources

This section provides the details of the modeling of the explosive sources. This energy summation algorithm is similar to that used for sonars, only differing in details such as the sampling rates and source parameters. These differences are summarized in the following subsections. A more significant difference is that the explosive sources require the modeling of additional pressure metrics: (1) peak pressure, and (2) "modified" positive impulse. The modeling of each of these metrics is described in detail in the subsections of 4.3.2.3.

4.3.2.1 Transmission Loss Calculations

Modeling impact volumes for explosive sources span requires the type of same TL data as needed for active sonars. However unlike active sonars, explosive ordnances and the EER source are very broadband, contributing significant energy from tens of Hertz to tens of kilohertz. To accommodate the broadband nature of these sources, TL data are sampled at seven frequencies from 10 Hz to 40 kHz, spaced every two octaves.

An important propagation consideration at low frequencies is the effect of surface-image interference. As either source or target approach the surface, pairs of paths that differ in history by a single surface reflection set up an interference pattern that ultimately causes the two paths to perfectly cancel each other when the source or target is at the surface. A fully coherent summation of the eigenrays produces such a result but also introduces extreme fluctuations that would have to be highly sampled in range and depth, and then smoothed to give meaningful results. An alternative approach is to implement what is sometimes called a semi-coherent summation. A semi-coherent sum attempts to capture significant effects of surface-image interference (namely the reduction of the field as the source or target approach the surface) without having to deal with the more rapid fluctuations associated with a fully coherent sum. The semi-coherent sum is formed by a random phase addition of paths that have already been multiplied by the expression:

$$\sin^2 [\, 4\pi\ f\ z_s\, z_a / (c^2\, t)\,]$$

where f is the frequency, z_s is the source depth, z_a is the animal depth, c is the sound speed and t is the travel time from source to animal along the propagation path. For small arguments of the sine function this expression varies directly as the frequency and the two depths. It is this relationship that causes the propagation field to go to zero as the depths approach the surface or the frequency approaches zero

A final important consideration is the broadband nature of explosive sources. This is handled by sampling the TL field at a limited number of frequencies. However, the image-interference correction given above varies substantially over that frequency spacing. To avoid possible under sampling, the image-interference correction is averaged over each frequency interval.

4.3.2.2 Source Parameters

Unlike active sonars, explosive sources are defined by only two parameters: (1) net explosive weight, and (2) source detonation depth. Values for these source parameters are defined earlier in subsection 4.1.2.

The effective energy source level, which is treated as a de facto input for the other sonars, is instead modeled directly for EER and munitions. For both, the energy source level is comparable to the model used for other explosives (Arons (1954), Weston (1960), McGrath (1971), Urick (1983), Christian and Gaspin (1974). The energy source level over a one-third octave band with a center frequency of f for a source with a net explosive weight of w pounds is given by

$$\mathbf{10 \log_{10} (0.26 f) + 10 \log_{10} (2 p_{max}^2 / [1/\theta^2 + 4 \pi f^2]) + 197 \ dB}$$

where the peak pressure for the shock wave at one meter is defined as

$$\mathbf{p_{max} = 21600 (w^{1/3} / 3.28)^{1.13} \ psi} \tag{4-1}$$

and the time constant is defined as:

$$\mathbf{\theta = [(0.058) (w^{1/3}) (3.28 / w^{1/3})^{0.22}] / 1000 \ msec} \tag{4-2}$$

In contrast to munitions that are modeled as omnidirectional sources, the EER source is a continuous line array that produces a directed source. The EER array consists of two explosive strips that are fired simultaneously from the center of the array. Each strip generates a beam pattern with the steer direction of the main lobe determined by the burn rate. The resulting response of the entire array is a bifurcated beam for frequencies above 200 Hz, while at lower frequencies the two beams tend to merge into one.

Since very short ranges are under consideration, the loss of directivity of the array needs to be accounted for in the near field of the array. This is accomplished by modeling the sound pressure level across the field as the coherent sum of contributions of infinitesimal sources along the array that are delayed according to the burn rate. For example, for frequency f the complex pressure contribution at a depth z and horizontal range x from an infinitesimal source located at a distance z’ above the center of the array is

$$e^{i}$$

where

$$\phi = kr' + \alpha z'$$

$$\alpha = 2\pi f / c_b$$

with k the acoustic wave number, c_b the burn rate of the explosive ribbon, and r’ the slant range from the infinitesimal source to the field point (x,z)

Beam patterns as function of vertical angle are then sampled at various ranges out to a maximum range that is approximately L^2 / λ where L is the array length and λ is the wavelength. This maximum range is a rule-of-thumb estimate for the end of the near field (Bartberger, 1965). Finally, commensurate with the resolution of the TL samples, these beam patterns are averaged over octave bands.

A couple of sample beam patterns are provided in Figure 4-7 and Figure 4-8. In both cases, the beam response is sampled at various ranges from the source array to demonstrate the variability across the near field. The 80-Hz family of beam patterns presented in Figure 4-7 shows the rise of a single main lobe as range increases.

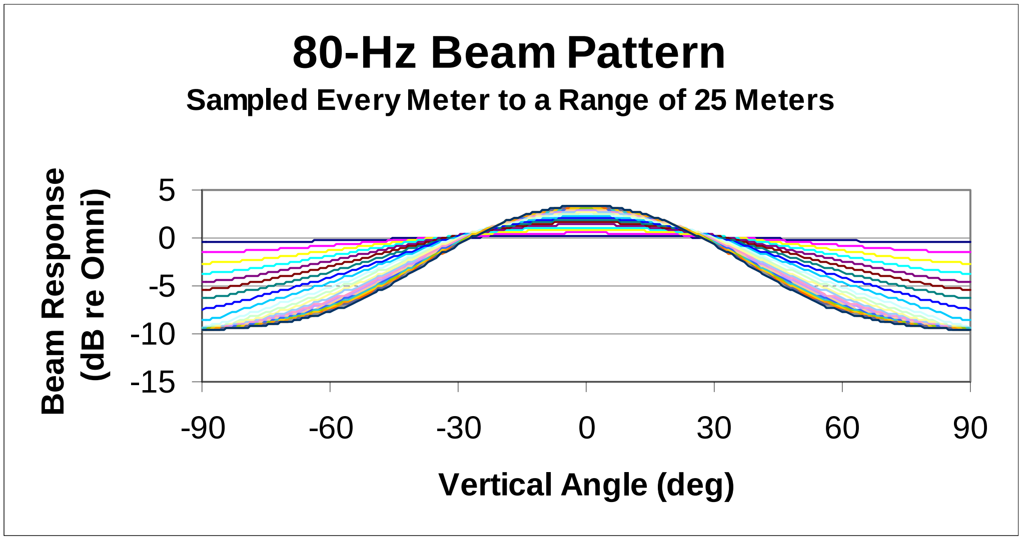


Figure 4-7. 80-Hz Beam Patterns across Near Field of EER Source

On the other hand, the 1250-Hz family of beam patterns depicted in Figure 4-8 demonstrates the typical high-frequency bifurcated beam.

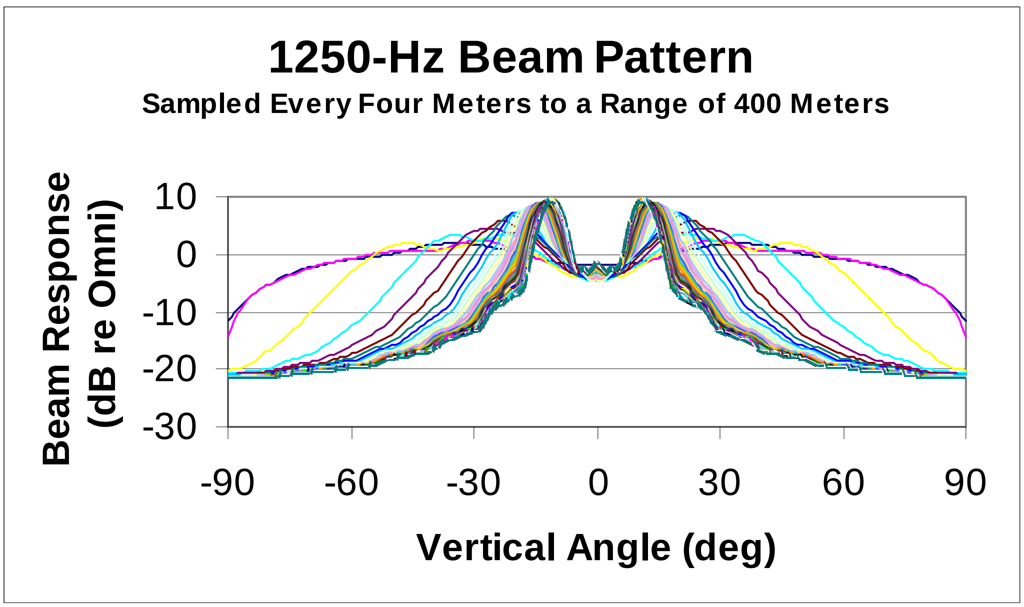


Figure 4-8. 1250-Hz Beam Patterns Across Near Field of EER Source

4.3.2.3 Impact Volumes for Various Metrics

The impact of explosive sources on marine wildlife is measured by three different metrics, each with its own thresholds. The energy metric, peak one-third octave, is treated in similar fashion as the energy metric used for the active sonars, including the summation of energy if there are multiple source emissions. The other two, peak pressure and positive impulse, are not accumulated but rather the maximum levels are taken.

4.3.2.4 Peak One-Third Octave Energy Metric

The computation of impact volumes for the energy metric follows closely the approach taken to model the energy metric for the active sonars. The only significant difference is that energy flux density is sampled at several frequencies in one-third-octave bands and only the peak one-third-octave level is accumulated.

4.3.2.5 Peak Pressure Metric

The peak pressure metric is a simple, straightforward calculation at each range/animal depth combination. First, the transmission ratio, modified by the source level in a one-octave band and the vertical beam pattern, is averaged across frequency on an eigenray-by-eigenray basis. This averaged transmission ratio (normalized by the total broadband source level) is then compared across all eigenrays with the maximum designated as the peak arrival. Peak pressure at that range/animal depth combination is then simply the product of:

- the square root of the averaged transmission ratio of the peak arrival,
- the peak pressure at a range of one meter (given by equation 4-1), and
- the similitude correction (given by $r^{-0.13}$, where r is the slant range along the eigenray estimated as tc with t the travel time along the dominant eigenray and c the nominal speed of sound).

If the peak pressure for a given grid point is greater than the specified threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

4.3.2.6 "Modified" Positive Impulse Metric

The modeling of positive impulse follows the work of Goertner (Goertner, 1982). The Goertner model defines a "partial" impulse as

$$\int_0^{T_{min}} p(t)\, dt$$

where p(t) is the pressure wave from the explosive as a function of time t, defined so that p(t) = 0 for t < 0. This pressure wave is modeled as

$$p(t) = p_{max}\, e^{-t/\theta}$$

where p_{max} is the peak pressure at one meter (see, equation B-1), and θ is the time constant defined as

$$\theta = 0.058\, w^{1/3} (r/w^{1/3})^{0.22} \text{ seconds}$$

with w the net explosive weight (pounds), and r the slant range between source and animal.

The upper limit of the "partial" impulse integral is

$$T_{min} = \min \{T_{cut}, T_{osc}\}$$

where T_{cut} is the time to cutoff and T_{osc} is a function of the animal lung oscillation period. When the upper limit is T_{cut}, the integral is the definition of positive impulse. When the upper limit is defined by T_{osc}, the integral is smaller than the positive impulse and thus is just a “partial” impulse. Switching the integral limit from T_{cut} to T_{osc} accounts for the diminished impact of the positive impulse upon the animals lungs that compress with increasing depth and leads to what is sometimes call a “modified” positive impulse metric.

The time to cutoff is modeled as the difference in travel time between the direct path and the surface-reflected path in an isospeed environment. At a range of r, the time to cutoff for a source depth z_s and an animal depth z_a is

$$T_{cut} = 1/c \; \{ [r^2 + (z_a + z_s)^2]^{1/2} - [r^2 + (z_a - z_s)^2]^{1/2} \}$$

where c is the speed of sound.

The animal lung oscillation period is a function of animal mass M and depth z_a and is modeled as

$$T_{osc} = 1.17 \, M^{1/3} \, (1 + z_a/33)^{-5/6}$$

where M is the animal mass (in kg) and z_a is the animal depth (in feet).

The modified positive impulse threshold is unique among the various injury and harassment metrics in that it is a function of depth and the animal weight. So instead of the user specifying the threshold, it is computed as $K \, (M/42)^{1/3} \, (1 + z_a / 33)^{1/2}$. The coefficient K depends upon the level of exposure. For the onset of slight lung injury, K is 19.7; for the onset of extensive lung hemorrhaging (1% mortality), K is 47.

Although the thresholds are a function of depth and animal weight, sometimes they are summarized as their value at the sea surface for a typical dolphin calf (with an average mass of 12.2 kg). For the onset of slight lung injury, the threshold at the surface is approximately 13 psi-msec; for the onset of extensive lung hemorrhaging (1% mortality), the threshold at the surface is approximately 31 psi-msec.

As with peak pressure, the “modified” positive impulse at each grid point is compared to the derived threshold. If the impulse is greater than that threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

4.3.2.7 Impact Volume per Explosive Detonation

The detonations of explosive sources are generally widely spaced in time and/or space. This implies that the impact volume for multiple firings can be easily derived by scaling the impact volume for a single detonation. Thus the typical impact volume vector for an explosive source is presented on a per-detonation basis.

4.3.3 Impact Volume by Region

The SOCAL Range is described by eleven environmental provinces. The hourly impact volume vector for operations involving any particular source is a linear combination of the eleven impact volume vectors with the weighting determined by the distribution of those thirteen environmental provinces within the range. Unique hourly impact volume vectors for winter and summer are calculated for each type of source and each metric/threshold combination.

4.4 RISK RESPONSE: THEORETICAL AND PRACTICAL IMPLEMENTATION

This section discusses the recent addition of a risk function "threshold" to acoustic effects analysis procedure. This approach includes two parts, a new metric, and a function to map exposure level under the new metric to probability of harassment. What these two parts mean, how they affect exposure calculations, and how they are implemented are the objects of discussion.

Thresholds and Metrics

The term "thresholds" is broadly used to refer to both thresholds and metrics. The difference, and the distinct roles of each in effects analyses, will be the foundation for understanding the dose-response approach, putting it in perspective, and showing that, conceptually, it is similar to past approaches.

Sound is a pressure wave, so at a certain point in space, sound is simply rapidly changing pressure. Pressure at a point is a function of time. Define p(t) as pressure (in micropascals) at a given point at time t (in seconds); this function is called a "time series." Figure 4-9 gives the time series of the first "hallelujah" in Handel's Hallelujah Chorus.

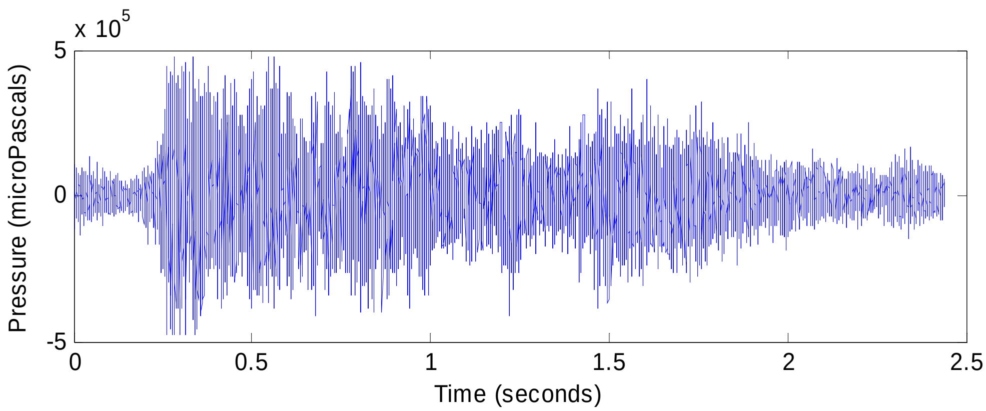


Figure 4-9. Time Series

The time-series of a source can be different at different places. Therefore, sound, or pressure, is not only a function of time, but also of location. Let the function p(t), then be expanded to p(t;x,y,z) and denote the time series at point (x,y,z) in space. Thus, the series in Figure 4-9 p(t) is for a given point (x,y,z). At a different point in space, it would be different.

Assume that the location of the source is (0,0,0) and this series is recorded at (0,10,-4). The time series above would be p(t;0,10,-4) for 0<t<2.5.

As in Figure A-9, pressure can be positive or negative, but usually the function is squared so it is always positive, this makes integration meaningful. Figure 4-10 is $p^2(t;0,10,-4)$.

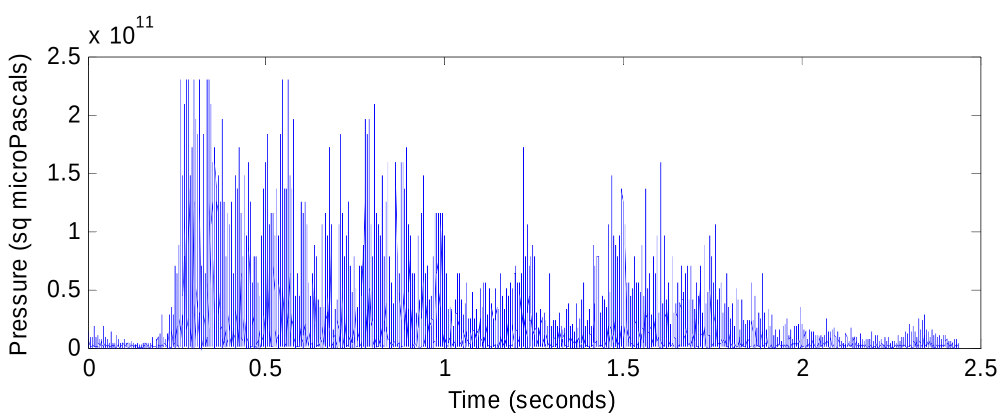


Figure 4-10. Time Series Squared

The metric chosen to evaluate the sound field at the end of this first "hallelujah" determines how the time series is summarized from thousands of points, as in Figure 4-9, to a single value for each point (x,y,z) in the space. The metric essentially "boils down" the four dimensional p(t,x,y,z) into a three dimensional function m(x,y,z) by dealing with time. There is more than one way to summarize the time component, so there is more than one metric.

Max SPL

One way to summarize $p^2(t;x,y,z)$ to one number over the 2.5 seconds is to only report the maximum value of the function over time or,

$$SPL_{\max} = \max\{p^2(t,x,y,z)\} \text{ for } 0<t<2.5$$

The $SPL_{\max}$ for this snippet of the Hallelujah Chorus is $2.3\times10^{11}\ \mu Pa^2$ and occurs at 0.2825 seconds, as shown in Figure A-11.

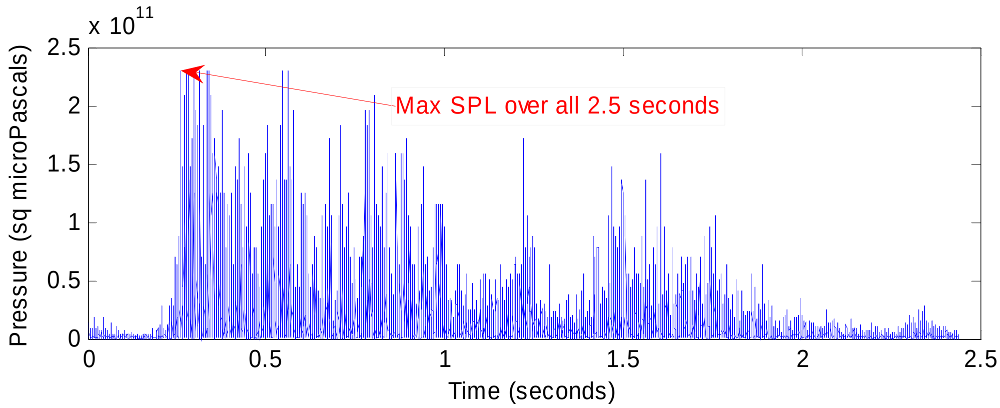


Figure 4-11. Max SPL of Time Series Squared Integration

$SPL_{\max}$ is not necessarily influenced by the duration of the sound (2.5 seconds in this case). Integrating the function over time does take this duration into account. A simple integration of $p^2(t;x,y,z)$ over t is common and usually called "energy."

$$Energy = \int_0^T p^2(t,x,y,z)dt \text{ where T is the maximum time of interest, in this case 2.5}$$

The energy for this snippet of the Hallelujah Chorus is $1.24\times10^{11}\ \mu Pa\cdot s$.

Energy is sometimes called "equal energy" because if p(t) is a constant function and the duration is doubled, the effect is the same as doubling the signal amplitude (y value). Thus, the duration and the signal have an "equal" influence on the energy metric.

Mathematically,

$$\int_0^{2T} p(t)^2\,dt = 2\int_0^{T} p(t)^2\,dt = \int_0^{T} 2\,p(t)^2\,dt$$

or a doubling in duration equals a doubling in energy equals a doubling in signal.

Sometimes, the integration metrics are referred to as having a "3 dB exchange rate" because if the duration is doubled, this integral increases by a factor of two, or 10log10(2)=3.01 dB. Thus, equal energy has "a 3 dB exchange rate."

After p(t) is determined (i.e., when the stimulus is over), propagation models can be used to determine p(t;x,y,z) for every point in the vicinity and for a given metric. Define

$m_a(x, y, z, T) =$ value of metric "a" at point (x,y,z) after time T

So,

$$m_{energy}(x, y, z; T) = \int_0^T p(t)^2\, dt$$

$$m_{\max SPL}(x, y, z; T) = \max(p(t))\ over\ [0, T]$$

Since modeling is concerned with the effects of an entire event, T is usually implicitly defined: a number that captures the duration of the event. This means that $m_a(x, y, z)$ is assumed to be measured over the duration of the received signal.

Three Dimensions vs Two Dimensions

To further reduce the calculation burden, it is possible to reduce the domain of $m_a(x, y, z)$ to two dimensions by defining $m_a(x, y) = \max\{m_a(x, y, z)\}$ over all z.

This reduction is not used for this analysis, which is exclusively three-dimensional.

Threshold

For a given metric, a threshold is a function that gives the probability of exposure at every value of m_a. This threshold function will be defined as

$$D(m_a(x, y, z)) = \Pr(effect\ at\ m_a(x, y, z))$$

The domain of D is the range of $m_a(x, y, z)$, and its range is the number of thresholds.

An example of threshold functions is the Heavyside (or unit step) function, currently used to determine permanent and temporary threshold shift (PTS and TTS) in cetaceans. For PTS, the metric is $m_{energy}(x, y, z)$, defined above, and the threshold function is a Heavyside function with a discontinuity at 215 dB, shown in Figure 4-12.

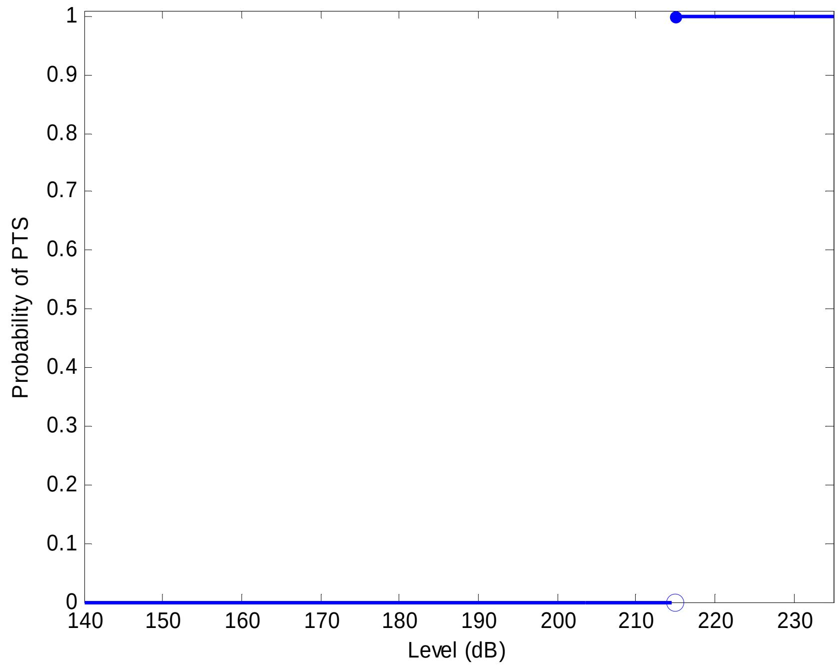


Figure 4-12. PTS Heavyside Threshold Function

Mathematically, this D is defined as:

$$D(m_{energy}) = \begin{cases} 0 \ \ for \ m_{energy} < 215 \\ 1 \ \ for \ m_{energy} \geq 215 \end{cases}$$

Any function can be used for D, as long as its range is in [0,1]. The dose-response functions use normal cumulative distribution functions (ncdfs) instead of heavyside functions, and use the max SPL metric instead of the energy metric. While a Heavyside function is specified by a single parameter, the discontinuity, a normal cumulative distribution function requires two parameters: the mean and the standard deviation. This particular approach defines a third parameter, "cutoff," to limit the support (domain of definition) of D. Mathematically, these "dose" functions are defined as

$$D(m_{\max SPL}) = \begin{cases} ncdf(\mu, \sigma, m_{\max SPL}) \ for \ m_a \geq a \\ 0 \ \ for \ m_{\max SPL} < a \end{cases}$$

where a=cutoff, μ=mean, and σ=standard deviation. For these dose functions, cutoff (a) is always a function of μ and σ, a relationship in the form of a= μ-k σ, where k is an integer. The mid-frequency dose function used for small odontocetes is $ncdf(189, 12, m_{\max SPL})$, with cutoff= μ-3 σ=153 dB.

Multiple Metrics and Thresholds

It is possible to have more than one metric, and more than one threshold in a given metric. For example, in this document, humpback whales have two metrics (energy and max SPL), and three thresholds (two for energy, one for max SPL). The energy thresholds are heavyside functions, as described above, with discontinuities at 215 and 195 for PTS and TTS respectively. The max SPL threshold is a dose-response function with μ=175, σ=10, and cutoff = μ-3 σ =145 for disturbance.

Calculation of Expected Exposures

Determining the number of expected exposures for disturbance is the object of this analysis.

Expected exposures in volume V= $\int_V \rho(V) D(m_a(V)) dV$

For this analysis, $m_a = m_{\max SPL}$, so

$$\int_V \rho(V) D(m_a(V)) dV = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \rho(x,y,z) D(m_{\max SPL}(x,y,z)) dxdydz$$

In this analysis, the densities are constant over the x/y plane, and the z dimension is always negative, so this reduces to

$$\int_{-\infty}^{0} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z)) dxdydz$$

Numeric Implementation

Numeric integration of $\int_{-\infty}^{\infty} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z)) dxdydz$ can be involved because, although the bounds are infinite, D is non-negative out to 141 dB, which, depending on the environmental specifics, can drive propagation loss calculations and their numerical integration out to more than 100 km.

The first step in the solution is to separate out the x/y-plane portion of the integral:

Define f(z)= $\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z)) dxdy$.

Calculation of this integral is the most involved and time consuming part of the calculation. Once it is complete,

$$\int_{-\infty}^{0} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z)) dxdydz = \int_{-\infty}^{0} \rho(z) f(z) dz,$$

which, when numerically integrated, is a simple dot product of two vectors.

Thus, the calculation of f(z) requires the majority of the computation resources for the numerical integration. The rest of this section presents a brief outline of the steps to calculate f(z) and preserve the results efficiently.

The concept of numerical integration is, instead of integrating over continuous functions, to sample the functions at small intervals and sum the samples to approximate the integral. The smaller the size of the intervals, the closer the approximation, but the longer the calculation, so a balance between accuracy and time is determined in the decision of step size. For this analysis, z is sampled in 5 meter steps to 1000 meters in depth and 10 meter steps to 2000 meters, which is the limit of animal depth in this analysis. The step size for x is 5 meters, and y is sampled with an interval that increases as the distance from the source increases. Mathematically,

$$z \in Z = \{0,5,...1000,1010,...,2000\}$$
$$x \in X = \{0,\pm 5,...,\pm 5k\}$$
$$y \in Y = \{0,\pm 5(1.005)^0, 5 \pm (1.005)^1, \pm 5(1.005)^2,...,5(1.005)^j\}$$

for integers k,j, which depend on the propagation distance for the source. For this analysis, k=20,000 and j=600

With these steps, $f(z_0) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z_0))dxdy$ is approximated as

$$\sum_{z\in Y}\sum_{x\in X} D(m_{\max SPL}(x,y,z_0))\Delta x\Delta y$$

where X,Y are defined as above.

This calculation must be repeated for each $z_0 \in Z$, to build the discrete function f(z).

With the calculation of f(z) complete, the integral of its product with $\rho(z)$ must be calculated to complete evaluation of

$$\int_{-\infty}^{\infty}\rho(z)\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))dxdydz = \int_{-\infty}^{0}\rho(z)f(z)dz$$

Since f(z) is discrete, and $\rho(z)$ can be readily made discrete,

$\int_{-\infty}^{0}\rho(z)f(z)dz$ is approximated numerically as $\sum_{z\in Z}\rho(z)f(z)$, a dot product.

Preserving Calculations for Future Use

Calculating f(z) is the most time-consuming part of the numerical integration, but the most time-consuming portion of the entire process is calculating $m_{\max SPL}(x,y,z)$ over the area range required for the minimum cutoff value (141 dB). The calculations usually require propagation estimates out to over 100 km, and those estimates, with the beam pattern, are used to construct a sound field that extends 200 km x 200 km--40,000 sq km, with a calculation at the steps for every value of X and Y, defined above. This is repeated for each depth, to a maximum of 2000 meters.

Saving the entire $m_{\max SPL}$ for each z is unrealistic, requiring great amounts of time and disk space. Instead, the different levels in the range of $m_{\max SPL}$ are sorted into 0.5 dB wide bins; the volume of water at each bin level is taken from $m_{\max SPL}$, and associated with its bin. Saving this, the amount of water ensonified at each level, at 0.5 dB resolution, preserves the ensonification information without using the space and time required to save $m_{\max SPL}$ itself. Practically, this is a histogram of occurrence of level at each depth, with 0.5 dB bins. Mathematically, this is simply defining the discrete functions $V_z(L)$, where $L = \{.5a\}$ for every positive integer a, for all $z \in Z$. These functions, or histograms, are saved for future work. The information lost by saving only the histograms is *where* in space the different levels occur, although *how often* they occur is saved. But the thresholds (dose response curves) are purely a function of level, not location, so this information is sufficient to calculate f(z).

Applying the dose function to the histograms is a dot

product: $\sum_{\ell \in L_1} D(\ell) V_{z_0}(\ell) \approx \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x, y, z_0))dxdy$

So, once the histograms are saved, neither $m_{\max SPL}(x, y, z)$ nor f(z) must be recalculated to

generate $\int_{-\infty}^{0} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x, y, z))dxdydz$ for a new threshold function.

For the interested reader, the following section includes an in-depth discussion of the method, software, and other details of the f(z) calculation.

Software Detail

The risk function metric uses the cumulative normal probability distribution to determine the probability that an animal is affected by a given sound pressure level. The probability distribution is defined by a mean, standard deviation, and low level cutoff, below which it is assumed that animals are not affected. The acoustic quantity of interest is the maximum sound pressure level experienced over multiple pings in a range-independent environment. The procedure for calculating the impact volume at a given depth is relatively simple. In brief, given the sound pressure level of the source and the transmission loss (TL) curve, the sound pressure level is calculated on a volumetric grid. For a given depth, volume associated with a sound pressure level interval is calculated. Then, this volume is multiplied by the probability that an animal will be affected by that sound pressure level. This gives the impact volume for that depth, that can be multiplied by the animal densities at that depth, to obtain the number of animals affected at that depth. The process repeats for each depth to construct the impact volume as a function of depth.

The case of a single emission of sonar energy, one ping, illustrates the computational process in more detail. First, the sound pressure levels are segregated into a sequence of bins that cover the range encountered in the area. The sound pressure levels are used to define a volumetric grid of the local sound field. The impact volume for each depth is calculated as follows: for each depth in the volumetric grid, the sound pressure level at each x/y plane grid point is calculated using the sound pressure level of the source, the TL curve, the horizontal beam pattern of the source, and the vertical beam patterns of the source. The sound pressure levels in this grid become the bins in the volume histogram. Figure 4-13 shows a volume histogram for a low power sonar. Level bins are 0.5 dB in width and the depth is 50 meters in an environment with water depth of 100 meters. The oscillatory structure at very low levels is due the flattening of the TL curve at long distances from the source, which magnifies the fluctuations of the TL as a function of range. The "expected" impact volume for a given level at a given depth is calculated by multiplying the volume in each level bin by the dose response probability function at that level. Total expected impact volume for a given depth is the sum of these "expected" volumes. Figure 4-14 is an example of the impact volume as a function of depth at a water depth of 100 meters.

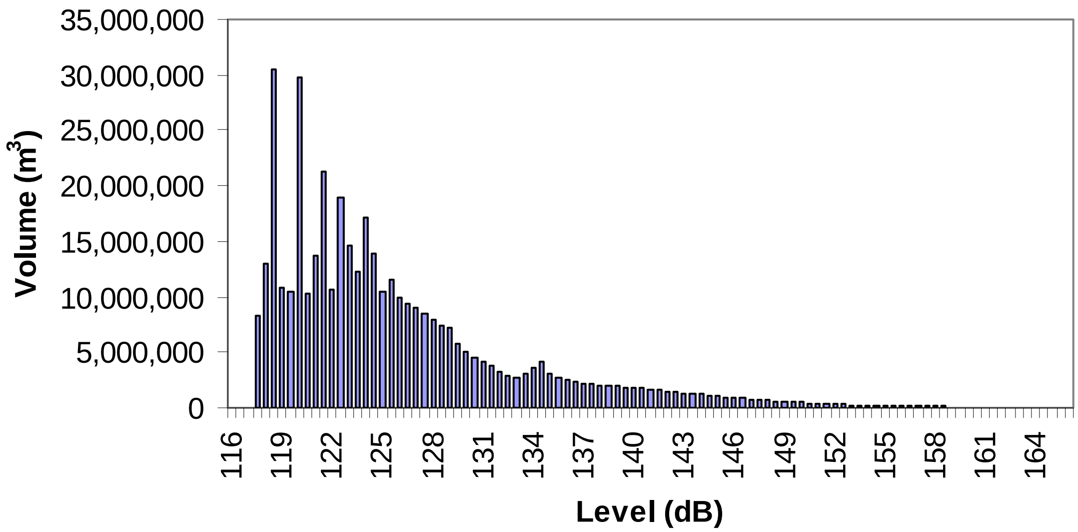


Figure 4-13. Example of a Volume Histogram

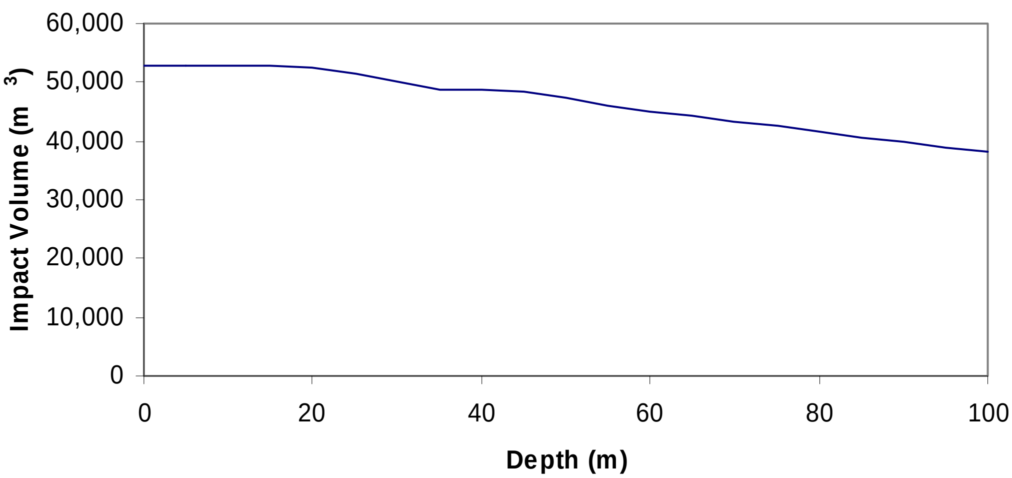


Figure 4-14. Example of the Dependence of Impact Volume on Depth

The volumetric grid covers the waters in and around the area of sonar operation. The grid for this analysis has a uniform spacing of 5 meters in the x-coordinate and a slowly expanding spacing in the y-coordinate that starts with 5 meters spacing at the origin. The growth of the grid size along the y-axis is a geometric series. Each successive grid size is obtained from the previous by multiplying it by 1+Ry, where Ry is the y-axis growth factor. This forms a geometric series. The n^{th} grid size is related to the first grid size by multiplying by $(1+Ry)^{(n-1)}$. For an initial grid size of

5 meters and a growth factor of 0.005, the 100th grid increment is 8.19 meters. The constant spacing in the x-coordinate allows greater accuracy as the source moves along the x-axis. The slowly increasing spacing in y reduces computation time, while maintaining accuracy, by taking advantage of the fact that TL changes more slowly at longer distances from the source. The x- and y-coordinates extend from –Rmax to +Rmax, where Rmax is the maximum range used in the TL calculations. The z direction uses a uniform spacing of 5 meters down to 1000 meters and 10 meters from 1000 to 2000 meters. This is the same depth mesh used for the effective energy metric as described above. The depth mesh does not extend below 2000 meters, on the assumption that animals of interest are not found below this depth.

The next three figures indicate how the accuracy of the calculation of impact volume depends on the parameters used to generate the mesh in the horizontal plane. Figure 4-19 shows the relative change of impact volume for one ping as a function of the grid size used for the x-axis. The y-axis grid size is fixed at 5m and the y-axis growth factor is 0, i.e., uniform spacing. The impact volume for a 5 meters grid size is the reference. For grid sizes between 2.5 and 7.5 meters, the change is less than 0.1%. A grid size of 5 meters for the x-axis is used in the calculations. Figure A-16 shows the relative change of impact volume for one ping as a function of the grid size used for the y-axis. The x-axis grid size is fixed at 5 meters and the y-axis growth factor is 0. The impact volume for a 5 meters grid size is the reference. This figure is very similar to that for the x-axis grid size. For grid sizes between 2.5 and 7.5 meters, the change is less than 0.1%. A grid size of 5 meters is used for the y-axis in our calculations. Figure 4-17 shows the relative change of impact volume for one ping as a function of the y-axis growth factor. The x-axis grid size is fixed at 5 meters and the initial y-axis grid size is 5 meters. The impact volume for a growth factor of 0 is the reference. For growth factors from 0 to 0.01, the change is less than 0.1%. A growth factor of 0.005 is used in the calculations.

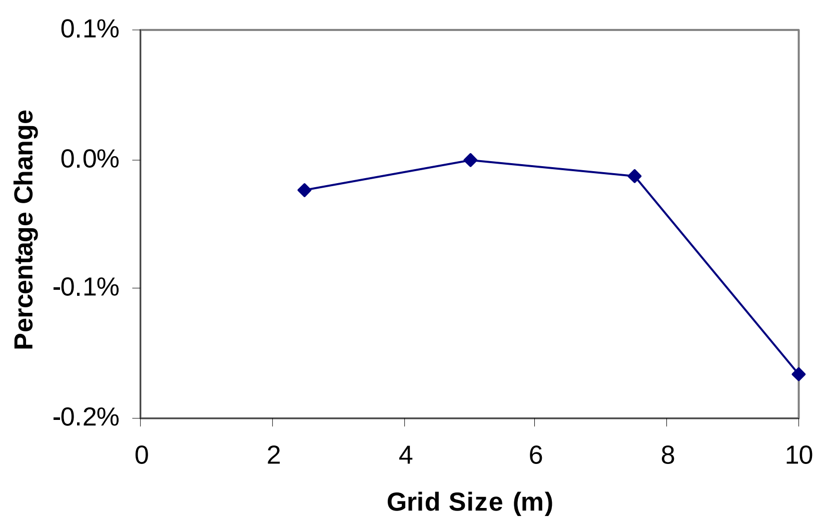


Figure 4-15. Change of Impact Volume as a Function of X-Axis Grid Size

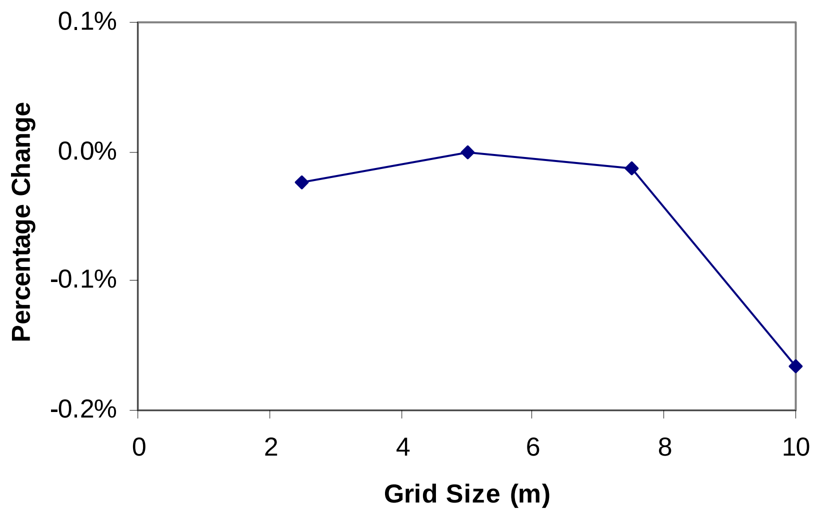


Figure 4-16. Change of Impact Volume as a Function of Y-Axis Grid Size

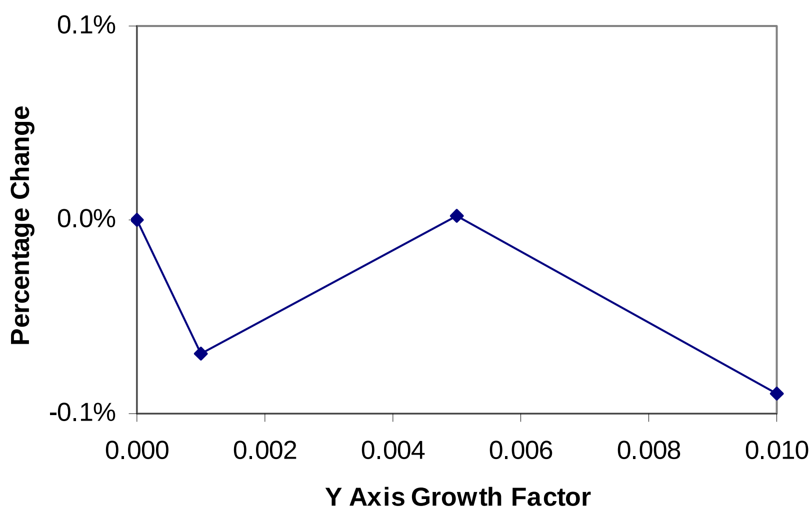


Figure 4-17. Change of Impact Volume as a Function of Y-Axis Growth Factor

Another factor influencing the accuracy of the calculation of impact volumes is the size of the bins used for sound pressure level. The sound pressure level bins extend from 100 dB (far lower than required) up to 300 dB (much higher than that expected for any sonar system). Figure 4-18 shows the relative change of impact volume for one ping as a function of the bin width. The x-axis grid size is fixed at 5 meters the initial y-axis grid size is 5 meters, and the y-axis growth factor is 0.005. The impact volume for a bin size of 0.5 dB is the reference. For bin widths from 0.25 dB to 1.00 dB, the change is about 0.1%. A bin width of 0.5 is used in our calculations.

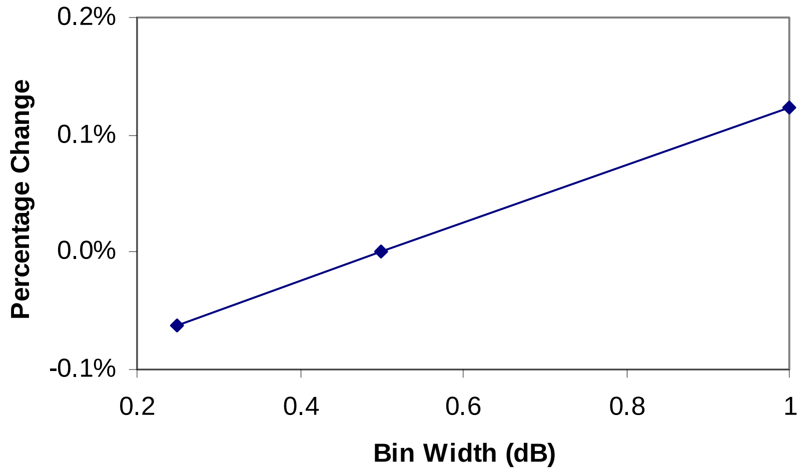


Figure 4-18. Change of Impact Volume as a Function of Bin Width

Two other issues for discussion are the maximum range (Rmax) and the spacing in range and depth used for calculating TL. The TL generated for the energy accumulation metric is used for dose-response analysis. The same sampling in range and depth is adequate for this metric because it requires a less demanding computation (i.e., maximum value instead of accumulated energy). Using the same value of Rmax needs some discussion since it is not clear that the same value can be used for both metrics. Rmax was set so that the TL at Rmax is more than needed to reach the energy accumulation threshold of 173 dB for 1000 pings. Since energy is accumulated, the same TL can be used for one ping with the source level increased by 30 dB (10 $\log_{10}$(1000)). Reducing the source level by 30 dB, to get back to its original value, permits the handling of a sound pressure level threshold down to 143 dB, comparable to the minimum required. Hence, the TL calculated to support energy accumulation for 1000 pings will also support calculation of impact volumes for the dose-response metric.

The process of obtaining the maximum sound pressure level at each grid point in the volumetric grid is straightforward. The active sonar starts at the origin and moves at constant speed along the positive x-axis emitting a burst of energy, a ping, at regularly spaced intervals. For each ping, the distance and horizontal angle connecting the sonar to each grid point is computed. Calculating the TL from the source to a grid point has several steps. The TL is made up of the sum of many eigenrays connecting the source to the grid point. The beam pattern of the source is applied to the eigenrays based on the angle at which they leave the source. After summing the vertically beamformed eigenrays on the range mesh used for the TL calculation, the vertically beamformed TL for the distance from the sonar to the grid point is derived by interpolation. Next, the horizontal beam pattern of the source is applied using the horizontal angle connecting the sonar to the grid point. To avoid problems in extrapolating TL, only use grid points with distances less than R_{max} are used. To obtain the sound pressure level at a grid point, the sound pressure level of the source is reduced by that TL. For the first ping, the volumetric grid is populated by the calculated sound pressure level at each grid point. For the second ping and subsequent pings, the source location increments along the x-axis by the spacing between pings and the sound pressure level for each grid point is again calculated for the new source location. Since the dose-response metric uses the maximum of the sound pressure levels at each grid point, the newly calculated sound pressure level at each grid point is compared to the sound pressure level stored in the grid. If the new level is larger than the stored level, the value at that grid point is replaced by the new sound pressure level.

For each bin, a volume is determined by summing the ensonified volumes with a maximum SPL in the bin's interval. This forms the volume histogram shown in Figure 4-13. Multiplying by the dose-response probability function for the level at the center of a bin gives the impact volume for that bin. The result can be seen in Figure 4-14, which is an example of the impact volume as a function of depth.

The impact volume for a sonar moving relative to the animal population increases with each additional ping. The rate at which the impact volume increases for the dose response metric is essentially linear with the number of pings. Figure 4-19 shows the dependence of impact volume on the number of pings. The function is linear; the slope of the line at a given depth is the impact volume added per ping. This number multiplied by the number of pings in an hour gives the hourly impact volume for the given depth increment. Completing this calculation for all depths in a province, for a given source, gives the hourly impact volume vector which contains the hourly impact volumes by depth for a province. Figure 4-20 provides an example of an hourly impact volume vector for a particular environment. Given the speed of the sonar, the hourly impact volume vector could be displayed as the impact volume vector per kilometer of track.

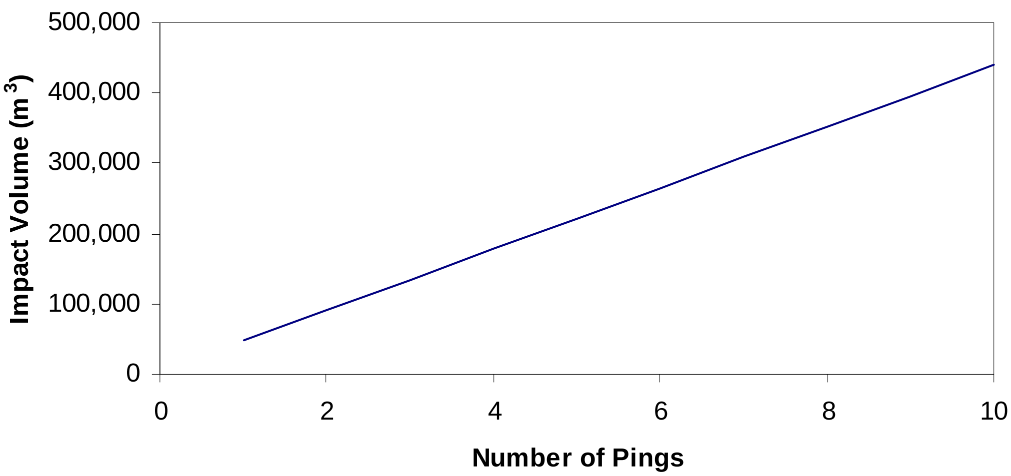


Figure 4-19. Dependence of Impact volume On the Number of Pings

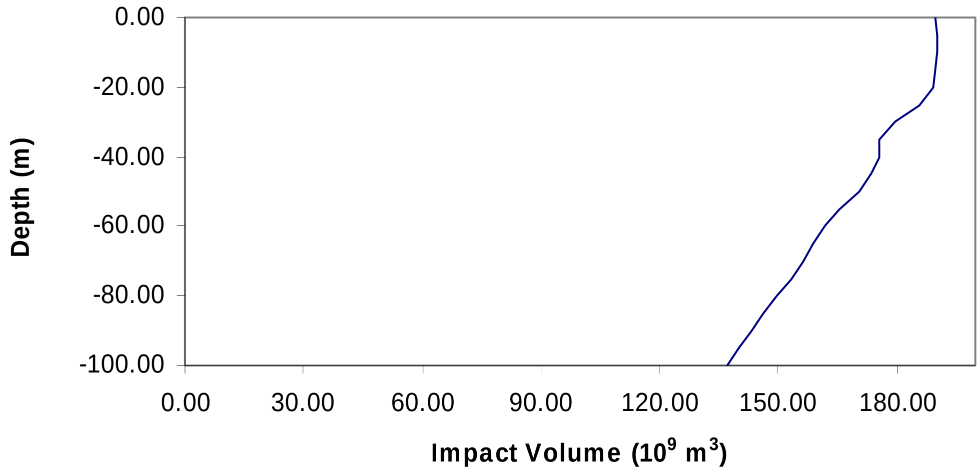


Figure 4-20. Example of an Hourly Impact Volume Vector

4.5 EXPOSURES

This section defines the animal densities and their depth distributions for the SOCAL Range. This is followed by a series of tables providing exposure estimates per unit of operation for each source type (active sonars and explosives).

4.5.1 Animal densities

Densities are usually reported by marine biologists as animals per square kilometer, which is an area metric (presented for each species in Section 2.1). This gives an estimate of the number of animals below the surface in a certain area, but does not provide any information about their distribution in depth. The impact volume vector (see subsection 4.4.3) specifies the volume of water ensonified above the specified threshold in each depth interval. A corresponding animal density for each of those depth intervals is required to compute the expected value of the number of exposures. The two-dimensional area densities do not contain this information, so three-dimensional densities must be constructed by using animal depth distributions to extrapolate the density at each depth. The density estimates used fro the acoustic modeling assumes a uniform density through the modeling area. Exposure Estimates

The following sperm whale example demonstrates the methodology used to create a three-dimensional density by merging the area densities with the depth distributions. The sperm whale surface density is 0.0028 whales per square kilometer. From the depth distribution report, "depth distribution for sperm whales based on information in the Amano paper is: 19% in 0-2 m, 10% in 2-200 m, 11% in 201-400 m, 11% in 401-600 m, 11% in 601-800 m and 38% in >800 m." So the sperm whale density at 0-2 m is 0.0028*0.19/0.002 = 0.266 per cubic km, at 2-200 m is 0.0028*0.10/0.198 = 0.001414 per cubic km, and so forth.

In general, the impact volume vector samples depth in finer detail than given by the depth distribution data. When this is the case, the densities are apportioned uniformly over the appropriate intervals. For example, suppose the impact volume vector provides volumes for the intervals 0-2 meters, 2-10 meters, and 10-50 meters. Then for the depth-distributed densities discussed in the preceding paragraph,

- 0.266 whales per cubic km is used for 0-2 meters,

- 0.001414 whales per cubic km is used for the 2-10 meters, and
- 0.001414 whales per square km is used for the 10-50 meters.

Once depth-varying, three-dimensional densities are specified for each species type, with the same depth intervals and the ensonified volume vector, the density calculations are finished. The expected number of ensonified animals within each depth interval is the ensonified volume at that interval multiplied by the volume density at that interval and this can be obtained as the dot product of the ensonified volume and animal density vectors.

Since the ensonified volume vector is the ensonified volume per unit operation (ie per hour, per sonobuoy, etc), the final exposure count for each animal is the unit operation exposure count multiplied by the number of units (hours, sonobuoys, etc). For sonar sources, exposures are reported at 195 dB, and 215 dB. For explosive sources, exposures are reported by level A (corresponding to 182 dB one-third-octave energy) and level B (corresponding to 205 dB one-third-octave energy and 13 psi-ms). These thresholds are explained in section 4.1.

4.5.2 Exposure Estimates Example

The following sperm whale example demonstrates the methodology used to create a three-dimensional density by merging the area densities with the depth distributions. The sperm whale surface density is 0.0028 whales per square kilometer. From the depth distribution report, "depth distribution for sperm whales based on information in the Amano paper is: 19% in 0-2 m, 10% in 2-200 m, 11% in 201-400 m, 11% in 401-600 m, 11% in 601-800 m and 38% in >800 m." So the sperm whale density at 0 to 2 m is (0.0028*0.19/0.002 =) 0.266 per cubic km, at 2-200 m is (0.0028*0.10/0.198 =) 0.001414 per cubic km, and so forth.

In general, the impact volume vector samples depth in finer detail than given by the depth distribution data. When this is the case, the densities are apportioned uniformly over the appropriate intervals. For example, suppose the impact volume vector provides volumes for the intervals 0 to 2 m, 2 to 10 m, and 10 to 50 m. Then for the depth-distributed densities discussed in the preceding paragraph,

- 0.266 whales per cubic km is used for 0 to 2 m,
- 0.001414 whales per cubic km is used for the 2 to 10 m, and
- 0.001414 whales per square km is used for the 10 to 50 m.

Once depth-varying, three-dimensional densities are specified for each species type, with the same depth intervals and the ensonified volume vector, the density calculations are finished. The expected number of ensonified animals within each depth interval is the ensonified volume at that interval multiplied by the volume density at that interval and this can be obtained as the dot product of the ensonified volume and animal density vectors.

Since the ensonified volume vector is the ensonified volume per unit operation (i.e., per hour, per sonobuoy, etc), the final exposure count for each animal is the unit operation exposure count multiplied by the number of units (hours, sonobuoys, etc). The tables below are organized by Alternative and threshold level; each table represents the total yearly exposures modeled at different threshold levels for each alternative. For sonar sources, exposures are reported at the appropriate dose function level, 195 dB, and 215 dB.

4.6 Summary of Marine Mammal Response to Acoustic and Explosive Exposures

The best scientific information on the status, abundance and distribution, behavior and ecology, diving behavior and acoustic abilities are provided for each species expected to be found within the SOCAL EIS Study Area. Information was reviewed on the response of marine mammals to other sound sources such as seismic air guns or ships but these sources tend to be longer in the period of exposure or continuous in nature. The response of marine mammals to those sounds, and mid-frequency active sonar, are variable with some animals showing no response or moving toward the sound source while others may move away (Review by Richardson et al. 1995; Andre et al. 1997; Nowacek et al. 2004). The analytical framework shows the range of physiological and behavioral responses that can occur when an animal is exposed to an acoustic source. Physiological effects include auditory trauma (TTS, PTS, and tympanic membrane rupture), stress or changes in health and bubble formation or decompression sickness. Behavioral responses may occur due to stress in response to the sound exposure. Behavioral responses may include flight response, changes in diving, foraging or reproductive behavior, changes in vocalizations (may cease or increase intensity), changes in migration or movement patterns or the use of certain habitats. Whether an animal responds, the types of behavioral changes, and the magnitude of those changes may depend on the intensity level of the exposure and the individual animal's prior status or behavior. Little information is available to determine the response of animals to mid-frequency active sonar and its effects on ultimate and proximate life functions or at the population or species level.

Sections 3.3 and 3.4 presented the concept that potential effects of sound include both physiological effects and behavioral effects. Sections 3.15 and 3.16 provide information on how physiological effects and behavioral responses are considered in development of acoustic modeling.

Acoustic exposures are evaluated based on their potential direct effects on marine mammals, and these effects are then assessed in the context of the species biology and ecology to determine if there is a mode of action that may result in the acoustic exposure warranting consideration as a harassment level effect. A large body of research on terrestrial animal and human response to airborne sound exists, but results from those studies are not readily extendible to the development of effect criteria and thresholds for marine mammals. For example, "annoyance" is one of several criteria used to define impact to humans from exposure to industrial sound sources. Comparable criteria cannot be developed for marine mammals because there is no acceptable method for determining whether a non-verbal animal is annoyed. Further, differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (e.g., human data tend to focus on 8-hour-long exposures) make extrapolation of human sound exposure standards inappropriate. Behavioral observations of marine mammals exposed to anthropogenic sound sources exist, however, there are few observations and no controlled measurements of behavioral disruption of cetaceans caused by sound sources with frequencies, waveforms, durations, and repetition rates comparable to those employed by the tactical sonars to be used in the SOCAL Range Complex. At the present time there is no consensus on how to account for behavioral effects on marine mammals exposed to continuous-type sounds (NRC 2003).

This application uses behavioral observations of trained cetaceans exposed to intense underwater sound under controlled circumstances to develop a criterion and threshold for behavioral effects of sound. These data are described in detail in Schlundt et al. (2000) and Finneran and Schlundt (2004). These data, because they are based on controlled, tonal sound exposures within the tactical sonar frequency range, are the most applicable.

When analyzing the results of the acoustic effect modeling to provide an estimate of harassment, it is important to understand that there are limitations to the ecological data used in the model, and to interpret the model results within the context of a given species' ecology.

Limitations in the model include:

- Density estimates (May be limited in duration and time of year and are modeled to derive density estimates).
- When reviewing the acoustic effect modeling results, it is also important to understand that the estimates of marine mammal sound exposures are presented without consideration of mitigation which may reduce the potential for estimated sound exposures to occur.
- Overlap of TTS and risk function.

4.6.1 Acoustic Impact Model Process Applicable to All Alternative Discussions

The methodology for analyzing potential impacts from sonar and explosives is presented in Section 4.2, which explains the model process in detail, describes how the impact threshold derived from Navy-NMFS consultations are derived, and discusses relative potential impact based on species biology.

The Navy acoustic exposure model process uses a number of inter-related software tools to assess potential exposure of marine mammals to Navy generated underwater sound including sonar and explosions. For sonar, these tools estimate potential impact volumes and areas over a range of thresholds for sonar specific operating modes. Results are based upon extensive pre-computations over the range of acoustic environments that might be encountered in the operating area (Section 4).

The acoustic model includes four steps used to calculate potential exposures:

1. Identify unique acoustic environments that encompass the operating area. Parameters include depth and seafloor geography, bottom characteristics and sediment type, wind and surface roughness, sound velocity profile, surface duct, sound channel, and convergence zones.

2. Compute transmission loss (TL) data appropriate for each sensor type in each of these acoustic environments. Propagation can be complex depending on a number of environmental parameters listed in step one, as well as sonar operating parameters such as directivity, source level, ping rate, and ping length, and for explosives the amount of explosive material detonated. The standard Navy CASS-GRAB acoustic propagation model is used to resolve complexities for underwater propagation prediction.

3. Use that TL to estimate the total sound energy received at each point in the acoustic environment.

4. Apply this energy to predicted animal density for that area to estimate potential acoustic exposure, with animals distributed in 3-D based on best available science on animal dive profiles.

Model Results Explanation

Acoustic exposures are evaluated based on their potential direct effects on marine mammals, and these effects are then assessed in the context of the species biology and ecology to determine if there is a mode of action that may result in the acoustic exposure warranting consideration as a harassment level effect.

A large body of research on terrestrial animal and human response to airborne sound exists, but results from those studies are not readily extendible to the development of behavioral criteria and thresholds for marine mammals. For example, “annoyance” is one of several criteria used to define impact to humans from exposure to industrial sound sources. Comparable criteria cannot be developed for marine mammals because there is no scientifically acceptable method for determining whether a non-verbal animal is annoyed (NRC 2003). Further, differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (e.g., human data tend to focus on 8-hour-long exposures) make extrapolation of human sound exposure standards inappropriate. Behavioral observations of marine mammals exposed to anthropogenic sound sources exists, however, there are few observations and no controlled measurements of behavioral disruption of cetaceans caused by sound sources with frequencies, waveforms, durations, and repetition rates comparable to those employed by the tactical sonars described in this EIS/OEIS (Deecke 2006).

At the present time there is no general scientifically accepted consensus on how to account for behavioral effects on marine mammals exposed to anthropogenic sounds including military sonar and explosions (NRC 2003, NRC 2005). While the first three blocks in Figure 4-21 can be easily defined (source, propagation, receiver) the remaining two blocks (perception and behavior) are not well understood given the difficulties in studying marine mammals at sea (NRC 2005). NRC (2005) acknowledges “there is not one case in which data can be integrated into models to demonstrate that noise is causing adverse affects on a marine mammal population.”

Source → **Propagation** → **Receiver** → **Perception** → **Behavior**

From: NRC. 2003. Ocean Noise And Marine Mammals. National Research Council of the National Academies. National Academies Press, Washington, DC.

Figure 4-21. Process Steps: Assessing Behavioural Effects or Absence of Behavioral Effects of Underwater Sound on Marine Species.

For purposes of predicting potential acoustic and explosive effects on marine mammals, the U.S Navy uses an acoustic impact model process with numeric criteria agreed upon with the NMFS. Tthere are some caveats necessary to understand in order to put these exposures in context.

For instance, 1) significant scientific uncertainties are implied and carried forward in any analysis using marine mammal density data as a predictor for animal occurrence within a given geographic area; 2) there are limitations to the actual model process based on information available (animal densities, animal depth distributions, animal motion data, impact thresholds, and supporting statistical model); and determination and understanding of what constitutes a significant behavioral effect is still unresolved.

The sources of marine mammal densities used in the SOCAL EIS/OEIS are derived from NMFS broad scale West Coast Surveys. These ship board surveys cover significant distance along the California coast out the extent of the U.S. EEZ. However, although survey design includes statistical placement of survey tracks, the survey itself can only cover so much ocean area and post-survey statistics are used to calculate animal abundances and densities (Barlow and Forney 2007). There is often significant statistical variation inherit within the calculation of the final density values depending on how many sightings were available during a survey.

Occurrence of marine mammals within any geographic area including Southern California is highly variable and strongly correlated to oceanographic conditions, bathymetry, and ecosystem level patterns rather than changes in reproduction success and survival (Forney 2000, Ferguson and Barlow 2001, Benson et al. 2002, Moore et al. 2002, Tynan 2005, Redfern 2006). For some species, distribution may be even more highly influence by relative small scale features over both short and long-term time scales (Balance et al. 2006, Etnoyer et al. 2006, Ferguson et al. 2006, Skov et al. 2007). Unfortunately, the scientific level of understanding of some large scale and most small scale processes thought to influence marine mammal distribution is incomplete.

Given the uncertainties in marine mammal density estimation and localized distributions, the U.S. Navy's acoustic impact models can not currently be use to predict occurrence of marine mammals within specific regions of Southern California. T o resolve this issue and allow modeling to precede, animals are "artificially and uniformly distributed" within the modeling provinces described in Section 4.2. This process does not account for animals that move into or out of the region based on foraging and migratory patterns, and adds a significant amount of variability to the model predictions.

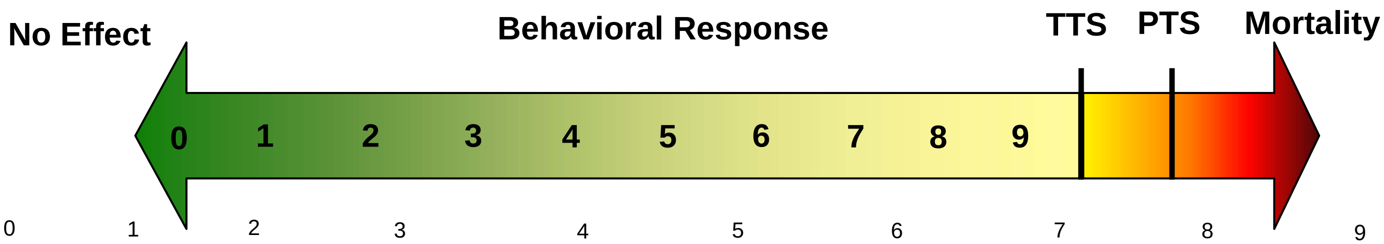
Results, therefore, from acoustic impact exposure models should be regarded as exceedingly conservative estimates strongly influenced by limited biological data. While numbers generated allow establishment of predicted marine mammal exposures for consultation with NMFS, the short duration and limited geographic extent of most sonar and explosive events does not necessarily mean that these exposures will ever be realized.

Comparison With SOCAL After Action Report Data

From exercise after action reports of major SOCAL exercises in 2007, marine mammal sightings ranged from 289 to 881 animals per event over four events. Approximately, 77 to 96% of these animals were dolphins. From all four exercises, only approximately 226 of 2303 animals were observed during mid-frequency operations and sonar was secured or powered down in all cases upon initial animal sighting and until the animal had departed the vicinity of the ship, or the ship moved from the vicinity of the animal. At no time were any of these animals potentially exposed to SEL of greater than 189 dB, with the exception of two groups of dolphins that closed with a ship to ride the bow wake while MFAS was in use, and one group of four whales observed at 50 yards during MFAS transmission and that could have been exposed to RL of 201 dB. Like other sighting, MFAS was secured when these marine mammals were first observed within 200 yards of the ship. Of interest in this evaluation, even accounting for marine mammal not detected visually, the numbers of animals potentially exposed during 2007 are many orders of magnitude below what was predicted by the SOCAL EIS/OEIS acoustic impact modeling (Tables 4-18, 4-20, 4-23).

Behavioral Responses

Behavioral responses to exposure from mid- and high-frequency active sonar and underwater detonations can range from no observable response to panic, flight and possibly stranding (Figure 3.9-7). The intensity of the behavioral responses exhibited by marine mammals depends on a number of conditions including the age, reproductive condition, experience, behavior (foraging or reproductive), species, received sound level, type of sound (impulse or continuous) and duration of sound (Reviews by Richardson et al., 1995; Wartzok et al. 2004; Cox et al. 2006, Nowacek et al. 2007; Southall et al. 2007). Most behavioral responses may be short term and of little consequence for the animal although certain responses may lead to a stranding or mother-offspring separation. Active sonar exposure is brief as the ship is constantly moving and the animal will likely be moving as well. Generally the louder the sound source the more intense the response although duration is also very important (Southall et al. 2007). According to the Southall et al. (2007) response spectrum, responses from 0-3 are brief and minor, 4-6 have a higher potential to affect foraging, reproduction or survival and 7-9 are likely to affect foraging, reproduction and survival. Mitigation measures would likely prevent animals from being exposed to the loudest sonar sounds that could cause PTS, TTS and more intense behavioral reactions (i.e. 7-9 on the response spectrum.



0	1	2	3	4	5	6	7	8	9
-no observable response	-Brief orientation response (investigation / visual orientation)	-Moderate or multiple orientation behaviors -Brief or minor cessation/ modification of vocal behavior -Brief or minor change in respiration rates	-Prolonged orientation behavior -Individual alert behavior -Minor changes in locomotion speed, direction, and/or dive profile but no avoidance o sound source -Moderate change in respiration rate -Minor cessation or modification of vocal behavior (duration < duration of source operation), including the Lombard Effect	-Moderate changes in locomotion speed, direction, and/or dive profile, but no avoidance of sound source -Brief, minor shift in group distribution -Moderate cessation or modification of vocal behavior (duration approx duration of source operation)	-Extensive or prolonged changes in locomotion speed, direction, and/or dive profile but not avoidance of sound source -Moderate shift in group distribution -Change in inter-animal distance and/or group size (aggregation or separation) -Prolonged cessation or modifications of vocal behavior (duration > duration of source operation)	-Minor or moderate individual and/or group avoidance of sound source -Brief or minor separation of females and dependent offspring -Aggressive behavior related to noise exposure (e.g., tail/flipper slapping, fluke display, jaw clapping/ gnashing teeth, abrupt directed movement, bubble clouds) -Extended cessation or modification of vocal behavior -Visible startle response -Brief cessation of reproductive behavior	-Excessive or prolonged aggressive behavior -Moderate separation of females and dependent offspring -Clear anti-predator response -Severe and/ or sustained avoidance of sound source -Moderate cessation of reproductive behavior	-Obvious aversion and/or progressive sensitization -Prolonged or significant separation of females and dependent offspring with disruption of acoustic reunion mechanisms -Long-term avoidance of area (> source operation) -Prolonged cessation of reproductive behavior	-Outright panic, flight, stampede, attach of conspecifics, or stranding events -Avoidance behavior related to predator detection

Figure 4-22. Marine Mammal Response Spectrum to Anthropogenic Sounds
(Numbered severity scale for ranking observed behaviors from Southall et al. 2007

There is little data on the consequences of sound exposure on vital rates of marine mammals. Several studies have shown the effects of chronic noise (either continuous or multiple pulses) on marine mammal presence in an area (e.g. Malme et al. 1984; McCauley et al. 1998; Nowacek et al. 2004)

Even for more cryptic species such as beaked whales, the main determinant of causing a stranding appears to be exposure in a narrow channel with no egress thus animals are exposed for prolonged period rather than just several sonar pings over a several minutes (See section 4.2). There are no narrow channels in the SOCAL Range Complex therefore it is unlikely that mid- or high-frequency active sonar would cause beaked whales to strand.

TTS

A temprorary threshold shift is a temporary increase in the threshold to hear a sound (usually less than 10 dB) over a small range of frequencies related to the sound source it was exposed to. The animal does not become deaf but requires a louder sound stimulus (relative to the amount of TTS) to detect that sound within the affected frequencies. TTS may last several minutes to several days and the duration is related to the intensity of the sound source and the duration of the sound. Sonar exposures are general short in duration and intermittent (several sonar pings per minute from a moving ship), and with mitigation measures in place, TTS in marine mammals exposed to mid- or high-frequency active sonar is unlikely to occur. There is currently no information to suggest that if an animal has TTS, that it will decrease the survival rate or reproductive fitness of that animal.

PTS

A permanent threshold shift is a permanent increase in the threshod to hear a sound (about 20 dB above TTS as determined in terrestrial animals) over a small range of frequencies related to the sound exposure. The animal does not become deaf but requires a louder sound stimulus (relative to the amount of PTS) to detect that sound within the affected frequencies. Sonar exposures are general short in duration and intermittent (several sonar pings per minute from a moving ship), and with mitigation measures in place, PTS in marine mammals exposed to mid- or high-frequency active sonar is unlikely to occur. There is currently no information to suggest that if an animal has PTS that it decrease the survival rate or reproductive fitness of that animal.

Population Level Effects

Some SOCAL Range Complex training activities will be conducted in the same general areas, so marine mammal populations could be exposed to repeated activities over time. The acoustic analyses assume that short-term non-injurious sound levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. Application of this criterion assumes an effect even though it is highly unlikely that all behavioral disruptions or instances of TTS will result in long-term significant effects. Approximately 62% (HRC Supplemental EIS) of the exposures modeled for the SOCAL Range Complex would be below 170 dB SPL and are below the previously use behavioral threshold used for RIMPAC, USWEX and COMPTUEX-JTFEX exercises. Mitigation measures reduce the likelihood of exposures to sound levels that would cause significant behavioral disruption, TTS or PTS. It is unlikely that the short term behavioral disruption would cause biologically significant or population level effects such as decreased survivor rate or reproductive fitness.

4.7 NO ACTION ALTERNATIVE

4.7.1 Non-Sonar Acoustic Impacts and Non-Acoustic Impacts

Ship Noise

Increased number of ships operating in the area will result in increased sound from vessel traffic. Marine mammals react to vessel-generated sounds in a variety of ways. Some respond negatively by retreating or engaging in antagonistic responses while other animals ignore the stimulus altogether (Watkins 1986; Terhune and Verboom 1999). Most studies have ascertained the short-term response to vessel sound and vessel traffic (Watkins et al. 1981; Baker et al. 1983; Magalhães et al. 2002); however, the long-term implications of ship sound on marine mammals is largely unknown (NMFS 2007). Anthropogenic sound, especially around regional commercial shipping hubs has increased in the marine environment over the past 50 years (Richardson, et al. 1995; Andrew et al. 2002; NRC 2003; Hildebrand 2004; NRC 2005). This sound increase can be attributed primarily to increases in vessel traffic as well as sound from other human sources (Richardson, et al. 1995; NRC 2005). NRC (2005) has a thorough discussion of both human and natural underwater sound sources.

Given the current ambient sound levels in the Southern California marine environment, the amount of sound contributed by the use of Navy vessels in the proposed exercises is very low. In addition, as opposed to commercial vessels, Navy ships are purposely designed and engineered for the lowest underwater acoustic signature possible given the limits of current naval shipbuilding technology. The goal with ship silencing technology is to limit the amount of sound a Navy vessel radiates that could be used by a potential adversary for detection. Given these factors, it is anticipated that any marine mammals exposed may exhibit either nor reactions or only short-term reactions, and would not suffer any long-term consequences from ship sound. This assessment is also applicable to discussions of Alternatives 1 and 2.

Ship Strikes

Collisions with commercial and Navy ships can cause major wounds and may occasionally cause fatalities to cetaceans. The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale). In addition, some baleen whales, such as the northern right whale and fin whale swim slowly and seem generally unresponsive to ship sound, making them more susceptible to ship strikes (Nowacek et al. 2004). Smaller marine mammals-for example, Pacific white-side dolphins and common dolphins move quickly throughout the water column and are often seen riding the bow wave of large ships. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC 2003).

The Navy has adopted mitigation measures that reduce the potential for collisions with surfaced marine mammals and sea turtles (See Chapter 5). These standard operating procedures include: (1) use of lookouts trained to detect all objects on the surface of the water, including marine mammals; (2) reasonable and prudent actions to avoid the close interaction of Navy assets and marine mammals; and (3) maneuvering to keep away from any observed marine mammal. Based on these standard operating procedures, collisions with marine mammals are not expected. This assessment is also applicable to discussions of Alternatives 1 and 2.

Torpedoes

There is a negligible risk that a marine mammal could be struck by a torpedo during ASW training activities. This conclusion is based on (1) review of torpedo design features, and (2) review of a large number of previous naval exercise ASW torpedo activities. The acoustic homing programs of torpedoes are designed to detect either the mechanical sound signature of the submarine or active sonar returns from its metal hull with large internal air volume interface. The torpedoes are specifically designed to ignore false targets. As a result, their homing logic does not detect or recognize the relatively small air volume associated with the lungs of marine mammals. They do not detect or home to marine mammals. The Navy has conducted exercise torpedo activities since 1968. At least 14,322 exercise torpedo runs have been conducted since

1968. There have been no recorded or reported instances of a marine species strike by an exercise torpedo. Every exercise torpedo activity is monitored acoustically by on-scene range personnel listening to range hydrophones positioned on the ocean floor in the immediate vicinity of the torpedo activity. After each torpedo run, the recovered exercise torpedo is thoroughly inspected for any damage. The torpedoes then go through an extensive production line refurbishment process for re-use. This production line has stringent quality control procedures to ensure that the torpedo will safely and effectively operate during its next run. Since these exercise torpedoes are frequently used against manned Navy submarines, this post activity inspection process is thorough and accurate. Inspection records and quality control documents are prepared for each torpedo run. This post exercise inspection is the basis that supports the conclusion of negligible risk of marine mammal strike. Therefore, there will be no significant impact and no significant harm to marine mammals resulting from interactions with torpedoes during SOCAL activities under the No Action Alternative, Alternative 1, or Alternative 2. The probability of direct strike of torpedoes associated with SOCAL training is negligible and therefore will have no effect on ESA-listed marine mammal species.

Military Expendable Material

Marine mammals are subject to entanglement in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Most documented cases of entanglements occur when whales encounter the vertical lines of fixed fishing gear. This section analyzes the potential effects of expended materials on marine mammals

The Navy endeavors to recover expended training materials. Notwithstanding, it is not possible to recover all training debris, and some may be encountered by marine mammals in the waters of the SOCAL Range Complex. Debris related to military activities that is not recovered generally sinks; the amount that might remain on or near the sea surface is low, and the density of such debris in the SOCAL Range Complex would be very low. Types of training debris that might be encountered include: parachutes of various types (e.g., those employed by personnel or on targets, flares, or sonobuoys); torpedo guidance wires, torpedo “flex hoses;” cable assemblies used to facilitate target recovery; sonobuoys; and Expendable Mobile Acoustic Training Target s (EMATT)

Entanglement in military-related debris was not cited as a source of injury or mortality for any marine mammals recorded in a large marine mammal and sea turtle stranding database for California waters. Range debris is highly unlikely to affect marine mammal species in the SOCAL Range Complex. The following discussion addresses categories of debris.

Sonobuoys. A sonobuoy is approximately 13 centimeters (cm) (5 inches [in]) in diameter, 1 meter (m) (3 feet [ft]) long, and weighs between 6 and 18 kilograms (kg) (14 and 39 pounds [lb]), depending on the type. In addition, aircraft-launched sonobuoys deploy a nylon parachute of varying sizes, ranging from 0.15 to 0.35 square meters (m2) (1.6 to 3.8 square feet [ft2]). The shroud lines range from 0.30 to 0.53 m (12 to 21 in) in length and are made of either cotton polyester with a 13.6-kg (30-lb) breaking strength or nylon with a 45.4-kg (100-lb) breaking strength. All parachutes are weighted with a 0.06-kg (2-ounce) steel material weight, which causes the parachute to sink from the surface within 15 minutes. At water impact, the parachute assembly, battery, and sonobuoy will sink to the ocean floor where they will be buried into its soft sediments or land on the hard bottom where they will eventually be colonized by marine organisms and degrade over time. These components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor. However, the active sonar activities using sonobuoys will not likely occur in the exact same location each time. Additionally, the materials will not likely settle in the same vicinity due to ocean currents.

Parachutes. Aircraft-launched sonobuoys, flares, torpedoes, and EMATTs deploy nylon parachutes of varying sizes. As described above, at water impact, the parachute assembly is expended and sinks, as all of the material is negatively buoyant. Some components are metallic and will sink rapidly. Entanglement and the eventual drowning of a marine mammal in a parachute assembly would be unlikely, since such an event would require the parachute to land directly on an animal, or the animal would have to swim into it before it sinks. The expended material will accumulate on the ocean floor and will be covered by sediments over time, remaining on the ocean floor and reducing the potential for entanglement. If bottom currents are present, the canopy may billow (bulge) and pose an entanglement threat to marine animals with bottom-feeding habits; however, the probability of a marine mammal encountering a submerged parachute assembly and the potential for accidental entanglement in the canopy or suspension lines is considered to be unlikely.

Torpedoes. The Mk-48 will be used during active sonar activities. These devices are approximately 19 ft (580 cm) long and 21 in (53 cm) in diameter. Mk-48 torpedoes when used in a non-detonation exercise mode are typically recovered. An assortment of air launch accessories, all of which consist of non-hazardous materials, would be expended into the marine environment during air launching of Mk-46 or Mk-54 torpedoes, which are lightweight torpedoes. Depending on the type of launch craft used, Mk-46 launch accessories may be comprised of a protective nose cover, suspension bands, air stabilizer, release wire, and propeller baffle (DoN 1996). Mk-54 air launch accessories may be comprised of a nose cap, suspension bands, air stabilizer, sway brace pad, arming wire, and fan stock clip (DoN 1996). Upon completion of an M6-46 EXTORP run, two steel-jacketed lead ballast weights are released to lighten the torpedo, allowing it to rise to the surface for recovery. Each ballast weighs 37 lbs (16.8 kg) and sinks rapidly to the bottom. In addition to the ballasted Mk-46 EXTORPs, Mk-46 REXTORPs launched from maritime patrol aircraft (MPA) must also be ballasted for safety purposes. Ballast weights for these REXTORPs are similarly released to allow for missile recovery. Ballasting the Mk-46 REXTORP for MPA use requires six ballasts, totaling 180 lbs (82 kg) of lead

Torpedo Guidance Wires. Torpedoes are equipped with a single-strand guidance wire, which is laid behind the torpedo as it moves through the water. The guidance wire is a maximum of 0.11 cm (0.043 in) in diameter and composed of a very fine thin-gauge copper-cadmium core with a polyolefin coating. The tensile breaking strength of the wire is a maximum of 19 kg (42 lb) and can be broken by hand. Up to 28 km (15 miles [mi]) of wire is deployed during a run, which will sink to the sea floor at a rate of 0.15 meters per second (m/sec) (0.5 feet per second [ft/sec]). At the end of a training torpedo run, the wire is released from the firing vessel and the torpedo to enable torpedo recovery. The wire sinks rapidly and settles on the ocean floor. Guidance wires are expended with each exercise torpedo launched. DoN (1996) analyzed the potential entanglement effects of torpedo control wires on sea turtles. The Navy analysis concluded that the potential for entanglement effects will be low for the following reasons, which apply also to potential entanglement of marine mammals:

- The guidance wire is a very fine, thin-gauge copper-cadmium core with a polyolefin coating. The tensile breaking strength of the wire is a maximum of 19 kg (42 lb) and can be broken by hand. With the exception of a chance encounter with the guidance wire while it was sinking to the sea floor (at an estimate rate of 0.2 m [0.5 ft] per second), a marine animal would be vulnerable to entanglement only if its diving and feeding patterns place it in contact with the bottom.
- The torpedo control wire is held stationary in the water column by drag forces as it is pulled from the torpedo in a relatively straight line until its length becomes sufficient for it to form a chain-like droop. When the wire is cut or broken, it is relatively straight and

the physical characteristics of the wire prevent it from tangling, unlike the monofilament fishing lines and polypropylene ropes identified in the entanglement literatures.

While it is possible that a marine mammal would encounter a torpedo guidance wire as it sinks to the ocean floor, the likelihood of such an event is considered remote, as is the likelihood of entanglement after the wire has descended to and rests upon the ocean floor.

Given the low potential probability of marine mammal entanglement with guidance wires, the potential for any harm or harassment to these species is extremely low. Therefore, there will be no significant impact to marine mammals resulting from interactions with torpedo guidance wire during SOCAL activities under the No Action Alternative, Alternative 1, and Alternative 2. In addition, there will be no significant harm to marine mammals resulting from interactions with torpedo guidance wire during. The torpedo guidance wires associated with SOCAL activities will also have no effect on ESA-listed marine mammal species

Torpedo Flex Hoses. The flex hose protects the torpedo guidance wire and prevents it from forming loops as it leaves the torpedo tube of a submarine. Improved flex hoses or strong flex hoses will be expended during torpedo exercises. DoN (1996) analyzed the potential for the flex hoses to affect sea turtles. This analysis concluded that the potential entanglement effects to marine animals will be insignificant for reasons similar to those stated for the potential entanglement effects of control wires:

- Due to weight, flex hoses will rapidly sing to the bottom upon release. With the exception of a chance encounter with the flex hose while it was sinking to the sea floor, a marine mammal would be vulnerable to entanglement only if its diving and feeding patterns placed it in contact with the bottom.
- Due to its stiffness, the 250-ft-long flex hose will not form loops that could entangle marine mammals.

Therefore, there will be no significant impact to marine mammals resulting from interactions with torpedo flex hoses under the No Action Alternative, Alternative 1, or Alternative 2. In addition, there will be no significant harm to marine mammals or ESA-listed marine species resulting from interactions with torpedo flex hoses.

EMATT. The Navy uses the EMATT and the MK-30 acoustic training targets (recovered), sonobuoys and exercise torpedoes during ASW sonar training exercises. EMATTs are approximately 5 by 36 inches (in) (12 by 91 centimeters [cm]) and weigh approximately 21 pounds (lbs). EMATTs are much smaller than sonobuoys and ADCs. Given the small sized of EMATTs and coupled with the low probability that an animal would occur at the immediate location of deployment and reconnaissance, provide little potential for a direct strike. Moreover, there is a negligible risk that a marine mammal could be struck by a torpedo during ASW training activities. The acoustic homing programs of torpedoes are designed to detect either the mechanical sound signature of the submarine or active sonar returns from its metal hull with large, internal air volume interface. Their homing logic does not detect or recognize the relatively small air volume associated with the lungs of marine mammals.

Therefore, the probability of direct strike by training target is remote, and there will be no significant impact to marine mammals resulting from interactions with targets, or exercise torpedoes during SOCAL activities under the No Action Alternative, Alternative 1, and Alternative 2. In addition, there will be no significant harm to marine mammals or ESA-listed marine species from interactions with targets, or exercise torpedoes.

EMATTs, their batteries, parachutes, and other components will scuttle and sink to the ocean floor and will be covered by sediments over time. In addition, the small amount of expended material will be spread over a relatively large area. Due to the small size and low density of the materials, these components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor, but due to ocean currents, the materials will not likely settle in the same vicinity. There will be no significant impact to marine habitat from expended EMATTs or their components.

Other Falling Expendable Material. Marine mammals are widely dispersed in the SOCAL Range Complex, therefore, there is an extremely low probability of injury to a marine mammal from falling debris such as munitions constituents, inert ordnance, or targets. The probability of negative interaction from direct strike, sound, or other energy by expendable material is remote. Therefore, there will be no significant impact to marine mammals resulting from interactions with targets, or exercise torpedoes during SOCAL activities under the No Action Alternative, Alternative 1, and Alternative 2. In addition, there will be no significant harm to marine mammals or ESA-listed marine species from interactions with targets, or exercise torpedoes.

4.7.2 Summary of Potential Mid- and High-Frequency Active Sonar Effects

The following table represents the number of sonar hours, dipping sonar, or sonobuoys usage per year for the different sonar sources including the 53C, 56C, submarine, AN/AWS-22 dipping sonar, SSQ-62 Sonobuoys, and MK-48 torpedo sonar.

Table 4-13. Summary of the sonar hours, number of sonar dips and sonobuoys deployed, and MK-48 torpedo events for each type of exercise for the No Action Alternative.

Event	SQS-53 C Sonar Hours	SQS-56 C Sonar Hours	Total Sonar Hours	AQS-22 Number of Dips	SSQ-62 Number of Sonobuoys	MK-48 Number of Torpedo Events
Major Exercise (8/yr)	927	231	1,158	299	1,999	9
Sustainment Exercise (2/yr)	75	19	94	39	151	3
IAC II (4/yr)	216	55	271	361	453	2
ULT, Coordinated Events & Maintenance	535	133	668	1,712	1,169	62
Total	1,753	438	2,191	2,411	3,773	77

Table 4-14 presents a summary of the estimated marine mammal exposures for potential non-injurious (Level B) harassment, as well as potential onset of injury (Level A) to cetaceans and pinnipeds. Tables 4-19 through 4-18 present estimated marine mammal exposures further separated by component activites as listed in Table 4-13. The numbers contained in these tables may be slightly less than those presented in Table 4-14 as a result of the order of summation and the application of rounding rules utilized in the calculation of exposures.

Specifically, under this assessment for mid-frequency active sonar, the risk function methodology estimates 83,686 annual exposures that could potentially result in behavioral sub-TTS (Level B Harassment); 16,706 annual exposures that could potentially result in TTS (Level B Harassment); and 26 annual exposures could result in potential injury as PTS (Level A Harassment). No mid-frequency active sonar exposures are predicted to result in any animal mortality.

It should be noted, however, that these exposure modeling results are statistically derived estimates of potential marine mammal sonar exposures without consideration of standard mitigation and monitoring procedures. The caveats to intrepreations of model results are explained previously. It is highly unlikely that a marine mammal would experience any long-term effects because the large SOCAL Range Complex training areas makes individual mammals' repeated or prolonged exposures to high-level sonar signals unlikely. Specifically, mid-frequency active sonars have limited marine mammal exposure ranges and relatively high platform speeds. The number of exposures that exceed the PTS threshold and result in Level A harassment from sonar is eight for six species (blue whale, gray whale, sperm whale, long-beaked common dolphin, shortbeaked common dolphin, and Pacific harbor seal). Therefore, long term effects on individuals, populations or stocks are unlikely.

When analyzing the results of the acoustic exposure modeling to provide an estimate of effects, it is important to understand that there are limitations to the ecological data (diving behavior, migration or movement patterns and population dynamics) used in the model, and that the model results must be interpreted within the context of a given species' ecology.

As described previously, this authorization request assumes that short-term non-injurious sound exposure levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. This approach is overestimating because there is no established scientific correlation between mid-frequency active sonar use and long term abandonment or significant alteration of behavioral patterns in marine mammals.

Because of the time delay between pings, and platform speed, an animal encountering the sonar will accumulate energy for only a few sonar pings over the course of a few minutes. Therefore, exposure to sonar would be a short-term event, minimizing any single animal's exposure to sound levels approaching the harassment thresholds.

The implementation of the mitigation and monitoring procedures as addressed in Section 11 will further minimize the potential for marine mammal exposures to underwater detonations. When reviewing the acoustic exposure modeling results, it is also important to understand that the estimates of marine mammal sound exposures are presented without consideration of standard protective measure operating procedures. Section 11 presents details of the mitigation measures currently used for ASW activities including detection of marine mammals and power down procedures if marine mammals are dectected within one of the safety zones. The Navy will work through the MMPA incidental harassment regulatory process to discuss the mitigation measures and their potential to reduce the likelihood for incidental harassment of marine mammals.

Table 4-14. No-Action Alternative: Summary of All Annual Mid- and High- Frequency Active Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Response	TTS	PTS
ESA Species			
Blue whale	463	113	1
Fin whale	101	21	0
Humpback whale	12	2	0
Sei whale	0	0	0
Sperm whale	104	17	1
Guadalupe fur seal	807	285	0
Sea otter	N/A	N/A	N/A
Mysticetes			
Bryde's whale	0	0	0
Gray whale	4,797	901	2
Minke whale	90	26	0
Odontocetes			
Baird's beaked whale	8	2	0
Bottlenose dolphin	853	317	0
Cuvier's beaked whale	288	63	0
Dall's porpoise	419	145	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	6	2	0
Long beaked common dolphin	2,255	715	1
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A!	N/A
Mesoplodon spp.	86	22	0
Northern right whale dolphin	811	277	0
Pacific white-sided dolphin	756	312	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	108	27	0
Risso's dolphin	1,968	570	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	19,377	6,148	8
Short-finned pilot whale	34	9	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	1,401	411	0
Ziphiid whales	65	15	0
Pinnipeds			
Northern elephant seal	599	7	0
Pacific harbor seal	906	6,290	13
California sea lion	46,715	5	0
Northern fur seal	656	5	0
Total	**83,686**	**16,706**	**26**

Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s, northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

Table 4-15. No Action Alternative Summary of ULT, Coordinated Events and Maintenance Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	212	52	0
Fin whale	44	9	0
Humpback whale	6	1	0
Sei whale	0	0	0
Sperm whale	46	8	0
Guadalupe fur seal	372	138	0
Sea otter	0	0	0
Mysticetes			
Bryde's whale	0	0	0
Gray whale	2,254	410	1
Minke whale	41	12	0
Odontocetes			
Baird's beaked whale	4	1	0
Bottlenose dolphin	394	146	0
Cuvier's beaked whale	124	30	0
Dall's porpoise	191	66	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	3	1	0
Long beaked common dolphin	1,083	333	1
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	39	10	0
Northern right whale dolphin	380	129	0
Pacific white-sided dolphin	356	143	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	48	13	0
Risso's dolphin	899	268	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	9,312	2,861	4
Short-finned pilot whale	16	5	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	641	187	0
Ziphiid whales	28	7	0
Pinnipeds			
Northern elephant seal	394	5	0
Pacific harbor seal	564	3,940	8
California sea lion	22,651	4	0
Northern fur seal	308	2	0
Total	**40,409**	**8,780**	**14**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

Table 4-16. No Action Alternative Summary of Major Exercise Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	190	45	0
Fin whale	43	8	0
Humpback whale	5	1	0
Sei whale	0	0	0
Sperm whale	44	6	0
Guadalupe fur seal	326	117	0
Sea otter	0	0	0
Mysticetes			
Bryde's whale	0	0	0
Gray whale	1,898	368	1
Minke whale	37	10	0
Odontocetes			
Baird's beaked whale	4	1	0
Bottlenose dolphin	340	127	0
Cuvier's beaked whale	125	24	0
Dall's porpoise	172	59	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	2	1	0
Long beaked common dolphin	849	282	0
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	36	8	0
Northern right whale dolphin	317	110	0
Pacific white-sided dolphin	294	126	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	45	10	0
Risso's dolphin	799	221	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	7,291	2,423	4
Short-finned pilot whale	14	4	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	569	167	0
Ziphiid whales	28	6	0
Pinnipeds			
Northern elephant seal	165	2	0
Pacific harbor seal	237	1,598	4
California sea lion	19,176	1	0
Northern fur seal	257	2	0
Total	**33,261**	**5,726**	**9**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

Table 4-17. No Action Alternative Summary of IAC II Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	43	11	0
Fin whale	9	2	0
Humpback whale	1	0	0
Sei whale	0	0	0
Sperm whale	9	2	0
Guadalupe fur seal	75	21	0
Sea otter	0	0	0
Mysticetes			
Bryde's whale	0	0	0
Gray whale	445	86	0
Minke whale	8	3	0
Odontocetes			
Baird's beaked whale	1	0	0
Bottlenose dolphin	83	31	0
Cuvier's beaked whale	26	7	0
Dall's porpoise	39	14	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	1	0	0
Long beaked common dolphin	233	71	0
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	8	2	0
Northern right whale dolphin	81	27	0
Pacific white-sided dolphin	74	30	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	10	3	0
Risso's dolphin	189	57	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	2,000	607	1
Short-finned pilot whale	3	1	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	133	39	0
Ziphiid whales	6	2	0
Pinnipeds			
Northern elephant seal	31	0	0
Pacific harbor seal	82	588	1
California sea lion	3,280	0	0
Northern fur seal	65	1	0
Total	**6,936**	**1,606**	**2**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

Table 4-18. No Action Alternative Summary of Sustainment Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	19	5	0
Fin whale	4	1	0
Humpback whale	1	0	0
Sei whale	0	0	0
Sperm whale	5	1	0
Guadalupe fur seal	34	10	0
Sea otter	0	0	0
Mysticetes			
Bryde's whale	0	0	0
Gray whale	200	38	0
Minke whale	4	1	0
Odontocetes			
Baird's beaked whale	0	0	0
Bottlenose dolphin	36	13	0
Cuvier's beaked whale	12	3	0
Dall's porpoise	17	6	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	0	0	0
Long beaked common dolphin	90	30	0
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	4	1	0
Northern right whale dolphin	34	11	0
Pacific white-sided dolphin	31	13	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	5	1	0
Risso's dolphin	82	24	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	775	256	0
Short-finned pilot whale	1	0	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	58	17	0
Ziphiid whales	3	1	0
Pinnipeds			
Northern elephant seal	9	0	0
Pacific harbor seal	24	165	0
California sea lion	1,608	0	0
Northern fur seal	26	0	0
Total	**3,080**	**594**	**0**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

4.7.3 Summary of Potential Underwater Detonation Effects

The modeled exposure harassment numbers for all training operations involving explosives are presented by species in Table 4-19. The modeling indicates 635 annual exposures to pressure from underwater detonations that could potentially result in TTS (Level B Harassment); 28 annual exposures from pressure from underwater detonations that could cause slight injury (Level A Harassment); and eight exposures that could cause severe injury or mortality.

Training operations involving explosives include Mine Neutralization, Air to Surface Missile Exercise, Surface to Surface Missile Exercise, Bombing Exercise, Sinking Exercise, Surface to Surface Gunnery exercise, and Naval Surface Fire Support. In a SINKEX, weapons are typically fired in order of decreasing range from the source with weapons fired until the target is sunk. Since the target may sink at any time during the exercise, the actual number of weapons used can vary widely. In the representative case, however, all of the ordnances are assumed expended; this represents the worst case of maximum exposure.

These exposure modeling results are estimates of marine mammal underwater detonation sound exposures without considerating similar model limitations as discussed in the summary of mid-frequency active sonar sub-section (Section 4.7.2). In addition, implementation of the mitigation and monitoring procedures as addressed in Section 11 will further minimize the potential for marine mammal exposures to underwater detonations.

Table 4-15. No-Action Underwater Detonation Exposures Summary.

Species	Level B Exposures	Level A Exposures	
	TTS 182 dB re 1 μPa^2-s /23 psi	50% TM Rupture 205 dB re 1 μPa^2-s Slight Lung Injury or 13 psi-ms	Onset Massive Lung Injury or Mortality 31 psi-ms
ESA Species			
Blue whale	1	1	0
Fin whale	0	0	0
Humpback whale	0	0	0
North Pacific right whale	N/A	N/A	N/A
Sei whale	0	0	0
Sperm whale	0	0	0
Guadalupe fur seal	2	0	0
Sea otter	N/A	N/A	N/A
Mysticetes			
Bryde's whale	0	0	0
Gray whale	5	0	0
Minke whale	0	0	0
Odontocetes			
Baird's beaked whale	0	0	0
Bottlenose dolphin	5	0	0
Cuvier's beaked whale	1	0	0
Dall's porpoise	1	0	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	0	0	0
Long-beaked common dolphin	20	1	0
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	0	0	0
Northern right whale dolphin	5	0	0
Pacific white-sided dolphin	5	0	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	0	0	0
Risso's dolphin	12	1	0
Rough-toothed dolphin	N/A	N/A	N/A
Short-beaked common dolphin	175	9	3
Short-finned pilot whale	0	0	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	5	0	0
Ziphiid whale	0	0	0
Pinnipeds			
Northern elephant seal	13	0	0
Pacific harbor seal	19	1	0
California sea lion	333	13	4
Northern fur seal	33	2	1
Total	**635**	**28**	**8**

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures

4.7.4 Species-Specific Potential Impacts: No Action Alternative

Blue Whale (*Balaenoptera musculus*)

The risk function and Navy post-modeling analysis estimates 463 blue whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 113 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One blue whale would be exposed to sound levels that could cause PTS.

One blue whale would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS one that would be exposed to slight physical injury, no blue whales would be exposed to impulsive sound or pressures that would cause severe injury or mortality (Table 4-19).

Given the large size (up to 98 ft [30 m]) of individual blue whales (Leatherwood et al. 1982), pronounced vertical blow, and aggregation of approximately two to three animals in a group (probability of track line detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of blue whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar; therefore, blue whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a large blue whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

In the unlikely event that blue whales are exposed to mid-frequency sonar, the anatomical information available on blue whales suggests that they are not likely to hear mid-frequency (1 kHz–10 kHz) sounds (Ketten 1997). There are no audiograms of baleen whales, but blue whales tend to react to anthropogenic sound below 1 kHz (e.g., seismic air guns), and most of their vocalizations are also in that range, suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). Based on this information, if they do no hear these sounds, they are not likely to respond physiologically or behaviorally to those received levels.

Based on the model results, behavioral patterns, acoustic abilities of blue whales, results of past training exercises, and the implementation of mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not likely result in any population level effects, death or injury to blue whales.

Fin Whale (*Balaenoptera physalus*)

The risk function and Navy post-modeling analysis estimates 101 fin whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 21 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No fin whales would be exposed to sound levels that could cause PTS.

No fin whales would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS or physical injury (Table 4-19).

Given the large size (up to 78 ft [24m]) of individual fin whales (Leatherwood et al. 1982), pronounced vertical blow, mean aggregation of three animals in a group (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003) it is very likely that lookouts would detect a group of fin whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, fin whales in the vicinity of operations would be detected by visual observers. Implementation of mitigation measures and probability of detecting a large fin whale reduces the likelihood of exposures to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

In the unlikely event that fin whales are exposed to mid-frequency sonar, the anatomical information available on fin whales suggests that they are not likely to hear mid-frequency (1 kHz–10 kHz) sounds (Richardson et al. 1995; Ketten 1997). Fin whales primarily produce low frequency calls (below 1 kHz) with source levels up to 186 dB re 1µPa at 1 m, although it is possible they produce some sounds in the range of 1.5 to 28 kHz (review by Richardson et al., 1995; Croll et al. 2002). There are no audiograms of baleen whales, but they tend to react to anthropogenic sound below 1 kHz, suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). Based on this information, if they do no hear these sounds, they are not likely to respond physiologically or behaviorally to those received levels.

In the St. Lawrence estuary area, fin whales avoided vessels with small changes in travel direction, speed and dive duration, and slow approaches by boats usually caused little response (MacFarlane 1981). Fin whales continued to vocalize in the presence of boat sound (Edds and Macfarlane 1987).

Based on the model results, behavioral patterns, acoustic abilities of fin whales, results of past SOCAL Range Complex training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would likely not result in any population level effects, death or injury to fin whales.

Humpback Whale (*Megaptera novaeangliae*)

The risk function and Navy post-modeling analysis estimates 12 humpback whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No humpback whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold and no exposure that would exceed the onset of massive lung injury threshold (Table 4-19). Target and demolition area clearance procedures would make sure there are no humpback whales within the safety zone and therefore potential exposure of humpback whales to sound levels to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Given the large size (up to 53 ft [16m] of individual humpback whales (Leatherwood et al. 1982), and pronounced vertical blow, it is very likely that lookouts would detect humpback whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, humpback whales that are present in the vicinity of ASW operations would be detected by visual observers reducing the likelihood of exposure, such that effects would be discountable.

There are no audiograms of baleen whales, but Houser et al. (2001) estimated their hearing rage 700 Hz-10 kHz but they tend to react to anthropogenic sound below 1 kHz, suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). A single study suggested that humpback whales responded to mid-frequency sonar (3.1-3.6 kHz re 1 μPa^2-s) sound (Maybaum 1989). The hand held sonar system had a sound artifact below 1,000 Hz which caused a response to the control playback (a blank tape) and may have affected the response to sonar (i.e. the humpback whale responded to the low frequency artifact rather than the mid-frequency active sonar sound). Humpback whales responded to small vessels (often whale watching boats) by changing swim speed, respiratory rates and social interactions depending on proximity to the vessel and vessel speed, with reponses varying by social status and gender (Watkins *et al*. 1981; Bauer, 1986; Bauer and Herman 1986). Animals may even move out of the area in response to vessel noise (Salden 1988). Humpback whale mother-calf pairs are generally in the shallow protected waters. ASW mid-frequency active sonar activities takes place through out the extensive SOCAL Range Complex but the areas inhabited by humpback whales is represents only a small portion of the SOCAL Range Complex. Frankel and Clark (2000; 2002) reported that there was only a minor response by humpback whales to the Acoustic Thermometry of Ocean Climate (ATOC) sound source and that response was variable with some animals being found closer to the sound source during operation.

Based on the model results, behavioral patterns, acoustic abilities of humpback whales, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not likely result in any population level effects, death or injury to humpback whales.

Sei Whale (*Balaenoptera borealis*)

The risk function and Navy post-modeling analysis estimates that no sei whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No sei whales would be exposed to sound levels that could cause PTS.

No sei whales would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS or physical injury (Table 4-19).

Given the large size (up to 53 ft [16m}) of individual sei whales (Leatherwood et al. 1982), pronounced vertical blow, aggregation of approximately three animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of sei whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, sei whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a large sei whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

There is little information on the acoustic abilities of sei whales or their response to human activities. The only recorded sounds of sei whales are frequency modulated sweeps in the range of 1.5 to 3.5 kHz (Thompson et al. 1979) but it is likely that they also vocalized at frequencies below 1 kHz as do fin whales. There are no audiograms of baleen whales but they tend to react to anthropogenic sound below 1 kHz suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). Sei whales were more difficult to approach than were fin whales and moved away from boats but were less responsive when feeding (Gunther 1949).

Based on the model results, behavioral patterns, acoustic abilities of sei whales, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not likely result in any death or injury to sei whales, but some Level B behavioral harassment may occur.

Sperm Whales (*Physeter macrocephalus*)

The risk function and Navy post-modeling analysis estimates 104 sperm whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 17 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One sperm whale would be exposed to sound levels that could cause PTS.

There would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold (Table 4-19). Target and demolition area clearance procedures would make sure there are no sperm whales within the safety zone, and therefore potential exposure of sperm whales to sound levels that exceed TTS are highly unlikely.

Given the large size (up to 56 ft [17m]) of individual sperm whales (Leatherwood et al. 1982), pronounced blow (large and angled), mean group size of approximately seven animals (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is very likely that lookouts would detect a group of sperm whales at the surface. Sperm whales can make prolonged dives of up to two hours making detection more difficult but passive acoustic monitoring can detect and localize sperm whales from their calls (Watwood et al. 2006). Additionally, mitigation measures call for continuous visual observation during operations with active sonar; therefore, sperm whales that migrate into the operating area would likely be detected by visual observers when the whales surface. Implementation of mitigation measures and probability of detecting a large sperm whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

In the unlikely event that sperm whales are exposed to mid-frequency sonar, the information available on sperm whales exposed to received levels of active mid-frequency sonar suggests that the response to mid-frequency (1 kHz to 10 kHz) sounds is variable (Richardson et al. 1995). While Watkins et al. (1985) observed that sperm whales exposed to 3.25 kHz to 8.4 kHz pulses interrupted their activities and left the area, other studies indicate that, after an initial disturbance, the animals return to their previous activity. During playback experiments off the Canary Islands, André et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signal did not exhibit any general avoidance reactions. When resting at the surface in a compact group, sperm whales initially reacted strongly but then ignored the signal completely (André et al. 1997).

Based on the model results, behavioral patterns, acoustic abilities of sperm whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to sperm whales..

Guadalupe fur Seal (*Arctocephalus townsendi*)

The risk function and Navy post-modeling analysis estimates 807 Guadalupe fur seals will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 285 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Guadalupe fur seals would be exposed to sound levels that could cause PTS.

Modeling indicates there would be two exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-19).

Guadalupe fur seals do not dive for long periods and may rest on the surface between foraging bouths (Gallo 1994) making them easier to detect. Additionally, mitigation measures call for continuous visual observation during operations with active sonar; therefore, Guadalupe fur seals that migrate into the operating area would likely be detected by visual observers when the fur seals surface. Implementation of mitigation measures and probability of detecting fur seals resting at the surface reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Guadalupe fur seals, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Guadalupe fur seals.

Bryde's Whale (*Balaenoptera edeni*)

The risk function and Navy post-modeling analysis estimates that no Bryde's whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Bryde's whales would be exposed to sound levels that could cause PTS.

No Bryde's whales would be exposed to impulsive sound or pressures from underwater detonations that would cause physical injury or mortality (Table 4-19).

Given the large size (up to 46 ft. [14 m]) of individual Bryde's whales, pronounced blow, and mean group size of approximately 1.5 animals and (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is very likely that lookouts would detect a group of Bryde's whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, minke whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a minke whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Bryde's whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Bryde's whales.

Gray Whale (*Eschrichtius robustus*)

The risk function and Navy post-modeling analysis estimates 4,797 gray whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 901 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. Two grays whale would be exposed to sound levels that could cause PTS.

Five gray whales would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS or slight physical injury (Table 4-19).

Given the large size (up to 46 ft. [14 m]) of individual gray whales, and pronounced blow (Leatherwood et al. 1982) and (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is very likely that lookouts would detect a group of gray whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, gray whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a minke whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of gray whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to gray whales.

Minke Whale (*Balaenoptera acutorostrata*)

The risk function and Navy post-modeling analysis estimates 90 minke whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 26 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No minke whales would be exposed to sound levels that could cause PTS.

No minke whales would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS or physical injury (Table 4-19).

Minke whales are difficult to spot visually but can be detected using passive acoustic monitoring. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, minke whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a minke whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of minke whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to minke whales.

Baird’s Beaked Whale (*Berardius baridii*)

The risk function and Navy post-modeling analysis estimates eight Baird’s beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Baird’s beaked whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-19).

Given the size (up to 15.5 ft. [4.7 m]) of individual Baird's beaked whales, aggregation of 2.3 animals, it is likely that lookouts would detect a group of Baird's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour making them difficult to detect (Baird et al. 2004). Implementation of mitigation measures reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Baird's beaked whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Baird's beaked whales.

Bottlenose Dolphin (*Tursiops truncatus*)

The risk function and Navy post-modeling analysis estimates 853 bottlenose dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 317 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No bottlenose dolphins would be exposed to sound levels that could cause PTS.

Five bottlenose dolphins would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS or slight physical injury. No bottlenose dolphins would be exposed to impulsive sound or pressures that would cause severe injury or mortality (Table 4-19).

Given the frequent surfacing, aggregation of approximately 9 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of bottlenose dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, bottlenose dolphins that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting bottlenose dolphins reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of bottlenose dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to bottlenose dolphins.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

The risk function and Navy post-modeling analysis estimates 288 Cuvier's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 63 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Cuvier's beaked whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would one exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-19).

Given the medium size (up to 23 ft. [7.0 m]) of individual Cuvier's beaked whales, aggregation of approximately two animals (Barlow 2006), it is likely that lookouts would detect a group of Cuvier's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird et al. 2004). Implementation of mitigation measures reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Cuvier's beaked whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Cuvier's beaked whales.

Dall's Porpoise (*Phocoenides dalli*)

The risk function and Navy post-modeling analysis estimates 419 Dall's porpoise will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 145 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One Dall's porpoise would be exposed to sound levels that could cause PTS.

Modeling indicates there would one exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-19).

Given the frequent surfacing and aggregation of approximately 2-20 animals, it is very likely that

lookouts would detect a group of Dall's porpoises at the surface. Additionally, protective measures call for continuous visual observation during operations with active sonar, therefore, Dall's porpoises that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of Dall's porpoises reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Dall's porpoise, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Dall's porpoise.

Killer Whale (*Orcinus orca*)

The risk function and Navy post-modeling analysis estimates six killer whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One killer whales would be exposed to sound levels that could cause PTS.

No killer whales would be exposed to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-19).

Given their size (up to 23 ft [7.0 m]), conspicuous coloring, pronounce dorsal fin and large mean group size of 6.5 animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003). It is very likely that lookouts would detect a group of killer whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, killer whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of killer whales reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of killer whales, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to killer whales.

Long Beaked Common Dolphin (*Delphinus capensis*)

The risk function and Navy post-modeling analysis estimates 2,255 long beaked common dolphin will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 715 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One long beaked common dolphin would be exposed to sound levels that could cause PTS.

Twenty long-beaked common dolphins would be exposed to impulsive sound or pressures from underwater that may cause TTS or slight injury and one to pressure that cause slight injury (Table 4-19).

Given the frequent surfacing and their large group size (Leatherwood et al. 1982), it is very likely, that lookouts would detect a group of long-beaked common dolphins at the surface. Additionally, protective measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, common dolphins that migrate into the operating area would be detected by visual observers. Exposure of long-beaked common dolphins to energy levels associated with Level A harassment would not occur because protective measures would be implemented, large groups of long-beaked common dolphins would be observed, and underwater detonations result in a small zone of influence. Exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of long-beaked common dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to long-beaked common dolphins.

Mesoplodont Whales *(Mesoplodon spp.)*

The risk function and Navy post-modeling analysis estimates 86 Mesoplodont whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 22 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Mesoplodont whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-19).

Given the size (up to 15.5 ft. [4.7 m]) of individual Mesoplodont beaked whales, it is likely that lookouts would detect a group of Mesoplodont beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird et al. 2004). Implementation of mitigation measures and probability of detecting a Mesoplodont whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Mesoplodont beaked whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Mesoplodont beaked whales.

Northern Right Whale Dolphin (*Lissodelphis borealis*)

The risk function and Navy post-modeling analysis estimates 811 northern right whale dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 277 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No northern right whale dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would five exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-19).

Given their large group size of up to 100 animals (Leatherwood et al. 1982), it is very likely, that

lookouts would detect a group of northern right whale dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, northern right whale dolphins that migrate into the operating area would be detected by visual observers. Implementation of protective measures and probability of detecting large groups of northern right whale dolphins reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of northern right whale dolphins, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to northern right whale dolphins.

Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)

The risk function and Navy post-modeling analysis estimates 756 Pacific white-sided dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 312 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Pacific white-sided dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would five exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-19).

Given their frequent surfacing and large group size of up to several thousand animals (Leatherwood et al. 1982), it is very likely that lookouts would detect a group of Pacific white-sided dolphins at the surface. Additionally, protective measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, Pacific white-sided dolphins that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of Pacific white-sided dolphins reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Pacific white-sided dolphins, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Pacific white-sided dolphins.

Pygmy Sperm Whale (*Kogia breviceps*)

The risk function and Navy post-modeling analysis estimates 108 pygmy sperm whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 27 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No pygmy sperm whales would be exposed to sound levels that could cause PTS.

Modeling indicates no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-19).

Given their size (up to 10 ft [3 m]) and behavior of resting at the surface (Leatherwood et al. 1982), it is very likely that lookouts would detect a pygmy sperm whale at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, pygmy sperm whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of pygmy sperm whales reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of pygmy sperm whale, results of past training, and the implementation of procedure mitigation measures presented in sections

5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to pygmy sperm whale.

Risso's Dolphin (*Grampus griseus*)

The risk function and Navy post-modeling analysis estimates 1,968 Risso's dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 570 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Risso's dolphins would be exposed to sound levels that could cause PTS.

Twelve Risso's dolphins would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS and one to impulsive sound or pressures that could cause slight injury (Table 4-19).

Given their frequent surfacing, light coloration and large group size of up to several hundred animals (Leatherwood et al. 1982), mean group size of 15.4 dolphins in Hawaii and probability of trackline detection of 0.76 in Beaufort Sea States of 6 or less (Barlow 2006), it is very likely that lookouts would detect a group of Risso's dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, Risso's dolphins that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of Risso's dolphins reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.Based on the model results, behavioral patterns, acoustic abilities of Risso's dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Risso's dolphins.

Short-Beaked Common Dolphin (*Delphinus delphis*)

The risk function and Navy post-modeling analysis estimates 19,377 short-beaked common dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 6,148 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. Eight short-beaked common dolphins would be exposed to sound levels that could cause PTS.

One-hundred seventy-five short-beaked common dolphins would be exposed to impulsive sound or pressures from underwater detonations that could cause TTS, nine exposures to impulsive sound or pressures that could cause slight injury and three exposures that could cause severe injury or mortality (Table 4.15).

Given the frequent surfacing and their large group size of up to 1,000 animals (Leatherwood et al. 1982), it is very likely, that lookouts would detect a group of short-beaked common dolphins at the surface. Additionally, protective measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, common dolphins that migrate into the operating area would be detected by visual observers. Exposure of short-beaked common dolphins to energy levels associated with Level A harassment would not occur because protective measures would be implemented, large groups of short-beaked common dolphins would be observed, and underwater detonations result in a small zone of influence. Exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of short-beaked common dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to short-beaked common dolphins.

Short-finned Pilot Whale (*Globicephala macrorhynchus*)

The risk function and Navy post-modeling analysis estimates 34 short-finned pilot whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be nine exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No short-finned pilot whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury or massive lung injury (Table 4-19).

Given their size (up to 20 ft [6.1 m]), and large mean group size of 22.5 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2006). It is very likely that lookouts would detect a group of short-finned pilot whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, short-finned pilot whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting groups of short-finned pilot whales reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of short-finned pilot whale, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to short-finned pilot whale.

Striped Dolphin (*Stenella coeruleoalba*)

The risk function and Navy post-modeling analysis estimates 1,401 striped dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 411 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No striped dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates five exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury or massive lung injury (Table 4-19).

Given their frequent surfacing, aerobatics and large mean group size of 37.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is very likely that lookouts would detect a group of striped dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, striped dolphins that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting groups of striped dolphins reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of striped dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to striped dolphins.

Ziphiid Whales (*Ziphus* spp.)

The risk function and Navy post-modeling analysis estimates 65 Ziphiid whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 15 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Ziphiid whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-19).

Given the medium size (up to 23 ft. [7.0 m]) of individual Ziphiid whales, aggregation of approximately two animals (Barlow 2006), it is likely that lookouts would detect a group of Ziphiid whales at the surface although Ziphiid whales make prolonged dives that can last up to an hour (Baird et al. 2004). Implementation of mitigation measures and probability of detecting a large sei whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Ziphiid whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Ziphiid whales.

Northern Elephant Seal (*Mirounga angustirostris*)

The risk function and Navy post-modeling analysis estimates 599 northern elephant seals will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be seven exposures to accumulated acoustic energy above 204 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS for northern elephant seals. No northern elephant seals would be exposed to sound levels that could cause PTS.

Modeling indicates there would be 13 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-19).

Northern elephant seals tend to dive for long periods, 20-30 minutes, and only spend about 10% of the time at the surface making them difficult to detect. Elephant seals migrate out of the Southern California area to forage for several months at a time (Le Boeuf 1994). Exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Northern elephant seals, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Northern elephant seals.

Pacific Harbor Seal (*Phoca vitulina richardii*)

The risk function and Navy post-modeling analysis estimates 906 Pacific harbor seals will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be 6,290 exposures to accumulated acoustic energy above 183 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS for harbor seals. Thirteen Pacific harbor seals would be exposed to sound levels that could cause PTS.

Modeling indicates there would be 19 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and one exposure to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-19).

Harbor seals forage near their rookeries (usually within 50 km) therefore they tend to remain in the Southern California area most of the time in comparison to northern elephant seals. Exposures to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of harbor seals, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to harbor seals.

California Sea Lion (*Zalophus californianus*)

The risk function and Navy post-modeling analysis estimates 46,715 California sea lions will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be five exposures to accumulated acoustic energy above 206 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS for California sea lions. No California sea lions would be exposed to sound levels that could cause PTS.

Modeling indicates there would be 333 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, 13 exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury, and four exposures to impulsive sound or pressures that could cause severe injury or mortality (Table 4-19).

California sea lions make short duration dives and may rest at the surface (Feldkamp et al. 1989) making them easier to detect than other pinnipeds. Exposures to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of California sea lions, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to harbor seals.

Northern Fur Seal (*Callorhinus ursinus*)

The risk function and Navy post-modeling analysis estimates 656 northern fur seals will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-14). Modeling also indicates there would be five exposures to accumulated acoustic energy above 206 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS for northern fur seals. No northern fur seals would be exposed to sound levels that could cause PTS.

Modeling indicates there would be 33 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, two exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury, and one exposure to impulsive sound or pressures that could cause severe injury or mortality (Table 4-19).

Northern fur seals do not dive for long periods and may rest on the surface between foraging bouths (Gentry and Goebel 1984) making them easier to detect. Additionally, mitigation measures call for continuous visual observation during operations with active sonar; therefore, northern fur seals that migrate into the operating area would likely be detected by visual observers when the fur seals surface. Implementation of mitigation measures and probability of detecting fur seals resting at the surface reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of northern fur seals, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to northern fur seals.

4.8 ALTERNATIVE 1

4.8.1 Non-Sonar Acoustic Impacts and Non-Acoustic Impacts

Non-acoustic impacts on marine mammals under Alternative 1 would be substantially the same as impacts identified under the No Action Alternative. Under Alternative 1, increased operations would not increase the risk of collisions between Navy ships and marine mammals, given the extensive mitigation measures in effect to avoid such an event. Based on these standard operating procedures, collisions with marine mammals are not expected under Alternative 1. With regard to potential encounters between marine mammals and unrecovered military debris expended on the SOCAL Range Complex: Debris related to military activities that is not recovered generally sinks; the amount that might remain on or near the sea surface is low, and the density of such debris in the SOCAL Range Complex would be very low under Alternative 1 as under the No Action Alternative. Impacts to marine mammals from expended debris are unlikely.

4.8.2 Summary of Potential Mid- and High-Frequency Active Sonar Effects

Table 4-20 represents the number of sonar hours, dipping sonar, or sonobuoys usage per year for the different sonar sources including the 53C, 56C, submarine, AN/AWS-22 dipping sonar, SSQ-62 Sonobuoys, and MK-48 torpedo sonar.

Table 4-20. Summary of the sonar hours, number of sonar dips and sonobuoys, and torpedo runs for each type of exercise for Alternative 1.

Event	SQS-53 C Sonar Hours	SQS-56 C Sonar Hours	Total Sonar Hours	AQS-22 Number of Dips	SSQ-62 Number of Sonobuoys	MK-48 Number of Torpedo Events
Major Exercise (8/yr)	986	246	1,232	318	2,127	10
Sustainment Exercise (2/yr)	80	20	100	42	161	3.2
IAC II (4/yr)	230	58	288	384	482	2.4
ULT, Coordinated Events & Maintenance	569	142	711	1,821	1,244	66.4
Total	**1,865**	**466**	**2,331**	**2,565**	**4,014**	**82**

Table 4-21 presents a summary of the estimated marine mammal exposures for potential non-injurious (Level B) harassment, as well as potential onset of injury (Level A) to cetaceans and pinnipeds. Tables 4-22 through 4-25 present estimated marine mammal exposures further separated by component activites as listed in Table 4-20. The numbers contained in these tables may be slightly less than those presented in Table 4-21 as a result of the order of summation and the application of rounding rules utilized in the calculation of exposures.

Specifically, under this assessment for mid-frequency active sonar, the risk function methodology estimates 89,028 annual exposures that could potentially result in behavioral sub-TTS (Level B Harassment); 17,772 annual exposures that could potentially result in TTS (Level B Harassment); and 28 annual exposures could result in potential injury as PTS (Level A Harassment). No mid-frequency active sonar exposures are predicted to result in any animal mortality.

It should be noted, however, that these exposure modeling results are statistically derived estimates of potential marine mammal sonar exposures without consideration of standard mitigation and monitoring procedures. The caveats to interpretations of model results are described previously. It is highly unlikely that a marine mammal would experience any long-term effects because the large SOCAL Range Complex training areas makes individual mammals' repeated or prolonged exposures to high-level sonar signals unlikely. Specifically, mid-frequency active sonars have limited marine mammal exposure ranges and relatively high platform speeds. The number of exposures that exceed the PTS threshold and result in Level A harassment from sonar is 28 for six species (blue whale, gray whale, long-beaked common dolphin, Pacific harbor seal, short-beaked common dolphin, and sperm whale). Therefore, long term effects on individuals, populations or stocks are unlikely.

When analyzing the results of the acoustic exposure modeling to provide an estimate of effects, it is important to understand that there are limitations to the ecological data (diving behavior, migration or movement patterns and population dynamics) used in the model, and that the model results must be interpreted within the context of a given species' ecology.

As described previously, this analysis assumes that short-term non-injurious sound exposure levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. This approach is overestimating because there is no established scientific correlation between mid-frequency active sonar use and long term abandonment or significant alteration of behavioral patterns in marine mammals.

Because of the time delay between pings, and platform speed, an animal encountering the sonar will accumulate energy for only a few sonar pings over the course of a few minutes. Therefore, exposure to sonar would be a short-term event, minimizing any single animal's exposure to sound levels approaching the harassment thresholds.

The implementation of the mitigation and monitoring procedures as addressed in Section 5 of the EIS/OEIS will further minimize the potential for marine mammal exposures to underwater detonations. When reviewing the acoustic exposure modeling results, it is also important to understand that the estimates of marine mammal sound exposures are presented without consideration of standard protective measure operating procedures. Section 5 presents details of the mitigation measures currently used for ASW activities including detection of marine mammals and power down procedures if marine mammals are detected within one of the safety zones. The Navy will work through the MMPA incidental harassment regulatory process to discuss the mitigation measures and their potential to reduce the likelihood for incidental harassment of marine mammals.

Table 4-21. Alternative 1 Summary of All Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	493	120	1
Fin whale	107	22	0
Humpback whale	13	2	0
Sei whale	0	0	0
Sperm whale	111	18	1
Guadalupe fur seal	859	303	0
Sea otter	N/A	N/A	N/A
Mysticetes			
Bryde's whale	0	0	0
Gray whale	5,103	959	2
Minke whale	96	28	0
Odontocetes			
Baird's beaked whale	9	2	0
Bottlenose dolphin	907	337	0
Cuvier's beaked whale	306	67	0
Dall's porpoise	446	154	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	6	2	0
Long beaked common dolphin	2,399	761	1
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	92	23	0
Northern right whale dolphin	863	295	0
Pacific white-sided dolphin	804	332	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	115	29	0
Risso's dolphin	2,094	606	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	20,614	6,540	9
Short-finned pilot whale	36	10	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	1,490	437	0
Ziphiid whales	69	16	0
Pinnipeds			
Northern elephant seal	637	7	0
Pacific harbor seal	964	6,692	14
California sea lion	49,697	5	0
Northern fur seal	698	5	0
Total	**89,028**	**17,772**	**28**

Thresholds: Cetaceans TTS = 195 dB re 1 µPa^2-s; PTS = 215 dB, re 1 µPa^2-s, northern elephant seal TTS = 204 re 1 µPa^2-s, PTS = 224 re 1 µPa^2-s; harbor seal TTS = 183 re 1 µPa^2-s, PTS = 203; Otariids TTS = 206 re 1 µPa^2-s, PTS = 226 re 1 µPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures

Table 4-22. Alternative 1 Summary of ULT, Coordinated Events and Maintenance Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	225	55	0
Fin whale	47	10	0
Humpback whale	6	1	0
Sei whale	0	0	0
Sperm whale	49	9	0
Guadalupe fur seal	396	147	0
Sea otter	N/A	N/A	N/A
Mysticetes			
Bryde's whale	0	0	0
Gray whale	2,398	436	1
Minke whale	44	13	0
Odontocetes			
Baird's beaked whale	4	1	0
Bottlenose dolphin	419	155	0
Cuvier's beaked whale	132	32	0
Dall's porpoise	203		0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	3	1	0
Long beaked common dolphin	1,152		1
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	41	11	0
Northern right whale dolphin	404	137	0
Pacific white-sided dolphin	379	152	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	51	14	0
Risso's dolphin	956	285	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	9,906	3,044	4
Short-finned pilot whale	17	5	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	682	199	0
Ziphiid whales	30	7	0
Pinnipeds			
Northern elephant seal	419	5	0
Pacific harbor seal	600	4,191	9
California sea lion	24,097	4	0
Northern fur seal	328	2	0
Total	**42,988**	**9,340**	**15**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

Table 4-23. Alternative 1 Summary of Major Exercises Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	202	48	1
Fin whale	46	9	0
Humpback whale	5	1	0
Sei whale	0	0	0
Sperm whale	47	6	0
Guadalupe fur seal	347	124	0
Sea otter	0	0	0
Mysticetes			
Bryde's whale	0	0	0
Gray whale	2,019	391	1
Minke whale	39	11	0
Odontocetes			
Baird's beaked whale	4	1	0
Bottlenose dolphin	362	135	0
Cuvier's beaked whale	133	25	0
Dall's porpoise	183	63	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	2	1	0
Long beaked common dolphin	903	300	1
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	38	9	0
Northern right whale dolphin	337	117	0
Pacific white-sided dolphin	313	134	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	48		0
Risso's dolphin	850	235	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	7,756	2,578	4
Short-finned pilot whale	15	4	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	605	178	0
Ziphiid whales	30		0
Pinnipeds			
Northern elephant seal	175	2	0
Pacific harbor seal	252	1,700	4
California sea lion	20,400	1	0
Northern fur seal	273	2	0
Total	**35,384**	**6,092**	**11**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

Table 4-24. Alternative 1 Summary of IAC II Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	46	12	0
Fin whale	10	2	0
Humpback whale	1	0	0
Sei whale	0	0	0
Sperm whale	10	2	0
Guadalupe fur seal	80	22	0
Sea otter	0	0	0
Mysticetes			
Bryde's whale	0	0	0
Gray whale	473	92	0
Minke whale	9	3	0
Odontocetes			
Baird's beaked whale	1	0	0
Bottlenose dolphin	88	33	0
Cuvier's beaked whale	28	7	0
Dall's porpoise	42	15	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	1	0	0
Long beaked common dolphin	248	75	0
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	9	2	0
Northern right whale dolphin	86	29	0
Pacific white-sided dolphin	79	32	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	11	3	0
Risso's dolphin	201	61	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	2,128	646	1
Short-finned pilot whale	3	1	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	141	42	0
Ziphiid whales	6	2	0
Pinnipeds			
Northern elephant seal	33	0	0
Pacific harbor seal	87	626	1
California sea lion	3,489	0	0
Northern fur seal	69	1	0
Total	**7,379**	**1,708**	**2**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

Table 4-25. Alternative 1 Summary of Sustainment Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	20	5	0
Fin whale	4	1	0
Humpback whale	1	0	0
Sei whale	0	0	0
Sperm whale	5	1	0
Guadalupe fur seal	36	10	0
Sea otter	0	0	0
Mysticetes			
Bryde's whale	0	0	0
Gray whale	213	40	0
Minke whale	4	1	0
Odontocetes			
Baird's beaked whale	0	0	0
Bottlenose dolphin	38	14	0
Cuvier's beaked whale	13	3	0
Dall's porpoise	18	6	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	0	0	0
Long beaked common dolphin	96	32	0
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	4	1	0
Northern right whale dolphin	36	12	0
Pacific white-sided dolphin	33	14	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	5	1	0
Risso's dolphin	87	25	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	824	272	0
Short-finned pilot whale	1	0	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	62	18	0
Ziphiid whales	3	1	0
Pinnipeds			
Northern elephant seal	10	0	0
Pacific harbor seal	25	175	0
California sea lion	1,711	0	0
Northern fur seal	28	0	0
Total	**3,277**	**632**	**0**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

4.8.3 Summary of Potential Underwater Detonation Effects

The modeled exposure harassment numbers for all training operations involving explosives are presented by species in Table 4-18. The modeling indicates 742 annual exposures to pressure from underwater detonations that could potentially result in TTS (Level B Harassment); 29 annual exposures from pressure from underwater detonations that could cause slight injury (Level A Harassment); and 10 exposures that could cause severe injury or mortality.

Training operations involving explosives include Mine Neutralization, Air to Surface Missile Exercise, Surface to Surface Missile Exercise, Bombing Exercise, Sinking Exercise, Surface to Surface Gunnery exercise, and Naval Surface Fire Support. In a SINKEX, weapons are typically fired in order of decreasing range from the source with weapons fired until the target is sunk. Since the target may sink at any time during the exercise, the actual number of weapons used can vary widely. In the representative case, however, all of the ordnances are assumed expended; this represents the worst case of maximum exposure.

These exposure modeling results are estimates of marine mammal underwater detonation sound exposures without considering similar model limitations as discussed in the summary of mid-frequency active sonar sub-section (Section 4.7.2). In addition, implementation of the mitigation and monitoring procedures will further minimize the potential for marine mammal exposures to underwater detonations.

Table 4-26. Alternative 1 Annual Underwater Detonation Exposures Summary.

Species	Level B Exposures	Level A Exposures	
	TTS 182 dB re 1 µPa^2-s/23 psi	50% TM Rupture 205 dB re 1 µPa^2-s or Slight Lung Injury 13 psi-ms	Onset Massive Lung Injury or Mortality 31 psi-ms
ESA Species			
Blue whale	2	0	0
Fin whale	1	0	0
Humpback whale	0	0	0
Sei whale	0	0	0
Sperm whale	1	0	0
Guadalupe fur seal	2	0	0
Sea otter			
Mysticetes			
Bryde’s whale	0	0	0
Gray whale	6	0	0
Minke whale	0	0	0
Odontocetes			
Baird’s beaked whale	0	0	0
Bottlenose dolphin	6	0	0
Cuvier’s beaked whale	1	0	0
Dall’s porpoise	2	0	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	0	0	0
Long-beaked common dolphin	24	1	0
Longman’s beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	0	0	0
Northern right whale dolphin	6	0	0
Pacific white-sided dolphin	6	0	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	1	0	0
Risso’s dolphin	14	1	0
Rough-toothed dolphin	N/A	N/A	N/A
Short-beaked common dolphin	202	10	4
Short-finned pilot whale	0	0	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	5	0	0
Ziphiid whale	0	0	0
Pinnipeds			
Northern elephant seal	15	0	0
Pacific harbor seal	22	1	0
California sea lion	388	14	5
Northern fur seal	38	2	1
Total	**742**	**29**	**10**

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures

4.8.4 Species-Specific Potential Impacts: Alternative 1

Blue Whale (*Balaenoptera musculus*)

The risk function and Navy post-modeling analysis estimates 493 blue whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 120 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One blue whale would be exposed to sound levels that could cause PTS.

Two blue whales would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS and one that would be exposed to impulsive sound or pressures that would cause slight injury (Table 4-26).

Given the large size (up to 98 ft [30 m]) of individual blue whales (Leatherwood et al. 1982), pronounced vertical blow, and aggregation of approximately two to three animals in a group (probability of track line detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of blue whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar; therefore, blue whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a large blue whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

In the unlikely event that blue whales are exposed to mid-frequency sonar, the anatomical information available on blue whales suggests that they are not likely to hear mid-frequency (1 kHz–10 kHz) sounds (Ketten 1997). There are no audiograms of baleen whales, but blue whales tend to react to anthropogenic sound below 1 kHz (e.g., seismic air guns), and most of their vocalizations are also in that range, suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). Based on this information, if they do no hear these sounds, they are not likely to respond physiologically or behaviorally to those received levels.

Based on the model results, behavioral patterns, acoustic abilities of blue whales, results of past training exercises, and the implementation of mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to blue whales.

Fin Whale (*Balaenoptera physalus*)

The risk function and Navy post-modeling analysis estimates 107 fin whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 22 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No fin whales would be exposed to sound levels that could cause PTS.

One fin whale would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS (Table 4-26).

Given the large size (up to 78 ft [24m]) of individual fin whales (Leatherwood et al. 1982), pronounced vertical blow, mean aggregation of three animals in a group (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003) it is very likely that lookouts would detect a group of fin whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, fin whales in the vicinity of operations would be detected by visual observers. Implementation of mitigation measures and probability of detecting a large fin whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitnessIn the unlikely event that fin whales are exposed to mid-frequency sonar, the anatomical information available on fin whales suggests that they are not likely to hear mid-frequency (1 kHz–10 kHz) sounds (Richardson et al. 1995; Ketten 1997). Fin whales primarily produce low frequency calls (below 1 kHz) with source levels up to 186 dB re 1µPa at 1 m, although it is possible they produce some sounds in the range of 1.5 to 28 kHz (review by Richardson et al. 1995; Croll et al. 2002). There are no audiograms of baleen whales, but they tend to react to anthropogenic sound below 1 kHz, suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). Based on this information, if they do no hear these sounds, they are not likely to respond physiologically or behaviorally to those received levels.

In the St. Lawrence estuary area, fin whales avoided vessels with small changes in travel direction, speed and dive duration, and slow approaches by boats usually caused little response (MacFarlane 1981). Fin whales continued to vocalize in the presence of boat sound (Edds and Macfarlane 1987). Even though any undetected fin whales transiting the SOCAL Range Complex may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects would not cause disruption of natural behavioral patterns to a point where such behavioral patterns would be abandoned or significantly altered.

Based on the model results, behavioral patterns, acoustic abilities of fin whales, results of past SOCAL Range Complex training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to fin whales.

Humpback Whale (*Megaptera novaeangliae*)

The risk function and Navy post-modeling analysis estimates 13 humpback whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No humpback whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-26). Target and demolition area clearance procedures would make sure there are no humpback whales within the safety zone and therefore potential exposure of humpback whales to sound levels that exceed TTS or injury levels are highly unlikely Given the mitigation measures detailed in Chapter 5, most ASW exercises take place in offshore waters and with the knowledge of the nearshore areas of humpback whale breeding aggregations, the Navy would likely avoid those nearshore areas regularly used by breeding humpback. This makes it is unlikely that mother calf pairs would be disturbed to the point of separation or the cessation of reproductive behaviors.

Given the large size (up to 53 ft [16m] of individual humpback whales (Leatherwood et al. 1982), and pronounced vertical blow, it is very likely that lookouts would detect humpback whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, humpback whales that are present in the vicinity of ASW operations would be detected by visual observers reducing the likelihood of exposureto sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitnessThere are no audiograms of baleen whales, but they tend to react to anthropogenic sound below 1 kHz, suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). A single study suggested that humpback whales responded to mid-frequency sonar (3.1-3.6 kHz re 1 µPa^2-s) sound (Maybaum 1989). The hand held sonar system had a sound artifact below 1,000 Hz which caused a response to the control playback (a blank tape) and may have affected the response to sonar (i.e. the humpback whale responded to the low frequency artifact rather than the mid-frequency active sonar sound). Humpback whales responded to small vessels (often whale watching boats) by changing swim speed, respiratory rates and social interactions depending on proximity to the vessel and vessel speed, with reponses varying by social status and gender (Watkins et al. 1981; Bauer, 1986; Bauer and Herman 1986). Animals may even move out of the area in response to vessel noise (Salden 1988). Humpback whale mother-calf pairs are generally in the shallow protected waters. ASW mid-frequency active sonar activities takes place through out the extensive SOCAL Range Complex but the areas inhabited by humpback whales is represents only a small portion of the SOCAL Range Complex. Frankel and Clark (2000; 2002) reported that there was only a minor response by humpback whales to the Acoustic Thermometry of Ocean Climate (ATOC) sound source and that response was variable with some animals being found closer to the sound source during operation.

Based on the model results, behavioral patterns, acoustic abilities of humpback whales, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not likely result in any population level effects, death or injury to humpback whales.

Sei Whale (*Balaenoptera borealis*)

The risk function and Navy post-modeling analysis estimates no sei whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No sei whales would be exposed to sound levels that could cause PTS.

No sei whales would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS or physical injury (Table 4-26).

Given the large size (up to 53 ft [16m}) of individual sei whales (Leatherwood et al. 1982), pronounced vertical blow, aggregation of approximately three animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of sei whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, sei whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a large sei whale reduces the likelihood of exposureto sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness There is little information on the acoustic abilities of sei whales or their response to human activities. The only recorded sounds of sei whales are frequency modulated sweeps in the range of 1.5 to 3.5 kHz (Thompson et al. 1979) but it is likely that they also vocalized at frequencies below 1 kHz as do fin whales. There are no audiograms of baleen whales but they tend to react to anthropogenic sound below 1 kHz suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). Sei whales were more difficult to approach than were fin whales and moved away from boats but were less responsive when feeding (Gunther 1949).

Based on the model results, behavioral patterns, acoustic abilities of sei whales, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not likely result in any population level effects, death or injury to sei whales.

Sperm Whales (*Physeter macrocephalus*)

The risk function and Navy post-modeling analysis estimates 111 sperm whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 18 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One sperm whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be one exposure from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold (Table 4-26). Target and demolition area clearance procedures would make sure there are no sperm whales within the safety zone, and therefore potential exposure of sperm whales to sound levels that exceed TTS are highly unlikely.

Given the large size (up to 56 ft [17m]) of individual sperm whales (Leatherwood et al. 1982), pronounced blow (large and angled), mean group size of approximately seven animals (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is likely that lookouts would detect a group of sperm whales at the surface. Sperm whales can make prolonged dives of up to two hours making detection more difficult but passive acoustic monitoring can detect and localize sperm whales from their calls (Watwood et al. 2006). Implementation of mitigation measures and probability of detecting a large sperm whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitnessIn the unlikely event that sperm whales are exposed to mid-frequency sonar, the information available on sperm whales exposed to received levels of active mid-frequency sonar suggests that the response to mid-frequency (1 kHz to 10 kHz) sounds is variable (Richardson et al. 1995). While Watkins et al. (1985) observed that sperm whales exposed to 3.25 kHz to 8.4 kHz pulses interrupted their activities and left the area, other studies indicate that, after an initial disturbance, the animals return to their previous activity. During playback experiments off the Canary Islands, André et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signal did not exhibit any general avoidance reactions. When resting at the surface in a compact group, sperm whales initially reacted strongly but then ignored the signal completely (André et al. 1997).

Based on the model results, behavioral patterns, acoustic abilities of sperm whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to sperm whales.

Guadalupe fur Seal (*Arctocephalus townsendi*)

The risk function and Navy post-modeling analysis estimates 859 Guadalupe fur seals will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 303 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Guadalupe fur seals would be exposed to sound levels that could cause PTS.

Modeling indicates there would two exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-26).

Guadalupe fur seals dive for short periods and often rest on the surface between foraging bouts (Gallo 1994) making them easier to detect. Exposures to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness

Based on the model results, behavioral patterns, acoustic abilities of Guadalupe fur seals, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Guadalupe fur seals.

Bryde's Whale (*Balaenoptera edeni*)

The risk function and Navy post-modeling analysis estimates no Bryde's whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Bryde's whales would be exposed to sound levels that could cause PTS.

No Bryde's whales would be exposed to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-26).

Given the large size (up to 46 ft. [14 m]) of individual Bryde's whales, pronounced blow, and mean group size of approximately 1.5 animals and (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is very likely that lookouts would detect a group of Bryde's whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, minke whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a minke whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitnessBased on the model results, behavioral patterns, acoustic abilities of Bryde's whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Bryde's whales.

Gray Whale (*Eschrichtius robustus*)

The risk function and Navy post-modeling analysis estimates 5,103 gray whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 959 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. Two gray whales would be exposed to sound levels that could cause PTS.

Six gray whales would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS (Table 4-26).

Given the large size (up to 46 ft. [14 m]) of individual gray whales, and pronounced blow (Leatherwood et al. 1982) and (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is very likely that lookouts would detect gray whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, gray whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a minke whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitnessBased on the model results, behavioral patterns, acoustic abilities of gray whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to gray whales.

Minke Whale (*Balaenoptera acutorostrata*)

The risk function and Navy post-modeling analysis estimates 96 minke whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 28 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No minke whales would be exposed to sound levels that could cause PTS.

No minke whales would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS or physical injury (Table 4-26).

Minke whales are difficult to spot visually but can be detected using passive acoustic monitoring. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, minke whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a minke whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitnessBased on the model results, behavioral patterns, acoustic abilities of minke whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to minke whales.

Baird's Beaked Whale (*Berardius baridii*)

The risk function and Navy post-modeling analysis estimates nine Baird's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Baird's beaked whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-26).

Given the size (up to 15.5 ft. [4.7 m]) of individual Baird's beaked whales, aggregation of 2.3 animals, it is likely that lookouts would detect a group of Baird's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird et al. 2004). Implementation of mitigation measures and probability of detecting a Baird's beaked whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitnessBased on the model results, behavioral patterns, acoustic abilities of Baird's beaked whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Baird's beaked whales.

Bottlenose Dolphin (*Tursiops truncatus*)

The risk function and Navy post-modeling analysis estimates 907 bottlenose dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 337 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No bottlenose dolphins would be exposed to sound levels that could cause PTS.

Six bottlenose dolphins would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS (Table 4-26).

Given the frequent surfacing, aggregation of approximately 9 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of bottlenose dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, bottlenose dolphins that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting bottlenose dolphins reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitnessBased on the model results, behavioral patterns, acoustic abilities of bottlenose dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to bottlenose dolphins.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

The risk function and Navy post-modeling analysis estimates 306 Cuvier's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 67 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Cuvier's beaked whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would one exposure to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-26).

Given the medium size (up to 23 ft. [7.0 m]) of individual Cuvier's beaked whales, aggregation of approximately two animals (Barlow 2006), it is likely that lookouts would detect a group of Cuvier's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird et al. 2004). Exposures to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitnessBased on the model results, behavioral patterns, acoustic abilities of Cuvier's beaked whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Cuvier's beaked whales.

Dall's Porpoise (*Phocoenides dalli*)

The risk function and Navy post-modeling analysis estimates 446 Dall's porpoise will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 154 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Dall's porpoises would be exposed to sound levels that could cause PTS.

Modeling indicates there would two exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-26).

Given the frequent surfacing and aggregation of approximately 2-20 animals, it is very likely that

lookouts would detect a group of Dall's porpoises at the surface. Additionally, protective measures call for continuous visual observation during operations with active sonar, therefore, Dall's porpoises that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of Dall's porpoises reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Dall's porpoise, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Dall's porpoise.

Killer Whale (*Orcinus orca*)

The risk function and Navy post-modeling analysis estimates six killer whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No killer whales would be exposed to sound levels that could cause PTS.

No killer whales would be exposed to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-26).

Given their size (up to 23 ft [7.0 m]), conspicuous coloring, pronounce dorsal fin and large mean group size of 6.5 animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003). It is very likely that lookouts would detect a group of killer whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, killer whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of killer whales reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness

Based on the model results, behavioral patterns, acoustic abilities of killer whales, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to killer whales.

Long Beaked Common Dolphin (*Delphinus capensis*)

The risk function and Navy post-modeling analysis estimates 2,399 long beaked common dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 761 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One long beaked common dolphin would be exposed to sound levels that could cause PTS.

Modeling indicates there would 24 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and one exposure to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-26).

Given the frequent surfacing and their large group size (Leatherwood et al. 1982), it is very likely, that lookouts would detect a group of long-beaked common dolphins at the surface. Additionally, protective measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, common dolphins that migrate into the operating area would be detected by visual observers. Exposure of long-beaked common dolphins to energy levels associated with Level A harassment would not occur because protective measures would be implemented, large groups of long-beaked common dolphins would be observed, and underwater detonations result in a small zone of influence. Exposures to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of long-beaked common dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to long-beaked common dolphins.

Mesoplodont Whales (Mesoplodon spp.)

The risk function and Navy post-modeling analysis estimates 92 Mesoplodont whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 23 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One Mesoplodont whalse would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of the onset of TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-26).

Given the size (up to 15.5 ft. [4.7 m]) of individual Mesoplodont beaked whales, it is likely that lookouts would detect a group of Mesoplodont beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird et al. 2004). Implementation of mitigation measures and probability of detecting a Mesoplodont whale reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitnessBased on the model results, behavioral patterns, acoustic abilities of Mesoplodont beaked whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Mesoplodont beaked whales.

Northern Right Whale Dolphin (*Lissodelphis borealis*)

The risk function and Navy post-modeling analysis estimates 863 northern right whale dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 295 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No northern right whale dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would six exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-26).

Given their large group size of up to 100 animals (Leatherwood et al. 1982), it is very likely, that lookouts would detect a group of northern right whale dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, northern right whale dolphins that migrate into the operating area would be detected by visual observers. Implementation of protective measures and probability of detecting large groups of northern right whale dolphins reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of northern right whale dolphins, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in population level effects, any death or injury to northern right whale dolphins.

Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)

The risk function and Navy post-modeling analysis estimates 804 Pacific white-sided dolphin will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 332 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Pacific white-sided dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would six exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-26).

Given their frequent surfacing and large group size of up to several thousand animals (Leatherwood et al. 1982), it is very likely that lookouts would detect a group of Pacific white-sided dolphins at the surface. Additionally, protective measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, Pacific white-sided dolphins that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of Pacific white-sided dolphins reduces the likelihood of exposure to to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Pacific white-sided dolphins, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Pacific white-sided dolphins.

Pygmy Sperm Whale (*Kogia breviceps*)

The risk function and Navy post-modeling analysis estimates 115 pygmy whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 29 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One pygmy whale would be exposed to sound levels that could cause PTS.

Modeling indicates one exposure to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-26).

Given their size (up to 10 ft [3 m]) and behavior of resting at the surface (Leatherwood et al. 1982), it is very likely that lookouts would detect a pygmy sperm whale at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, pygmy sperm whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of pygmy sperm whales reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of pygmy sperm whale, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to pygmy sperm whale.

Risso's Dolphin (*Grampus griseus*)

The risk function and Navy post-modeling analysis estimates 2,094 Risso's dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 606 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Risso's dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would 14 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and one exposure to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-26).

Given their frequent surfacing, light coloration and large group size of up to several hundred animals (Leatherwood et al. 1982), mean group size of 15.4 dolphins in Hawaii and probability of trackline detection of 0.76 in Beaufort Sea States of 6 or less (Barlow 2006), it is very likely that lookouts would detect a group of Risso's dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, Risso's dolphins that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of Risso's dolphins reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Risso's dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Risso's dolphins.

Short- Beaked Common Dolphin (*Delphinus delphis*)

The risk function and Navy post-modeling analysis estimates 20,614 short-beaked common dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 6,540 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. Nine short-beaked common dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would 202 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and 10 exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and four exposures that would cause severe injury or mortality (Table 4-26).

Given the frequent surfacing and their large group size of up to 1,000 animals (Leatherwood et al. 1982), it is very likely, that lookouts would detect a group of short-beaked common dolphins at the surface. Additionally, protective measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, common dolphins that migrate into the operating area would be detected by visual observers. Exposure of long-beaked common dolphins to energy levels associated with Level A harassment would not occur because protective measures would be implemented, large groups of long-beaked common dolphins would be observed, and underwater detonations result in a small zone of influence. Exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of short-beaked common dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to long-beaked common dolphins.

Short-finned Pilot Whale (*Globicephala macrorhynchus*)

The risk function and Navy post-modeling analysis estimates 36 short-finned pilot whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 10 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No short-finned pilot whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury or massive lung injury (Table 4-26).

Given their size (up to 20 ft [6.1 m]), and large mean group size of 22.5 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2006). It is very likely that lookouts would detect a group of short-finned pilot whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, short-finned pilot whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting groups of short-finned pilot whales reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of short-finned pilot whale, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to short-finned pilot whale.

Striped Dolphin (*Stenella coeruleoalba*)

The risk function and Navy post-modeling analysis estimates 1,490 striped dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 437 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No striped dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates five exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury or massive lung injury (Table 4-26).

Given their frequent surfacing, aerobatics and large mean group size of 37.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is very likely that lookouts would detect a group of striped dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, striped dolphins that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting groups of striped dolphins reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of striped dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 11.1

for sonar and 11.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to striped dolphins.

Ziphiid Whales (*Ziphus* spp.)

The risk function and Navy post-modeling analysis estimates 69 Ziphiid whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 16 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Ziphiid whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-26).

Given the medium size (up to 23 ft. [7.0 m]) of individual Ziphiid whales, aggregation of approximately two animals (Barlow 2006), it is likely that lookouts would detect a group of Ziphiid whales at the surface although Ziphiid whales make prolonged dives that can last up to an hour (Baird et al. 2004). Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, Ziphiid whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a large sei whale reduces the likelihood of exposureto sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.Based on the model results, behavioral patterns, acoustic abilities of Ziphiid whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Ziphiid whales.

Northern Elephant Seal (*Mirounga angustirostris*)

The risk function and Navy post-modeling analysis estimates 637 northern elephant seals will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be seven exposures to accumulated acoustic energy above 204 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS for northern elephant seals. No northern elephant seals would be exposed to sound levels that could cause PTS.

Modeling indicates there would 15 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause physical injury (Table 4-26).

Northern elephant seals tend to dive for long periods, 20-30 minutes, and only spend about 10% of the time at the surface making them difficult to detect. Elephant seals migrate out of the Southern California area to forage for several months at a time (Le Boeuf 1994). Exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of Northern elephant seals, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Northern elephant seals.

Pacific Harbor Seal (*Phoca vitulina richardii*)

The risk function and Navy post-modeling analysis estimates 964 Pacific harbor seals will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be 6,692 exposures to accumulated acoustic energy above 183 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS for Pacific harbor seals. Fourteen Pacific harbor seals would be exposed to sound levels that could cause PTS.

Modeling indicates there would 22 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and one exposure to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-26).

Harbor seals forage near their rookeries (usually within 50 km) therefore they tend to remain in the Southern California area most of the time in comparison to northern elephant seals. Exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of harbor seals, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to harbor seals.

California Sea Lion (*Zalophus californianus*)

The risk function and Navy post-modeling analysis estimates 49,697 California sea lions will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be five exposures to accumulated acoustic energy above 206 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS for California sea lions. No California sea lions would be exposed to sound levels that could cause PTS.

Modeling indicates there would 388 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, 14 exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and five exposures that would cause severe injury or mortality (Table 4-26).

California sea lions make short duration dives and may rest at the surface (Feldkamp et al. 1989) making them easier to detect than other pinnipeds. Exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of California sea lions, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to harbor seals.

Northern Fur Seal (*Callorhinus ursinus*)

The risk function and Navy post-modeling analysis estimates 698 northern fur seals will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-21). Modeling also indicates there would be five exposures to accumulated acoustic energy above 206 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS for northern fur seals. No northern fur seals would be exposed to sound levels that could cause PTS.

Modeling indicates there would 38 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, two exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that could cause severe injury or mortality (Table 4-26).

Northern fur seals do not dive for long periods and may rest on the surface between foraging bouths (Gentry and Goebel 1984) making them easier to detect. Additionally, mitigation measures call for continuous visual observation during operations with active sonar; therefore, northern fur seals that migrate into the operating area would likely be detected by visual observers when the fur seals surface. Implementation of mitigation measures and probability of detecting fur seals resting at the surface reduces the likelihood of exposure to sound levels that would likely cause a behavioral response that would affect vital rates (foraging, reproduction or survival), TTS or PTS. It is unlikely that the short duration and intermittent mid- or high-frequency active sonar exposure would cause a decrease in survivor rate or reproductive fitness.

Based on the model results, behavioral patterns, acoustic abilities of northern fur seals, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to northern fur seals.

4.9 ALTERNATIVE 2

4.9.1 Non-Sonar Acoustic Impacts and Non-Acoustic Impacts

Non-acoustic impacts on marine mammals under Alternative 2 would be substantially the same as impacts identified under the No Action Alternative. Under Alternative 2, increased operations would not increase the risk of collisions between Navy ships and marine mammals, given the extensive mitigation measures in effect to avoid such an event. Based on these standard operating procedures, collisions with marine mammals are not expected under Alternative 2. With regard to potential encounters between marine mammals and unrecovered military debris expended on the SOCAL Range Complex: Debris related to military activities that is not recovered generally sinks; the amount that might remain on or near the sea surface is low, and the density of such debris in the SOCAL Range Complex would be very low under Alternative 2 as under the No Action Alternative. Impacts to marine mammals from expended debris are unlikely.

4.9.2 Summary of Potential Mid- and High-Frequency Active Sonar Effects

Table 4-27 represents the number of sonar hours, dipping sonar, or sonobuoys usage per year for the different sonar sources including the 53C, 56C, submarine, AN/AWS-22 dipping sonar, SSQ-62 Sonobuoys, and MK-48 torpedo sonar.

Table 4-27. Summary of the sonar hours, number of sonar dips and sonobuoys, and torpedo runs for each type of exercise for Alternative 2.

Event	SQS-53 C Sonar Hours	SQS-56 C Sonar Hours	Total Sonar Hours	AQS-22 Number of Dips	SSQ-62 Number of Sonobuoys	MK-48 Number of Torpedo Events
Major Exercise (8/yr)	1,045	261	1,306	337	2,255	11
Sustainment Exercise (2/yr)	85	21	106	45	171	3
IAC II (4/yr)	244	61	305	407	511	3
ULT, Coordinated Events & Maintenance	603	151	754	1,930	1319	70
Total	1,977	494	2,471	2,719	4,255	87

Table 4-28 presents a summary of the estimated marine mammal exposures for potential non-injurious (Level B) harassment, as well as potential onset of injury (Level A) to cetaceans and pinnipeds. Tables 4-29 through 4-32 present estimated marine mammal exposures further separated by component activites as listed in Table 4-27. The numbers contained in these tables may be slightly less than those presented in Table 4-28 as a result of the order of summation and the application of rounding rules utilized in the calculation of exposures.

Specifically, under this assessment for mid-frequency active sonar, the risk function methodology estimates 94,370 annual exposures that could potentially result in behavioral sub-TTS (Level B Harassment); 18,838 annual exposures that could potentially result in TTS (Level B Harassment); and 30 annual exposures could result in potential injury as PTS (Level A Harassment). No mid-frequency active sonar exposures are predicted to result in any animal mortality.

It should be noted, however, that these exposure modeling results are statistically derived estimates of potential marine mammal sonar exposures without consideration of standard mitigation and monitoring procedures. The caveats to interpretations of model results are described previously. It is highly unlikely that a marine mammal would experience any long-term effects because the large SOCAL Range Complex training areas makes individual mammals' repeated or prolonged exposures to high-level sonar signals unlikely. Specifically, mid-frequency active sonars have limited marine mammal exposure ranges and relatively high platform speeds. The number of exposures that exceed the PTS threshold and result in Level A harassment from sonar is 30 for six species (blue whale, gray whale, long-beaked common dolphin, Pacific harbor seal, short-beaked common dolphin, and sperm whale). Therefore, long term effects on individuals, populations or stocks are unlikely.

When analyzing the results of the acoustic exposure modeling to provide an estimate of effects, it is important to understand that there are limitations to the ecological data (diving behavior, migration or movement patterns and population dynamics) used in the model, and that the model results must be interpreted within the context of a given species' ecology.

As described previously, this analysis assumes that short-term non-injurious sound exposure levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. This approach is overestimating because there is no established scientific correlation between mid-frequency active sonar use and long term abandonment or significant alteration of behavioral patterns in marine mammals.

Because of the time delay between pings, and platform speed, an animal encountering the sonar will accumulate energy for only a few sonar pings over the course of a few minutes. Therefore, exposure to sonar would be a short-term event, minimizing any single animal's exposure to sound levels approaching the harassment thresholds.

The implementation of the mitigation and monitoring procedures as addressed in Section 11 will further minimize the potential for marine mammal exposures to underwater detonations. When reviewing the acoustic exposure modeling results, it is also important to understand that the estimates of marine mammal sound exposures are presented without consideration of standard protective measure operating procedures. Section 5 of the EIS/OEIS presents details of the mitigation measures currently used for ASW activities including detection of marine mammals and power down procedures if marine mammals are detected within one of the safety zones. The Navy will work through the MMPA incidental harassment regulatory process to discuss the mitigation measures and their potential to reduce the likelihood for incidental harassment of marine mammals.

Table 4-28. Alternative 2 Summary of All Annual Mid- and High-Frequency Active Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	523	127	1
Fin whale	113	23	0
Humpback whale	14	2	0
Sei whale	0	0	0
Sperm whale	118	19	1
Guadalupe fur seal	911	321	0
Sea otter	N/A	N/A	N/A
Mysticetes			
Bryde's whale	0	0	0
Gray whale	5,409	1,017	2
Minke whale	102	30	0
Odontocetes			
Baird's beaked whale	10	2	0
Bottlenose dolphin	961	357	0
Cuvier's beaked whale	324	71	0
Dall's porpoise	473	163	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	6	2	0
Long beaked common dolphin	2,543	807	1
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	98	24	0
Northern right whale dolphin	915	313	0
Pacific white-sided dolphin	852	352	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	122	31	0
Risso's dolphin	2,220	642	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	21,851	6,932	10
Short-finned pilot whale	38	11	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	1,579	463	0
Ziphiid whales	73	17	0
Pinnipeds			
Northern elephant seal	675	7	0
Pacific harbor seal	1,022	7,094	15
California sea lion	52,679	5	0
Northern fur seal	740	5	0
Total	**94,370**	**18,838**	**30**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

Table 4-29: Alternative 2 Summary of ULT, Coordinated Events and Maintenance Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	239	58	0
Fin whale	50	11	0
Humpback whale	6	1	0
Sei whale	0	0	0
Sperm whale	52	10	0
Guadalupe fur seal	420	156	0
Sea otter	0	0	0
Mysticetes			
Bryde’s whale	0	0	0
Gray whale	2,542	462	1
Minke whale	47	14	0
Odontocetes			
Baird’s beaked whale	4	1	0
Bottlenose dolphin	444	164	0
Cuvier’s beaked whale	140	34	0
Dall’s porpoise	215	74	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	3	1	0
Long beaked common dolphin	1,221	375	1
Longman’s beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	43	12	0
Northern right whale dolphin	428	145	0
Pacific white-sided dolphin	402	161	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	54	15	0
Risso’s dolphin	1,013	302	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	10,500	3,227	4
Short-finned pilot whale	18	5	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	723	211	0
Ziphiid whales	32	7	0
Pinnipeds			
Northern elephant seal	444	5	0
Pacific harbor seal	636	4,442	10
California sea lion	25,543	4	0
Northern fur seal	348	2	0
Total	**45,567**	**9,900**	**16**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

Table 4-30: Alternative 2 Summary of Major Exercises Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	214	51	1
Fin whale	49	10	0
Humpback whale	5	1	0
Sei whale	0	0	0
Sperm whale	50	6	0
Guadalupe fur seal	368	131	0
Sea otter	0	0	0
Mysticetes			
Bryde's whale	0	0	0
Gray whale	2,140	414	1
Minke whale	41	12	0
Odontocetes			
Baird's beaked whale	4	1	0
Bottlenose dolphin	384	143	0
Cuvier's beaked whale	141	27	0
Dall's porpoise	194	67	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	2	1	0
Long beaked common dolphin	957	318	0
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	40	10	0
Northern right whale dolphin	357	124	0
Pacific white-sided dolphin	332	142	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	51	12	0
Risso's dolphin	901	249	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	8,221	2,733	4
Short-finned pilot whale	16	4	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	641	189	0
Ziphiid whales	32	6	0
Pinnipeds			
Northern elephant seal	186	2	0
Pacific harbor seal	267	1802	4
California sea lion	21,624	1	0
Northern fur seal	289	2	0
Total	**37,507**	**6,458**	**10**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

Table 4-31: Alternative 2 Summary of IAC II Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	49	13	0
Fin whale	11	2	0
Humpback whale	1	0	0
Sei whale	0	0	0
Sperm whale	11	2	0
Guadalupe fur seal	85	23	0
Sea otter	0	0	0
Mysticetes			
Bryde's whale	0	0	0
Gray whale	501	98	0
Minke whale	10	3	0
Odontocetes			
Baird's beaked whale	1	0	0
Bottlenose dolphin	93	35	0
Cuvier's beaked whale	30	7	0
Dall's porpoise	45	16	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	1	0	0
Long beaked common dolphin	263	80	0
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	10	2	0
Northern right whale dolphin	91	31	0
Pacific white-sided dolphin	84	34	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	12	3	0
Risso's dolphin	213	65	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	2,256	685	1
Short-finned pilot whale	3	1	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	149	45	0
Ziphiid whales	6	2	0
Pinnipeds			
Northern elephant seal	35	0	0
Pacific harbor seal	92	664	1
California sea lion	3,698	0	0
Northern fur seal	73	1	0
Total	**7,822**	**1,810**	**2**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

Table 4-32: Alternative 2 Summary of Sustainment Annual Sonar Exposures

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	21	5	0
Fin whale	4	1	0
Humpback whale	1	0	0
Sei whale	0	0	0
Sperm whale	5	1	0
Guadalupe fur seal	38	11	0
Sea otter	0	0	0
Mysticetes			
Bryde's whale	0	0	0
Gray whale	226	42	0
Minke whale	4	1	0
Odontocetes			
Baird's beaked whale	0	0	0
Bottlenose dolphin	40	15	0
Cuvier's beaked whale	14	3	0
Dall's porpoise	19	6	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	0	0	0
Long beaked common dolphin	102	34	0
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	4	1	0
Northern right whale dolphin	38	13	0
Pacific white-sided dolphin	35	15	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	5	1	0
Risso's dolphin	92	27	0
Rough-toothed dolphin	N/A	N/A	N/A
Short beaked common dolphin	873	288	0
Short-finned pilot whale	1	0	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	66	19	0
Ziphiid whales	3	1	0
Pinnipeds			
Northern elephant seal	11	0	0
Pacific harbor seal	27	186	0
California sea lion	1,814	0	0
Northern fur seal	30	0	0
Total	**3,474**	**670**	**0**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Harbor seal TTS = 183 re 1 μPa^2-s, PTS = 203 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s.

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures.

4.9.3 Summary of Potential Underwater Detonation Effects

The modeled exposure harassment numbers for all training operations involving explosives are presented by species in Table 4-33. The modeling indicates 817 annual exposures to pressure from underwater detonations that could potentially result in TTS (Level B Harassment); 36 annual exposures from pressure from underwater detonations that could cause slight injury (Level A Harassment); and 12 exposures that could cause severe injury or mortality.

Training operations involving explosives include Mine Neutralization, Air to Surface Missile Exercise, Surface to Surface Missile Exercise, Bombing Exercise, Sinking Exercise, Surface to Surface Gunnery exercise, and Naval Surface Fire Support. In a SINKEX, weapons are typically fired in order of decreasing range from the source with weapons fired until the target is sunk. Since the target may sink at any time during the exercise, the actual number of weapons used can vary widely. In the representative case, however, all of the ordnances are assumed expended; this represents the worst case of maximum exposure.

These exposure modeling results are estimates of marine mammal underwater detonation sound exposures without considering similar model limitations as discussed in the summary of mid-frequency active sonar sub-section (Section 4.7.2). In addition, implementation of the mitigation and monitoring procedures will further minimize the potential for marine mammal exposures to underwater detonations.

Table 4-33. Alternative 2 Annual Underwater Detonation Exposures Summary.

Species	Level B Exposures	Level A Exposures	
	TTS 182 dB re 1 μPa²-s /23 psi	50% TM Rupture 205 dB re 1 μPa²-s or Slight Lung Injury 13 psi-ms	Onset Massive Lung Injury or Mortality 31 psi-ms
ESA Species			
Blue whale	2	1	0
Fin whale	1	0	0
Humpback whale	0	0	0
Sei whale	0	0	0
Sperm whale	1	0	0
Guadalupe fur seal	2	1	0
Sea otter	N/A	N/A	N/A
Mysticetes			
Bryde's whale	0	0	0
Gray whale	7	0	0
Minke whale	0	0	0
Odontocetes			
Baird's beaked whale	0	0	0
Bottlenose dolphin	6	0	0
Cuvier's beaked whale	2	0	0
Dall's porpoise	2	0	0
Dwarf sperm whale	N/A	N/A	N/A
False killer whale	N/A	N/A	N/A
Killer whale	0	0	0
Long-beaked common dolphin	26	1	1
Longman's beaked whale	N/A	N/A	N/A
Melon-headed whale	N/A	N/A	N/A
Mesoplodon spp.	0	0	0
Northern right whale dolphin	6	0	0
Pacific white-sided dolphin	6	0	0
Pantropical spotted dolphin	N/A	N/A	N/A
Pygmy killer whale	N/A	N/A	N/A
Pygmy sperm whale	1	0	0
Risso's dolphin	15	1	0
Rough-toothed dolphin	N/A	N/A	N/A
Short-beaked common dolphin	227	12	4
Short-finned pilot whale	0	0	0
Spinner dolphin	N/A	N/A	N/A
Striped dolphin	6	0	0
Ziphiid whale	0	0	0
Pinnipeds			
Northern elephant seal	17	0	0
Pacific harbor seal	24	1	0
California sea lion	424	16	6
Northern fur seal	42	3	1
Total	**817**	**36**	**12**

N/A: Not applicable – Based on a few historic observations, its habitat preference or overall distribution, a species may occur rarely in the SOCAL Range Complex, but no density estimates were available for modeling exposures..

4.9.4 Species-Specific Potential Impacts: Alternative 2

Blue Whale (*Balaenoptera musculus*)

The risk function and Navy post-modeling analysis estimates 523 blue whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 127 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One blue whale would be exposed to sound levels that could cause PTS.

Modeling indicates there would two exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and one exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-33).

Given the large size (up to 98 ft [30 m]) of individual blue whales (Leatherwood et al. 1982), pronounced vertical blow, and aggregation of approximately two to three animals in a group (probability of track line detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of blue whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar; therefore, blue whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a large blue whale reduces the likelihood of exposure, such that effects would be discountable.

In the unlikely event that blue whales are exposed to mid-frequency sonar, the anatomical information available on blue whales suggests that they are not likely to hear mid-frequency (1 kHz–10 kHz) sounds (Ketten 1997). There are no audiograms of baleen whales, but blue whales tend to react to anthropogenic sound below 1 kHz (e.g., seismic air guns), and most of their vocalizations are also in that range, suggesting that they are more sensitive to low frequency sounds (Richardson *et al*. 1995). Based on this information, if they do no hear these sounds, they are not likely to respond physiologically or behaviorally to those received levels.

Based on the model results, behavioral patterns, acoustic abilities of blue whales, results of past training exercises, and the implementation of mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would likely not result in any population level effects, death or injury to blue whales.

Fin Whale (*Balaenoptera physalus*)

The risk function and Navy post-modeling analysis estimates 113 fin whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 23 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No fin whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would one exposure to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury (Table 4-33).

Given the large size (up to 78 ft [24m]) of individual fin whales (Leatherwood et al. 1982), pronounced vertical blow, mean aggregation of three animals in a group (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003) it is very likely that lookouts would detect a group of fin whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, fin whales in the vicinity of operations would be detected by visual observers. Implementation of mitigation measures and probability of detecting a large fin whale reduces the likelihood of exposure, such that effects would be discountable.

In the unlikely event that fin whales are exposed to mid-frequency sonar, the anatomical information available on fin whales suggests that they are not likely to hear mid-frequency (1 kHz–10 kHz) sounds (Richardson et al. 1995; Ketten 1997). Fin whales primarily produce low frequency calls (below 1 kHz) with source levels up to 186 dB re 1µPa at 1 m, although it is possible they produce some sounds in the range of 1.5 to 28 kHz (review by Richardson et al. 1995; Croll et al. 2002). There are no audiograms of baleen whales, but they tend to react to anthropogenic sound below 1 kHz, suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). Based on this information, if they do no hear these sounds, they are not likely to respond physiologically or behaviorally to those received levels.

In the St. Lawrence estuary area, fin whales avoided vessels with small changes in travel direction, speed and dive duration, and slow approaches by boats usually caused little response (MacFarlane 1981). Fin whales continued to vocalize in the presence of boat sound (Edds and Macfarlane 1987). Even though any undetected fin whales transiting the SOCAL Range Complex may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects would not cause disruption of natural behavioral patterns to a point where such behavioral patterns would be abandoned or significantly altered.

Based on the model results, behavioral patterns, acoustic abilities of fin whales, results of past SOCAL Range Complex training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would likely not result in any population level effects, death or injury to fin whales.

Humpback Whale (*Megaptera novaeangliae*)

The risk function and Navy post-modeling analysis estimates 14 humpback whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No humpback whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-33).

Given the large size (up to 53 ft [16m] of individual humpback whales (Leatherwood et al. 1982), and pronounced vertical blow, it is very likely that lookouts would detect humpback whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, humpback whales that are present in the vicinity of ASW operations would be detected by visual observers reducing the likelihood of exposure, such that effects would be discountable.

There are no audiograms of baleen whales, but they tend to react to anthropogenic sound below 1 kHz, suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). A single study suggested that humpback whales responded to mid-frequency sonar (3.1-3.6 kHz re 1 μPa^2-s) sound (Maybaum 1989). The hand held sonar system had a sound artifact below 1,000 Hz which caused a response to the control playback (a blank tape) and may have affected the response to sonar (i.e. the humpback whale responded to the low frequency artifact rather than the mid-frequency active sonar sound). Humpback whales responded to small vessels (often whale watching boats) by changing swim speed, respiratory rates and social interactions depending on proximity to the vessel and vessel speed, with reponses varying by social status and gender (Watkins et al. 1981; Bauer 1986; Bauer and Herman 1986). Animals may even move out of the area in response to vessel noise (Salden 1988). Humpback whale mother-calf pairs are generally in the shallow protected waters. ASW mid-frequency active sonar activities takes place through out the extensive SOCAL Range Complex but the areas inhabited by humpback whales is represents only a small portion of the SOCAL Range Complex. Frankel and Clark (2000; 2002) reported that there was only a minor response by humpback whales to the Acoustic Thermometry of Ocean Climate (ATOC) sound source and that response was variable with some animals being found closer to the sound source during operation.

Based on the model results, behavioral patterns, acoustic abilities of humpback whales, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not likely result in any population level effects, death or injury to humpback whales.

Sei Whale (*Balaenoptera borealis*)

The risk function and Navy post-modeling analysis estimates no sei whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No sei whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-33).

Given the large size (up to 53 ft [16m}) of individual sei whales (Leatherwood et al. 1982), pronounced vertical blow, aggregation of approximately three animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of sei whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, sei whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a large sei whale reduces the likelihood of exposure, such that effects would be discountable.

There is little information on the acoustic abilities of sei whales or their response to human activities. The only recorded sounds of sei whales are frequency modulated sweeps in the range of 1.5 to 3.5 kHz (Thompson et al. 1979) but it is likely that they also vocalized at frequencies below 1 kHz as do fin whales. There are no audiograms of baleen whales but they tend to react to anthropogenic sound below 1 kHz suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). Sei whales were more difficult to approach than were fin whales and moved away from boats but were less responsive when feeding (Gunther 1949).

Based on the model results, behavioral patterns, acoustic abilities of sei whales, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not likely result in any population level effects, death or injury to sei whales.

Sperm Whales (*Physeter macrocephalus*)

The risk function and Navy post-modeling analysis estimates 118 sperm whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 19 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One sperm whale would be exposed to sound levels that could cause PTS.

Modeling indicates there would one exposure to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-33).

Given the large size (up to 56 ft [17m]) of individual sperm whales (Leatherwood et al. 1982), pronounced blow (large and angled), mean group size of approximately seven animals (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is very likely that lookouts would detect a group of sperm whales at the surface. Sperm whales can make prolonged dives of up to two hours (Watwood et al. 2006) making detection more difficult. Additionally, mitigation measures call for continuous visual observation during operations with active sonar; therefore, sperm whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a large sperm whale reduces the likelihood of exposure, such that effects would be discountable.

In the unlikely event that sperm whales are exposed to mid-frequency sonar, the information available on sperm whales exposed to received levels of active mid-frequency sonar suggests that the response to mid-frequency (1 kHz to 10 kHz) sounds is variable (Richardson et al. 1995). While Watkins et al. (1985) observed that sperm whales exposed to 3.25 kHz to 8.4 kHz pulses interrupted their activities and left the area, other studies indicate that, after an initial disturbance, the animals return to their previous activity. During playback experiments off the Canary Islands, André et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signal did not exhibit any general avoidance reactions. When resting at the surface in a compact group, sperm whales initially reacted strongly but then ignored the signal completely (André et al. 1997).

Based on the model results, behavioral patterns, acoustic abilities of sperm whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to sperm whales.

Guadalupe fur Seal (*Arctocephalus townsendi*)

The risk function and Navy post-modeling analysis estimates 911 Guadalupe fur seals will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 321 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Guadalupe fur seals would be exposed to sound levels that could cause PTS.

Modeling indicates there would two exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and one exposure to impulsive sound or pressures from underwater detonations that would cause slight physical injury and no exposures that would cause severe injury or mortality (Table 4-33).

Guadalupe fur seals dive for short periods and often rest on the surface between foraging bouts (Gallo 1994) making them easier to detect.

Based on the model results, behavioral patterns, acoustic abilities of Guadalupe fur seals, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Guadalupe fur seals.

Bryde's Whale (*Balaenoptera edeni*)

The risk function and Navy post-modeling analysis estimates no Bryde's whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Bryde's whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-33).

Given the large size (up to 46 ft. [14 m]) of individual Bryde's whales, pronounced blow, and mean group size of approximately 1.5 animals and (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is very likely that lookouts would detect a group of Bryde's whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, minke whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a minke whale reduces the likelihood of exposure, such that effects would be discountable.

Based on the model results, behavioral patterns, acoustic abilities of Bryde's whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Bryde's whales.

Gray Whale (*Eschrichtius robustus*)

The risk function and Navy post-modeling analysis estimates 5,409 gray whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 1,017 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. Two gray whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would seven exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-33).

Given the large size (up to 46 ft. [14 m]) of individual gray whales, pronounced blow, and group size of up to 16 animals (Leatherwood et al. 1982) and (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is very likely that lookouts would detect a group of gray whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, gray whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a gray whale reduces the likelihood of exposure, such that effects would be discountable.

Based on the model results, behavioral patterns, acoustic abilities of gray whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to gray whales.

Minke Whale (*Balaenoptera acutorostrata*)

The risk function and Navy post-modeling analysis estimates 102 minke whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 30 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No minke whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury (Table 4-33).

Minke whales are difficult to spot visually but can be detected using passive acoustic monitoring. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, minke whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting a minke whale reduces the likelihood of exposure, such that effects would be discountable.

Based on the model results, behavioral patterns, acoustic abilities of minke whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to minke whales.

Baird's Beaked Whale (*Berardius baridii*)

The risk function and Navy post-modeling analysis estimates 10 Baird's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Baird's beaked whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury (Table 4-33).

Given the size (up to 15.5 ft. [4.7 m]) of individual Baird's beaked whales, aggregation of 2.3 animals, it is likely that lookouts would detect a group of Baird's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird et al. 2004). . Implementation of mitigation measures and probability of detecting a large sei whale reduces the likelihood of exposure, such that effects would be discountable.

Based on the model results, behavioral patterns, acoustic abilities of Baird's beaked whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Baird's beaked whales.

Bottlenose Dolphin (*Tursiops truncatus*)

The risk function and Navy post-modeling analysis estimates 961 bottlenose dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 357 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No bottlenose dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would six exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury (Table 4-33).

Given the frequent surfacing, aggregation of approximately 9 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of bottlenose dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, bottlenose dolphins that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting bottlenose dolphins reduces the likelihood of exposure, such that effects would be discountable.

Based on the model results, behavioral patterns, acoustic abilities of bottlenose dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to bottlenose dolphins.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

The risk function and Navy post-modeling analysis estimates 324 Cuvier's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 71 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Cuvier's beaked whale would be exposed to sound levels that could cause PTS.

Modeling indicates there would two exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury (Table 4-33).

Given the medium size (up to 23 ft. [7.0 m]) of individual Cuvier's beaked whales, aggregation of approximately two animals (Barlow 2006), it is likely that lookouts would detect a group of Cuvier's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird et al. 2004). Implementation of mitigation measures and probability of detecting a large sei whale reduces the likelihood of exposure, such that effects would be discountable.

Based on the model results, behavioral patterns, acoustic abilities of Cuvier's beaked whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Cuvier's beaked whales.

Dall's Porpoise (*Phocoenides dalli*)

The risk function and Navy post-modeling analysis estimates 473 Dall's porpoises will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28).

Modeling also indicates there would be 163 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Dall's porpoises would be exposed to sound levels that could cause PTS.

Modeling indicates there would two exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury (Table 4-33).

Given the frequent surfacing and aggregation of approximately 2-20 animals, it is very likely that

lookouts would detect a group of Dall's porpoises at the surface. Additionally, protective measures call for continuous visual observation during operations with active sonar, therefore, Dall's porpoises that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of Dall's porpoises reduces the likelihood of exposure.

Based on the model results, behavioral patterns, acoustic abilities of Dall's porpoise, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Dall's porpoise.

Killer Whale (*Orcinus orca*)

The risk function and Navy post-modeling analysis estimates six killer whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No killer whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury (Table 4-33).

Given their size (up to 23 ft [7.0 m]), conspicuous coloring, pronounce dorsal fin and large mean group size of 6.5 animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow, 2003). It is very likely that lookouts would detect a group of killer whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, killer whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of killer whales reduces the likelihood of exposure.

Based on the model results, behavioral patterns, acoustic abilities of killer whales, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5..2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to killer whales.

Long Beaked Common Dolphin (*Delphinus capensis*)

The risk function and Navy post-modeling analysis estimates 2,543 long beaked common dolphin will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 807 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One long beaked common dolphin would be exposed to sound levels that could cause PTS.

Modeling indicates there would 26 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and one exposure to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury or mortality (Table 4-33).

Given the frequent surfacing and their large group size (Leatherwood et al. 1982), it is very likely, that lookouts would detect a group of long-beaked common dolphins at the surface. Additionally, protective measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, common dolphins that migrate into the operating area would be detected by visual observers. Exposure of long-beaked common dolphins to energy levels associated with Level A harassment would not occur because protective measures would be implemented, large groups of long-beaked common dolphins would be observed, and underwater detonations result in a small zone of influence.

Based on the model results, behavioral patterns, acoustic abilities of long-beaked common dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to long-beaked common dolphins.

Mesoplodont Whales (Mesoplodon spp.)

The risk function and Navy post-modeling analysis estimates 98 Mesoplodont whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 24 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Mesoplodont whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury (Table 4-33).

Given the size (up to 15.5 ft. [4.7 m]) of individual Mesoplodont beaked whales, it is likely that lookouts would detect a group of Mesoplodont beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird et al. 2004). Implementation of mitigation measures and probability of detecting a Mesoplodont whale reduces the likelihood of exposure, such that effects would be discountable.

Based on the model results, behavioral patterns, acoustic abilities of Mesoplodont beaked whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Mesoplodont beaked whales.

Northern Right Whale Dolphin (*Lissodelphis borealis*)

The risk function and Navy post-modeling analysis estimates 915 northern right whale dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 313 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No northern right whale dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would six exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury (Table 4-33).

Given their large group size of up to 100 animals (Leatherwood et al. 1982), it is very likely, that

lookouts would detect a group of northern right whale dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, northern right whale dolphins that migrate into the operating area would be detected by visual observers. Implementation of protective measures and probability of detecting large groups of northern right whale dolphins reduces the likelihood of exposure.

Based on the model results, behavioral patterns, acoustic abilities of northern right whale dolphins, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to northern right whale dolphins.

Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)

The risk function and Navy post-modeling analysis estimates 852 Pacific white-sided dolphin will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 352 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Pacific white-sided dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would six exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury or mortality (Table 4-33).

Given their frequent surfacing and large group size of up to several thousand animals (Leatherwood et al. 1982), it is very likely that lookouts would detect a group of Pacific white-sided dolphins at the surface. Additionally, protective measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, Pacific white-sided dolphins that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of Pacific white-sided dolphins reduces the likelihood of exposure.

Based on the model results, behavioral patterns, acoustic abilities of Pacific white-sided dolphins, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Pacific white-sided dolphins.

Pygmy Sperm Whale (*Kogia breviceps*)

The risk function and Navy post-modeling analysis estimates 122 pygmy sperm whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 31 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No pygmy sperm whales would be exposed to sound levels that could cause PTS.

Modeling indicates one exposure to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury (Table 4-33).

Given their size (up to 10 ft [3 m]) and behavior of resting at the surface (Leatherwood et al. 1982), it is very likely that lookouts would detect a pygmy sperm whale at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, pygmy sperm whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of pygmy sperm whales reduces the likelihood of exposure.

Based on the model results, behavioral patterns, acoustic abilities of pygmy sperm whale, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to pygmy sperm whale.

Risso's Dolphin (*Grampus griseus*)

The risk function and Navy post-modeling analysis estimates 2,220 Risso's dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 642 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Risso's dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would 15 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and one exposure to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury or mortality (Table 4-33).

Given their frequent surfacing, light coloration and large group size of up to several hundred animals (Leatherwood et al. 1982), probability of trackline detection of 0.76 in Beaufort Sea States of 6 or less (Barlow 2006), it is very likely that lookouts would detect a group of Risso's dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, Risso's dolphins that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting large groups of Risso's dolphins reduces the likelihood of exposure.

Based on the model results, behavioral patterns, acoustic abilities of Risso's dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Risso's dolphins.

Short-Beaked Common Dolphin (*Delphinus delphis*)

The risk function and Navy post-modeling analysis estimates 21,851 short-beaked common dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 6,932 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. Ten short-beaked common dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would 227 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and 12 exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and four exposures that would cause severe injury or mortality (Table 4-33).

Given the frequent surfacing and their large group size of up to 1,000 animals (Leatherwood et al. 1982), it is very likely, that lookouts would detect a group of short-beaked common dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar and underwater detonations, therefore, common dolphins that migrate into the operating area would be detected by visual observers. Exposure of short-beaked common dolphins to energy levels associated with Level A harassment would not occur because mitigation measures would be implemented, large groups of short-beaked common dolphins would be observed, and underwater detonations result in a small zone of influence.

Based on the model results, behavioral patterns, acoustic abilities of short-beaked common dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to short-beaked common dolphins.

Short-finned Pilot Whale (*Globicephala macrorhynchus*)

The risk function and Navy post-modeling analysis estimates 38 short-finned pilot whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 11 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No short-finned pilot whale would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury (Table 4-33).

Given their size (up to 20 ft [6.1 m]), and large mean group size of 22.5 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2006). It is very likely that lookouts would detect a group of short-finned pilot whales at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, short-finned pilot whales that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting groups of short-finned pilot whales reduces the likelihood of exposure.

Based on the model results, behavioral patterns, acoustic abilities of short-finned pilot whale, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to short-finned pilot whale.

Striped Dolphin (*Stenella coeruleoalba*)

The risk function and Navy post-modeling analysis estimates 1,579 striped dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 463 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No striped dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would six exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that would cause severe injury (Table 4-33).

Given their frequent surfacing, aerobatics and large mean group size of 37.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is very likely that lookouts would detect a group of striped dolphins at the surface. Additionally, mitigation measures call for continuous visual observation during operations with active sonar, therefore, striped dolphins that migrate into the operating area would be detected by visual observers. Implementation of mitigation measures and probability of detecting groups of striped dolphins reduces the likelihood of exposure.

Based on the model results, behavioral patterns, acoustic abilities of striped dolphins, results of past training, and the implementation of procedure mitigation measures presented in sections 11.1 for sonar and 11.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to striped dolphins.

Ziphiid Whales (*Ziphus* spp.)

The risk function and Navy post-modeling analysis estimates 73 Ziphiid whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 17 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Ziphiid whales would be exposed to sound levels that could cause PTS.

Modeling indicates there would be no exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and no exposures that would cause severe injury or mortality (Table 4-33).

Given the medium size (up to 23 ft. [7.0 m]) of individual Ziphiid whales, aggregation of approximately two animals (Barlow 2006), it is likely that lookouts would detect a group of Ziphiid whales at the surface although Ziphiid whales make prolonged dives that can last up to an hour (Baird et al. 2004). Implementation of mitigation measures and probability of detecting a large sei whale reduces the likelihood of exposure, such that effects would be discountable.

Based on the model results, behavioral patterns, acoustic abilities of Ziphiid whales, results of past training, and the implementation of procedure protective measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to Ziphiid whales.

Northern Elephant Seal (*Mirounga angustirostris*)

The risk function and Navy post-modeling analysis estimates 675 northern elephant seals will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be seven exposures to accumulated acoustic energy above 204 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS for northern elephant seals. No northern elephant seals would be exposed to sound levels that could cause PTS.

Modeling indicates there would 17 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and no exposures that would cause severe injury or mortality (Table 4-33).

Northern elephant seals tend to dive for long periods, 20-30 minutes, and only spend about 10% of the time at the surface making them difficult to detect. Elephant seals migrate out of the Southern California area to forage for several months at a time (Le Boeuf 1994).

Based on the model results, behavioral patterns, acoustic abilities of Northern elephant seals, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Comples training events would not result in any population level effects, death or injury to Northern elephant seals.

Pacific Harbor Seal (*Phoca vitulina richardii*)

The risk function and Navy post-modeling analysis estimates 1,022 Pacific harbor seals will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be 7,094 exposures to accumulated acoustic energy above 183 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS for Pacific harbor seals. Fifteen Pacific harbor seals would be exposed to sound levels that could cause PTS.

Modeling indicates there would 24 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and one exposure to impulsive sound or pressures from underwater detonations that would cause slight physical injury and no exposures that would cause severe injury or mortality (Table 4-33).

Harbor seals forage near their rookeries (usually within 50 km) therefore they tend to remain in the Southern California area most of the time in comparison to northern elephant seals.

Based on the model results, behavioral patterns, acoustic abilities of harbor seals, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to harbor seals.

California Sea Lion (*Zalophus californianus*)

The risk function and Navy post-modeling analysis estimates 52,679 California sea lions will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be five exposures to accumulated acoustic energy above 206 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS for California sea lions. No California sea lions would be exposed to sound levels that could cause PTS.

Modeling indicates there would 424 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and 16 exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and six exposures that could cause severe injury or mortality (Table 4-33).

California sea lions make short duration dives and may rest at the surface (Feldkamp et al. 1989) making them easier to detect than other pinnipeds.

Based on the model results, behavioral patterns, acoustic abilities of California sea lions, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to harbor seals.

Northern Fur Seal (*Callorhinus ursinus*)

The risk function and Navy post-modeling analysis estimates 740 northern fur seals will exhibit behavioral responses NMFS will classify as harassment under the MMPA (Table 4-28). Modeling also indicates there would be five exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No northern fur seals would be exposed to sound levels that could cause PTS.

Modeling indicates there would 42 exposures to impulsive sound or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and three exposures to impulsive sound or pressures from underwater detonations that would cause slight physical injury and one exposure that could cause severe injury or mortality (Table 4-33).

Nothern fur seals make short duration dives and often rest at the surface (Antonelis et al. 1990) making them easier to detect.

Based on the model results, behavioral patterns, acoustic abilities of northern fur seals, results of past training, and the implementation of procedure mitigation measures presented in sections 5.1 for sonar and 5.2 for underwater detonations, the Navy finds that the SOCAL Range Complex training events would not result in any population level effects, death or injury to northern fur seals.

4.9.5 Summary of Effects by Alternative

Modeled effects of Navy activities on marine mammals, as identified in this section, do not account for reductions in potential impacts through application of the extensive mitigation measures detailed in Section 3.9.10.

4.9.5.1 Potential Non-Acoustic Impacts

Impacts to marine mammals from Navy activities in the SOCAL Range Complex may result from non-acoustic sources including ship collisions, entanglement or falling debris. Impacts from these sources are inherently unpredictable; however, impacts from such sources are considered unlikely, would not result in any death or injury to any marine mammal species and would have negligible impact, if any, on annual survival, recruitment, and birth rates.

4.9.5.2 Potential Mid- and High-Frequency Active Sonar Effects

No Action Alternative-The risk function methodology estimates 83,686 annual exposures to mid- or high-frequency active sonar that could result in a behavioral change (Level B harassment), 16,706 could result in TTS (Level B Harassment). Twenty-six annual exposures could result in injury as PTS. The modeled sonar exposure numbers by species are presented in Table 4-14. These exposure modeling results are estimates of marine mammal sonar exposures without consideration of standard mitigation and monitoring procedures.

Alternative 1-The risk function methodology estimates 89,028 annual exposures to mid- or high-frequency active sonar that could result in a behavioral change, 17,772 could result in TTS (Level B Harassment). Twenty-eight annual exposures could result in injury as PTS. The modeled sonar exposure numbers by species are presented in Table 4-17.

Alternative 2-The risk function methodology estimates 94,370 annual exposures to mid- or high frequency active sonar that could result in a behavioral change, 18,838 could result in TTS (Level B Harassment). Thirty annual exposures could result in injury as PTS. The modeled sonar exposure numbers by species are presented in Table 4-28.

4.9.5.3 Potential Underwater Detonation Effects

No Action Alternative-Modeling estimates 635 annual exposures to pressure from underwater detonations could result in TTS (Level B Harassment). Twenty-eight annual exposures could result in slight injury. Eight annual exposures could result in severe injury or mortality. The modeled explosive exposure numbers by species are presented in Table 4-19

Alternative 1-Modeling estimates 742 annual exposures to pressure from underwater detonations could result in TTS (Level B Harassment). Twenty-nine annual exposures could result in slight injury. Ten annual exposures could result in severe injury or mortality. The modeled explosive exposure numbers by species are presented in Table 4-18.

Alternative 2-Modeling estimates 817 annual exposures to pressure from underwater detonations could result in TTS (Level B Harassment). Thirty-six annual exposures could result in slight injury. Twelve annual exposures could result in severe injury or mortality. The modeled explosive exposure numbers by species are presented in Table 4-33.

4.9.5.4 Statement Regarding Potential Mortality of Marine Mammals

Without consideration of mitigation measures for underwater detonations, the modeling results from the SOCAL Range Complex analysis predict underwater detonations could cause mortality to long-and short-beaked common dolphins, northern fur seals, and California sea lions (12 mortalities total are predicted). However, given range clearance procedures with long set-up times, standard mitigation measures presented in Section 3.10 and again in Chapter 5, and the likelihood that these species can be readily detected, Level A exposures and mortally are unlikely to occur. In light of the modeled results, however, the Navy will request authorization for take, by mortality, of long-and short-beaked common dolphins, northern fur seals, and California sea lions.

The history of Navy activities in the southern California and analysis in this document indicate that military readiness activities are not expected to result in any sonar–induced Level A injury or mortalities to marine mammals.

Evidence from five beaked whale strandings, all of which have taken place outside or the SOCAL Range Complex, and have occurred over approximately a decade, suggests that the exposure of beaked whales to MFA sonar in the presence of certain conditions (e.g., multiple units using tactical sonar, steep bathymetry, constricted channels, strong surface ducts, etc.) may result in strandings, potentially leading to mortality. Although these physical factors believed to contribute to the likelihood of beaked whale strandings are not present, in the aggregate, in the SOCAL Range Complex, scientific uncertainty exists regarding what other factors, or combination of factors, may contribute to beaked whale strandings. Accordingly, to allow for scientific uncertainty regarding contributing causes of beaked whale strandings and the exact mechanisms of the physical effects, the Navy will also request authorization for take, by mortality, of the beaked whale species present in Southern California.

5 MITIGATION MEASURES

The Navy has implemented a comprehensive suite of mitigation measures reduce impacts to marine mammals that might result from Navy training and RDT&E activities in the SOCAL Range Complex. In order to make the findings necessary to issue a Letter of Authorization (LOA) under the Marine Mammal Protection Act (MMPA), it may be necessary for National Marine Fisheries Service (NMFS) to require additional mitigation or monitoring measures beyond those addressed in this Draft Environmental Impact Statement (EIS)/ Overseas Environmental Impact Statement (OEIS). These measures could include measures considered, but eliminated in this EIS/OEIS, or as yet undeveloped measures. The public will have an opportunity, through the MMPA process, both to provide information to NMFS in the comment period following NMFS' Notice of Receipt of the application for an LOA, and to review any additional mitigation or monitoring measures that NMFS might propose in the comment period at the proposed rule stage. The final suite of measures developed as a result of the MMPA process would be identified and analyzed in the Final EIS/OEIS.

Effective training in the SOCAL Range Complex dictates that ship, submarine, and aircraft participants utilize their sensors and exercise weapons to their optimum capabilities as required by the mission. This section is a comprehensive list of mitigation measures that would be utilized for training activities analyzed in the SOCAL EIS/OEIS in order to minimize potential for impacts on marine mammals and sea turtles in the SOCAL Range Complex.

This section includes mitigation measures that are followed for all types of exercises; those that are associated with a particular type of training event; and those that apply generally to all Navy training at sea. For major exercises, the applicable mitigation measures are incorporated into a naval message which is disseminated to all of the units participating in the exercise or training event and applicable responsible commands. Appropriate measures are also provided to non-Navy participants (other DoD and allied forces) as information in order to ensure their use by these participants.

5.1 SONAR MITIGATION MEASURES

General Maritime Measures

Personnel Training – Watchstanders and Lookouts

The use of shipboard lookouts is a critical component of all Navy protective measures. Navy shipboard lookouts (also referred to as “watchstanders”) are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the officer of the deck (OOD) (e.g., trash, a periscope, marine mammals, sea turtles) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water.

- All commanding officers (COs), executive officers (XOs), lookouts, OODs, junior OODs (JOODs), maritime patrol aircraft aircrews, and Anti-submarine Warfare (ASW)/Mine Warfare (MIW) helicopter crews will complete the NMFS-approved Marine Species Awareness Training (MSAT) by viewing the U.S. Navy MSAT digital versatile disk (DVD). MSAT may also be viewed on-line at https://mmrc.tecquest.net. All bridge watchstanders/lookouts will complete both parts one and two of the MSAT; part two is optional for other personnel. This training addresses the lookout’s role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments and general observation information to aid in avoiding interactions with marine species.

- Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Education and Training Command [NAVEDTRA] 12968-B).
- Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts will complete the Personal Qualification Standard Program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). Personnel being trained as lookouts can be counted among those listed below as long as supervisors monitor their progress and performance.
- Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of protective measures if marine species are spotted.

Operating Procedures & Collision Avoidance

- Prior to major exercises, a Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order will be issued to further disseminate the personnel training requirement and general marine species protective measures.
- COs will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.
- While underway, surface vessels will have at least two lookouts with binoculars; surfaced submarines will have at least one lookout with binoculars. Lookouts already posted for safety of navigation and man-overboard precautions may be used to fill this requirement. As part of their regular duties, lookouts will watch for and report to the OOD the presence of marine mammals and sea turtles.
- On surface vessels equipped with a multi-function active sensor, pedestal mounted “Big Eye” (20x10) binoculars will be properly installed and in good working order to assist in the detection of marine mammals and sea turtles in the vicinity of the vessel.
- Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-B).
- After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook. (NAVEDTRA 12968-B)
- While in transit, naval vessels will be alert at all times, use extreme caution, and proceed at a “safe speed” so that the vessel can take proper and effective action to avoid a collision with any marine animal and can be stopped within a distance appropriate to the prevailing circumstances and conditions.
- When whales have been sighted in the area, Navy vessels will increase vigilance and take reasonable and practicable actions to avoid collisions and activities that might result in close interaction of naval assets and marine mammals. Actions may include changing speed and/or direction and are dictated by environmental and other conditions (e.g., safety, weather).

- Naval vessels will maneuver to keep at least 460 m (1,500 ft) away from any observed whale and avoid approaching whales head-on. This requirement does not apply if a vessel's safety is threatened, such as when change of course will create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver. Restricted maneuverability includes, but is not limited to, situations when vessels are engaged in dredging, submerged operations, launching and recovering aircraft or landing craft, minesweeping operations, replenishment while underway and towing operations that severely restrict a vessel's ability to deviate course. Vessels will take reasonable steps to alert other vessels in the vicinity of the whale.
- Where feasible and consistent with mission and safety, vessels will avoid closing to within 200-yd of sea turtles and marine mammals other than whales (whales addressed above).
- Floating weeds and kelp, algal mats, clusters of seabirds, and jellyfish are good indicators of sea turtles and marine mammals. Therefore, increased vigilance in watching for sea turtles and marine mammals will be taken where these are present.
- Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties. Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.
- All vessels will maintain logs and records documenting training operations should they be required for event reconstruction purposes. Logs and records will be kept for a period of 30 days following completion of a major training exercise.

Measures for Specific Training Events

Mid-Frequency Active Sonar Operations

General Maritime Mitigation Measures: Personnel Training

- All lookouts onboard platforms involved in ASW training events will review the NMFS-approved Marine Species Awareness Training material prior to use of mid-frequency active sonar.
- All COs, XOs, and officers standing watch on the bridge will have reviewed the Marine Species Awareness Training material prior to a training event employing the use of mid-frequency active sonar.
- Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Educational Training [NAVEDTRA], 12968-B).
- Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts will complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not forbid personnel being trained as lookouts from being counted as those listed in previous measures so long as supervisors monitor their progress and performance.

- Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of mitigation measures if marine species are spotted.

General Maritime Mitigation Measures: Lookout and Watchstander Responsibilities

- On the bridge of surface ships, there will always be at least three people on watch whose duties include observing the water surface around the vessel.
- All surface ships participating in ASW training events will, in addition to the three personnel on watch noted previously, have at all times during the exercise at least two additional personnel on watch as marine mammal lookouts.
- Personnel on lookout and officers on watch on the bridge will have at least one set of binoculars available for each person to aid in the detection of marine mammals.
- On surface vessels equipped with mid-frequency active sonar, pedestal mounted "Big Eye" (20x110) binoculars will be present and in good working order to assist in the detection of marine mammals in the vicinity of the vessel.
- Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-B).
- After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook.
- Personnel on lookout will be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew or indicative of a marine species that may need to be avoided as warranted.

Operating Procedures

- A Letter of Instruction, Mitigation Measures Message, or Environmental Annex to the Operational Order will be issued prior to the exercise to further disseminate the personnel training requirement and general marine mammal mitigation measures.
- COs will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.
- All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) will monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.
- During mid-frequency active sonar operations, personnel will utilize all available sensor and optical systems (such as night vision goggles) to aid in the detection of marine mammals.
- Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

- Aircraft with deployed sonobuoys will use only the passive capability of sonobuoys when marine mammals are detected within 200 yds (183 m) of the sonobuoy.
- Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.
- Safety Zones—When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 1,000 yds (914 m) of the sonar dome (the bow), the ship or submarine will limit active transmission levels to at least 6 decibels (dB) below normal operating levels. (A 6 dB reduction equates to a 75 percent power reduction. The reason is that decibel levels are on a logarithmic scale, not a linear scale. Thus, a 6 dB reduction results in a power level only 25 percent of the original power.)
    - Ships and submarines will continue to limit maximum transmission levels by this 6-dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 m) beyond the location of the last detection.
    - Should a marine mammal be detected within or closing to inside 500 yds (457 m) of the sonar dome, active sonar transmissions will be limited to at least 10 dB below the equipment's normal operating level. (A 10 dB reduction equates to a 90 percent power reduction from normal operating levels.). Ships and submarines will continue to limit maximum ping levels by this 10-dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (457 m) beyond the location of the last detection.
    - Should the marine mammal be detected within or closing to inside 200 yds (183 m) of the sonar dome, active sonar transmissions will cease. Sonar will not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (457 m) beyond the location of the last detection.
    - Special conditions applicable for dolphins and porpoises only: If, after conducting an initial maneuver to avoid close quarters with dolphins or porpoises, the OOD concludes that dolphins or porpoises are deliberately closing to ride the vessel's bow wave, no further mitigation actions are necessary while the dolphins or porpoises continue to exhibit bow wave riding behavior.
    - If the need for power-down should arise as detailed in “Safety Zones” above, the Navy shall follow the requirements as though they were operating at 235 dB—the normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 sonar was being operated).
- Prior to start up or restart of active sonar, operators will check that the Safety Zone radius around the sound source is clear of marine mammals.
- Sonar levels (generally)—Navy will operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.
- Helicopters shall observe/survey the vicinity of an ASW training event for 10 minutes before the first deployment of active (dipping) sonar in the water.

- Helicopters shall not dip their sonar within 200 yds (183 m) of a marine mammal and shall cease pinging if a marine mammal closes within 200 yds (183 m) after pinging has begun.
- Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW training events involving active mid-frequency sonar.
- Increased vigilance during ASW training events with tactical active sonar when critical conditions are present.

  Based on lessons learned from strandings in Bahamas 2000, Madeiras 2000, Canaries 2002 and Spain 2006, beaked whales are of particular concern since they have been associated with mid-frequency active sonar operations. The Navy should avoid planning Major ASW Training Exercises with mid-frequency active sonar in areas where they will encounter conditions which, in their aggregate, may contribute to a marine mammal stranding event.

  The conditions to be considered during exercise planning include:

  - Areas of at least 1,000-meter depth near a shoreline where there is a rapid change in bathymetry on the order of 1,000-6,000 yds (914-5486 m) occurring across a relatively short horizontal distance (e.g., 5 nautical miles [nm]).
  - Cases for which multiple ships or submarines (≥ 3) operating mid-frequency active sonar in the same area over extended periods of time (≥ 6 hours) in close proximity (≤ 10 nm apart).
  - An area surrounded by land masses, separated by less than 35 nm and at least 10 nm in length, or an embayment, wherein operations involving multiple ships/subs (≥ 3) employing mid-frequency active sonar near land may produce sound directed toward the channel or embayment that may cut off the lines of egress for marine mammals.
  - Though not as dominant a condition as bathymetric features, the historical presence of a significant surface duct (i.e., a mixed layer of constant water temperature extending from the sea surface to 100 or more feet [ft]).

If the Major Range Event is to occur in an area where the above conditions exist in their aggregate, these conditions must be fully analyzed in environmental planning documentation. The Navy will increase vigilance by undertaking the following additional mitigation measure:

- A dedicated aircraft (Navy asset or contracted aircraft) will undertake reconnaissance of the embayment or channel ahead of the exercise participants to detect marine mammals that may be in the area exposed to active sonar. Where practical, advance survey should occur within about 2 hours prior to mid-frequency active sonar use and periodic surveillance should continue for the duration of the exercise. Any unusual conditions (e.g., presence of sensitive species, groups of species milling out of habitat, and any stranded animals) shall be reported to the Office in Tactical Command, who should give consideration to delaying, suspending, or altering the exercise.
- All safety zone power down requirements described above will apply.
- The post-exercise report must include specific reference to any event conducted in areas where the above conditions exist, with exact location and time/duration of the event, and noting results of surveys conducted.

5.2 UNDERWATER DETONATION MITIGATION MEASURES

Surface-to-Surface Gunnery (5-inch, 76 mm, 20 mm, 25 mm and 30 mm explosive rounds)

- Lookouts will visually survey for floating weeds and kelp, and algal mats which may be inhabited by immature sea turtles in the target area. Intended impact shall not be within 600 yds (585 m) of known or observed floating weeds and kelp, and algal mats.
- For exercises using targets towed by a vessel or aircraft, target-towing vessels/aircraft shall maintain a trained lookout for marine mammals and sea turtles. If a marine mammal or sea turtle is sighted in the vicinity, the tow aircraft/vessel will immediately notify the firing vessel, which will suspend the exercise until the area is clear.
- A 600 yard radius buffer zone will be established around the intended target.
- From the intended firing position, trained lookouts will survey the buffer zone for marine mammals and sea turtles prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.
- The exercise will be conducted only when the buffer zone is visible and marine mammals and sea turtles are not detected within it.

Surface-to-Surface Gunnery (non-explosive rounds)

- Lookouts will visually survey for floating weeds and kelp, and algal mats which may be inhabited by immature sea turtles in the target area. Intended impact will not be within 200 yds (183 m) of known or observed floating weeds and kelp, and algal mats.
- A 200 yd (183 m) radius buffer zone will be established around the intended target.
- From the intended firing position, trained lookouts will survey the buffer zone for marine mammals and sea turtles prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.
- If applicable, target towing vessels will maintain a lookout. If a marine mammal or sea turtle is sighted in the vicinity of the exercise, the tow vessel will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.
- The exercise will be conducted only when the buffer zone is visible and marine mammals and sea turtles are not detected within the target area and the buffer zone.

Surface-to-Air Gunnery (explosive and non-explosive rounds)

- Vessels will orient the geometry of gunnery exercises in order to prevent debris from falling in the area of sighted marine mammals, sea turtles, algal mats, and floating kelp.
- Vessels will expedite the recovery of any parachute deploying aerial targets to reduce the potential for entanglement of marine mammals and sea turtles.
- Target towing aircraft shall maintain a lookout. If a marine mammal or sea turtle is sighted in the vicinity of the exercise, the tow aircraft will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

Air-to-Surface Gunnery (explosive and non-explosive rounds)

- If surface vessels are involved, lookouts will visually survey for floating kelp, which may be inhabited by immature sea turtles, in the target area. Impact should not occur within 200 yds (183 m) of known or observed floating weeds and kelp or algal mats.
- A 200 yd (183 m) radius buffer zone will be established around the intended target.
- If surface vessels are involved, lookout(s) will visually survey the buffer zone for marine mammals and sea turtles prior to and during the exercise.
- Aerial surveillance of the buffer zone for marine mammals and sea turtles will be conducted prior to commencement of the exercise. Aerial surveillance altitude of 500 feet to 1,500 feet (ft) (152 - 456 m) is optimum. Aircraft crew/pilot will maintain visual watch during exercises. Release of ordnance through cloud cover is prohibited: aircraft must be able to actually see ordnance impact areas.
- The exercise will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

Small Arms Training - (grenades, explosive and non-explosive rounds)

- Lookouts will visually survey for floating weeds or kelp, algal mats, marine mammals, and sea turtles. Weapons will not be fired in the direction of known or observed floating weeds or kelp, algal mats, marine mammals, sea turtles.

Air-to-Surface At-Sea Bombing Exercises (explosive bombs and cluster munitions, rockets)

- If surface vessels are involved, trained lookouts will survey for floating kelp, which may be inhabited by immature sea turtles. Ordnance shall not be targeted to impact within 1,000 yds (914 m) of known or observed floating kelp, sea turtles, or marine mammals.
- A buffer zone of 1,000 yd (914 m) radius will be established around the intended target.
- Aircraft will visually survey the target and buffer zone for marine mammals and sea turtles prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 feet or lower, if safe to do so, and at the slowest safe speed. Release of ordnance through cloud cover is prohibited: aircraft must be able to actually see ordnance impact areas. Survey aircraft should employ most effective search tactics and capabilities.
- The exercises will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

Air-to-Surface At-Sea Bombing Exercises (non-explosive bombs and cluster munitions, rockets)

- If surface vessels are involved, trained lookouts will survey for floating kelp, which may be inhabited by immature sea turtles, and for sea turtles and marine mammals. Ordnance shall not be targeted to impact within 1,000 yds (914 m) of known or observed floating kelp, sea turtles, or marine mammals.
- A 1,000 yd (914 m) radius buffer zone will be established around the intended target.
- Aircraft will visually survey the target and buffer zone for marine mammals and sea turtles prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 ft (152 m) or lower, if safe to do so, and at the slowest safe speed. Release of ordnance through cloud cover is prohibited: aircraft must be able to actually

see ordnance impact areas. Survey aircraft should employ most effective search tactics and capabilities.

- The exercise will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

Air-to-Surface Missile Exercises (explosive and non-explosive)

- Ordnance shall not be targeted to impact within 1,800 yds (1646 m) of known or observed floating kelp, which may be inhabited by immature sea turtles, or coral reefs.
- Aircraft will visually survey the target area for marine mammals and sea turtles. Visual inspection of the target area will be made by flying at 1,500 (457 m) feet or lower, if safe to do so, and at slowest safe speed. Firing or range clearance aircraft must be able to actually see ordnance impact areas. Explosive ordnance shall not be targeted to impact within 1,800 yds (1646 m) of sighted marine mammals and sea turtles.

Underwater Detonations (up to 20-lb charges)

To ensure protection of marine mammals and sea turtles during underwater detonation training, the operating area must be determined to be clear of marine mammals and sea turtles prior to detonation. Implementation of the following mitigation measures continue to ensure that marine mammals would not be exposed to temporary threshold shift (TTS), permanent threshold shift (PTS), or injury from physical contact with training mine shapes during Major Exercises.

Exclusion Zones

All Mine Warfare and Mine Countermeasures Operations involving the use of explosive charges must include exclusion zones for marine mammals and sea turtles to prevent physical and/or acoustic effects to those species. These exclusion zones shall extend in a 700-yard arc radius around the detonation site.

Pre-Exercise Surveys

For Demolition and Ship Mine Countermeasures Operations, pre-exercise survey shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any marine mammal or sea turtle. Should such an animal be present within the survey area, the exercise shall be paused until the animal voluntarily leaves the area. The Navy will suspend detonation exercises and ensure the area is clear for a full 30 minutes prior to detonation. Personnel will record any protected species marine mammal and sea turtle observations during the exercise as well as measures taken if species are detected within the exclusion zone.

Post-Exercise Surveys

Surveys within the same radius shall also be conducted within 30 minutes after the completion of the explosive event.

Reporting

If there is evidence that a marine mammal or sea turtle may have been stranded, injured or killed by the action, Navy training activities will be immediately suspended and the situation immediately reported by the participating unit to the Officer in Charge of the Exercise (OCE), who will follow Navy procedures for reporting the incident to Commander, Pacific Fleet, Commander, Navy Region Southwest, Environmental Director, and the chain-of-command.

Mining Operations

Mining Operations involve aerial drops of inert training shapes on target points. Aircrews are scored for their ability to accurately hit the target points. Although this operation does not involve live ordnance, marine mammals have the potential to be injured if they are in the immediate vicinity of a target points; therefore, the safety zone shall be clear of marine mammals and sea turtles around the target location. Pre- and post-surveys and reporting requirements outlined for underwater detonations shall be implemented during Mining Operations. To the maximum extent feasible, the Navy shall retrieve inert mine shapes dropped during Mining Operations.

Sink Exercise

The selection of sites suitable for Sink Exercises (SINKEXs) involves a balance of operational suitability, requirements established under the Marine Protection, Research and Sanctuaries Act (MPRSA) permit granted to the Navy (40 Code of Federal Regulations § 229.2), and the identification of areas with a low likelihood of encountering Endangered Species Act (ESA) listed species. To meet operational suitability criteria, locations must be within a reasonable distance of the target vessels' originating location. The locations should also be close to active military bases to allow participating assets access to shore facilities. For safety purposes, these locations should also be in areas that are not generally used by non-military air or watercraft. The MPRSA permit requires vessels to be sunk in waters which are at least 1,000 fathoms (3,000 yds / 2742 m)) deep and at least 50 nm from land.

In general, most listed species prefer areas with strong bathymetric gradients and oceanographic fronts for significant biological activity such as feeding and reproduction. Typical locations include the continental shelf and shelf-edge.

SINKEX Mitigation Plan

The Navy has developed range clearance procedures to maximize the probability of sighting any ships or protected species in the vicinity of an exercise, which are as follows:

- All weapons firing would be conducted during the period 1 hour after official sunrise to 30 minutes before official sunset.
- Extensive range clearance operations would be conducted in the hours prior to commencement of the exercise, ensuring that no shipping is located within the hazard range of the longest-range weapon being fired for that event.
- Prior to conducting the exercise, remotely sensed sea surface temperature maps would be reviewed. SINKEX would not be conducted within areas where strong temperature discontinuities are present, thereby indicating the existence of oceanographic fronts. These areas would be avoided because concentrations of some listed species, or their prey, are known to be associated with these oceanographic features.
- An exclusion zone with a radius of 1.0 nm would be established around each target. This exclusion zone is based on calculations using a 990-pound (lb) H6 net explosive weight high explosive source detonated 5 ft below the surface of the water, which yields a distance of 0.85 nm (cold season) and 0.89 nm (warm season) beyond which the received level is below the 182 decibels (dB) re: 1 micropascal squared-seconds (µPa2-s) threshold established for the WINSTON S. CHURCHILL (DDG 81) shock trials (U.S.

Navy, 2001). An additional buffer of 0.5 nm would be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which extends from the exclusion zone at 1.0 nm out an additional 0.5 nm, would be surveyed. Together, the zones extend out 2 nm from the target.

- A series of surveillance over-flights would be conducted within the exclusion and the safety zones, prior to and during the exercise, when feasible. Survey protocol would be as follows:
  - Overflights within the exclusion zone would be conducted in a manner that optimizes the surface area of the water observed. This may be accomplished through the use of the Navy's Search and Rescue Tactical Aid, which provides the best search altitude, ground speed, and track spacing for the discovery of small, possibly dark objects in the water based on the environmental conditions of the day. These environmental conditions include the angle of sun inclination, amount of daylight, cloud cover, visibility, and sea state.
  - All visual surveillance activities would be conducted by Navy personnel trained in visual surveillance. At least one member of the mitigation team would have completed the Navy's marine mammal training program for lookouts.
  - In addition to the overflights, the exclusion zone would be monitored by passive acoustic means, when assets are available. This passive acoustic monitoring would be maintained throughout the exercise. Potential assets include sonobuoys, which can be utilized to detect any vocalizing marine mammals (particularly sperm whales) in the vicinity of the exercise. The sonobuoys would be re-seeded as necessary throughout the exercise. Additionally, passive sonar onboard submarines may be utilized to detect any vocalizing marine mammals in the area. The OCE would be informed of any aural detection of marine mammals and would include this information in the determination of when it is safe to commence the exercise.
  - On each day of the exercise, aerial surveillance of the exclusion and safety zones would commence 2 hours prior to the first firing.
  - The results of all visual, aerial, and acoustic searches would be reported immediately to the OCE. No weapons launches or firing would commence until the OCE declares the safety and exclusion zones free of marine mammals and threatened and endangered species.
  - If a protected species observed within the exclusion zone is diving, firing would be delayed until the animal is re-sighted outside the exclusion zone, or 30 minutes have elapsed. After 30 minutes, if the animal has not been re-sighted it would be assumed to have left the exclusion zone. This is based on a typical dive time of 30 minutes for traveling listed species of concern. The OCE would determine if the listed species is in danger of being adversely affected by commencement of the exercise.
  - During breaks in the exercise of 30 minutes or more, the exclusion zone would again be surveyed for any protected species. If protected species are sighted within the exclusion zone, the OCE would be notified, and the procedure described above would be followed.

  - Upon sinking of the vessel, a final surveillance of the exclusion zone would be monitored for 2 hours, or until sunset, to verify that no listed species were harmed.

- Aerial surveillance would be conducted using helicopters or other aircraft based on necessity and availability. The Navy has several types of aircraft capable of performing this task; however, not all types are available for every exercise. For each exercise, the available asset best suited for identifying objects on and near the surface of the ocean would be used. These aircraft would be capable of flying at the slow safe speeds necessary to enable viewing of marine vertebrates with unobstructed, or minimally obstructed, downward and outward visibility. The exclusion and safety zone surveys may be cancelled in the event that a mechanical problem, emergency search and rescue, or other similar and unexpected event preempts the use of one of the aircraft onsite for the exercise.
- Every attempt would be made to conduct the exercise in sea states that are ideal for marine mammal sighting, Beaufort Sea State 3 or less. In the event of a 4 or above, survey efforts would be increased within the zones. This would be accomplished through the use of an additional aircraft, if available, and conducting tight search patterns.
- The exercise would not be conducted unless the exclusion zone could be adequately monitored visually.
- In the unlikely event that any listed species are observed to be harmed in the area, a detailed description of the animal would be taken, the location noted, and if possible, photos taken. This information would be provided to NOAA Fisheries via the Navy's regional environmental coordinator for purposes of identification.
- An after action report detailing the exercise's time line, the time the surveys commenced and terminated, amount, and types of all ordnance expended, and the results of survey efforts for each event would be submitted to NOAA Fisheries.

Mitigation Measures Related to Explosive Source Sonobuoys (AN/SSQ-110A) (AN/SSQ-110A)

- Crews will conduct visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search should be conducted below 457 m (500 yd) at a slow speed, if operationally feasible and weather conditions permit. In dual aircraft operations, crews are allowed to conduct coordinated area clearances.
- Crews shall conduct a minimum of 30 minutes of visual and aural monitoring of the search area prior to commanding the first post detonation. This 30-minute observation period may include pattern deployment time.
- For any part of the briefed pattern where a post (source/receiver sonobuoy pair) will be deployed within 914 m (1,000 yd) of observed marine mammal activity, deploy the receiver ONLY and monitor while conducting a visual search. When marine mammals are no longer detected within 914 m (1,000 yd) of the intended post position, co-locate the explosive source sonobuoy (AN/SSQ-110A) (source) with the receiver.
- When able, crews will conduct continuous visual and aural monitoring of marine mammal activity. This is to include monitoring of own-aircraft sensors from first sensor placement to checking off station and out of RF range of these sensors.
- Aural Detection:

  - o If the presence of marine mammals is detected aurally, then that should cue the aircrew to increase the diligence of their visual surveillance. Subsequently, if no marine mammals are visually detected, then the crew may continue multi-static active search.

- Visual Detection:
  - o If marine mammals are visually detected within 914 m (1,000 yd) of the explosive source sonobuoy (AN/SSQ-110A) intended for use, then that payload shall not be detonated. Aircrews may utilize this post once the marine mammals have not been re-sighted for 10 minutes, or are observed to have moved outside the 914 m (1,000 yd) safety buffer.
  - o Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 914 m (1,000 yd) safety buffer.
- Aircrews shall make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the "Payload 1 Release" command followed by the "Payload 2 Release" command. Aircrews shall refrain from using the "Scuttle" command when two payloads remain at a given post. Aircrews will ensure that a 914 m (1,000 yd) safety buffer, visually clear of marine mammals, is maintained around each post as is done during active search operations.
- Aircrews shall only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary or tertiary method.
- Ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ-110A) that can not be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.
- Mammal monitoring shall continue until out of own-aircraft sensor range.

5.3 SOCAL MARINE SPECIES MONITORING PLAN

The Navy is developing a Marine Species Monitoring Plan (MSMP) that provides recommendations for site-specific monitoring for MMPA and ESA listed species (primarily marine mammals) within the SOCAL Range Complex, including during training. The primary goals of monitoring are to evaluate trends in marine species distribution and abundance in order to assess potential population effects from Navy training activities and determine the effectiveness of the Navy's mitigation measures. The information gained from the monitoring will also allow the Navy to evaluate the models used to predict effects to marine mammals.

By using a combination of monitoring techniques or tools appropriate for the species of concern, type of Navy activities conducted, sea state conditions, and the size of the Range Complex, the detection, localization, and observation of marine mammals and sea turtles can be maximized. The following available monitoring techniques and tools are described in this monitoring plan for monitoring for range events (several days or weeks) and monitoring of population effects such as abundance and distribution (months or years):

- Visual Observations – Vessel-, Aerial- and Shore-based Surveys (for marine mammals and sea turtles) will provide data on population trends (abundance, distribution, and presence) and response of marine species to Navy training activities. Navy lookouts will also record observations of detected marine mammals from Navy ships during appropriate training and test events.

- Acoustic Monitoring – Passive Acoustic Monitoring possibly using towed hydrophone arrays, Autonomous Acoustic Recording buoys and U.S. Navy Instrument Acoustic Range (for marine mammals only) may provide presence/absence data on cryptic species that are difficult to detect visually (beaked whales and minke whales) that could address long term population trends and response to Navy training exercises.

- Tagging – Tagging marine mammals with instruments to messure their dive depth and duration, determine location and record the received level of natural and anthropogenic sounds.

- Additional Methods – Oceanographic Observations and Other Environmental Factors will be obtained during ship-based surveys and satellite remote sensing data. Oceanographic data is important factor that influences the abundance and distribution of prey items and therefore the distribution and movements of marine mammals.

The monitoring plan will be reviewed annually by Navy biologists to determine the effectiveness of the monitoring elements and to consider any new monitoring tools or techniques that may have become available.

Research

The Navy provides a significant amount of funding and support to marine research. The agency provides nearly 10 million dollars annually to universities, research institutions, federal laboratories, private companies, and independent researchers around the world to study marine mammals. The U.S. Navy sponsors seventy percent of all U.S. research concerning the effects of human-generated sound on marine mammals and 50 percent of such research conducted worldwide. Major topics of Navy-supported research include the following:

- Better understanding of marine species distribution and important habitat areas,
- Developing methods to detect and monitor marine species before and during training,
- Understanding the effects of sound on marine mammals, sea turtles, fish, and birds, and
- Developing tools to model and estimate potential effects of sound.

This research is directly applicable to Fleet training activities, particularly with respect to the investigations of the potential effects of underwater noise sources on marine mammals and other protected species. Proposed training activities employ sonar and underwater explosives, which introduce sound into the marine environment.

The Marine Life Sciences Division of the Office of Naval Research currently coordinates six programs that examine the marine environment and are devoted solely to studying the effects of noise and/or the implementation of technology tools that will assist the Navy in studying and tracking marine mammals. The six programs are as follows:

- Environmental Consequences of Underwater Sound,
- Non-Auditory Biological Effects of Sound on Marine Mammals,
- Effects of Sound on the Marine Environment,
- Sensors and Models for Marine Environmental Monitoring,

- Effects of Sound on Hearing of Marine Animals, and
- Passive Acoustic Detection, Classification, and Tracking of Marine Mammals.

The Navy has also developed the technical reports referenced within this document, which include the Marine Resource Assessments and the Navy OPAREA Density Estimates (NODE) reports. Furthermore, research cruises by the National Marine Fisheries Service (NMFS) and by academic institutions have received funding from the U.S. Navy.

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and other research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods on instrumented ranges. However, acoustic detection, identification, localization, and tracking of individual animals still requires a significant amount of research effort to be considered a reliable method for marine mammal monitoring. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential mitigation and monitoring tool.

Overall, the Navy will continue to fund ongoing marine mammal research, and is planning to coordinate long term monitoring/studies of marine mammals on various established ranges and operating areas. The Navy will continue to research and contribute to university/external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include mitigation and monitoring programs; data sharing with NMFS and via the literature for research and development efforts; and future research as described previously.

Coordination and Reporting

The Navy will coordinate with the local NMFS Stranding Coordinator for any unusual marine mammal behavior and any stranding, beached live/dead or floating marine mammals that may occur coincident with Navy training activities.

Alternative Mitigation Measures Considered but Eliminated

As described in Chapter 4, the vast majority of estimated sound exposures of marine mammals during proposed active sonar activities would not cause injury. Potential acoustic effects on marine mammals would be further reduced by the mitigation measures described above. Therefore, the Navy concludes the proposed action and mitigation measures would achieve the least practical adverse impact on species or stocks of marine mammals.

A determination of “least practicable adverse impacts” includes consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity in consultation with the DoD. Therefore, the following additional mitigation measures were analyzed and eliminated from further consideration:

- Reduction of training. The requirements for training have been developed through many years of iteration to ensure sailors achieve levels of readiness to ensure they are prepared to properly respond to the many contingencies that may occur during an actual mission. These training requirements are designed provide the experience needed to ensure sailors are properly prepared for operational success. There is no extra training built in to the plan, as this would not be an efficient use of the resources needed to support the training (e.g. fuel, time). Therefore, any reduction of training would not allow sailors to achieve satisfactory levels of readiness needed to accomplish their mission.
- Use of ramp-up to attempt to clear the range prior to the conduct of exercises. Ramp-up procedures, (slowly increasing the sound in the water to necessary levels), are not a

viable alternative for training exercises because the ramp-up would alert opponents to the participants' presence. This affects the realism of training in that the target submarine would be able to detect the searching unit prior to themselves being detected, enabling them to take evasive measures. This would insert a significant anomaly to the training, affecting its realism and effectiveness. Though ramp-up procedures have been used in testing, the procedure is not effective in training sailors to react to tactical situations, as it provides an unrealistic advantage by alerting the target. Using these procedures would not allow the Navy to conduct realistic training, thus adversely impacting the effectiveness of the military readiness activity.

- Visual monitoring using third-party observers from air or surface platforms, in addition to the existing Navy-trained lookouts.
    - The use of third-party observers would compromise security due to the requirement to provide advance notification of specific times/locations of Navy platforms.
    - Reliance on the availability of third-party personnel would also impact training flexibility, thus adversely affecting training effectiveness.
    - The presence of other aircraft in the vicinity of naval exercises would raise safety concerns for both the commercial observers and naval aircraft.
    - Use of Navy observers is the most effective means to ensure quick and effective implementation of mitigation measures if marine species are spotted. A critical skill set of effective Navy training is communication. Navy lookouts are trained to act swiftly and decisively to ensure that appropriate actions are taken.
    - Use of third-party observers is not necessary because Navy personnel are extensively trained in spotting items on or near the water surface. Navy spotters receive more hours of training, and use their spotting skills more frequently, than many third-party trained personnel.
    - Crew members participating in training activities involving aerial assets have been specifically trained to detect objects in the water. The crew's ability to sight from both surface and aerial platforms provides excellent survey capabilities using the Navy's existing exercise assets.
    - Security clearance issues would have to be overcome to allow non-Navy observers onboard exercise participants.
    - Some training events will span one or more 24-hour periods, with operations underway continuously in that timeframe. It is not feasible to maintain non-Navy surveillance of these operations, given the number of non-Navy observers that would be required onboard.
    - Surface ships having active mid-frequency sonar have limited berthing capacity. As exercise planning includes careful consideration of this limited capacity in the placement of exercise controllers, data collection personnel, and Afloat Training Group personnel on ships involved in the exercise. Inclusion of non-Navy observers onboard these ships would require that in some cases there would be no additional berthing space for essential Navy personnel required to fully evaluate and efficiently use the training opportunity to accomplish the exercise objectives.

  - Contiguous ASW events may cover many hundreds of square miles. The number of civilian ships and/or aircraft required to monitor the area of these events would be considerable. It is, thus, not feasible to survey or monitor the large exercise areas in the time required ensuring these areas are devoid of marine mammals. In addition, marine mammals may move into or out of an area, if surveyed before an event, or an animal could move into an area after an exercise took place. Given that there are no adequate controls to account for these or other possibilities and there are no identified research objectives, there is no utility to performing either a before or an after the event survey of an exercise area.
  - Survey during an event raises safety issues with multiple, slow civilian aircraft operating in the same airspace as military aircraft engaged in combat training activities. In addition, most of the training events take place far from land, limiting both the time available for civilian aircraft to be in the exercise area and presenting a concern should aircraft mechanical problems arise.
  - Scheduling civilian vessels or aircraft to coincide with training events would impact training effectiveness, since exercise event timetables cannot be precisely fixed and are instead based on the free-flow development of tactical situations. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would slow the unceasing progress of the exercise and impact the effectiveness of the military readiness activity.
  - Multiple simultaneous training events continue for extended periods. There are not enough qualified third-party personnel to accomplish the monitoring task.
- Reducing or securing power during the following conditions.
  - Low-visibility / night training: ASW can require a significant amount of time to develop the “tactical picture,” or an understanding of the battle space such as area searched or unsearched, identifying false contacts, understanding the water conditions, etc. Reducing or securing power in low-visibility conditions would affect a commander’s ability to develop this tactical picture and would not provide realistic training.
  - Strong surface duct: The complexity of ASW requires the most realistic training possible for the effectiveness and safety of the sailors. Reducing power in strong surface duct conditions would not provide this training realism because the unit would be operating differently than it would in a combat scenario, reducing training effectiveness and the crew’s ability. Additionally, water conditions may change rapidly, resulting in continually changing mitigation requirements, resulting in a focus on mitigation versus training.
- Vessel speed: Establish and implement a set vessel speed.
  - Navy personnel are required to use caution and operate at a slow, safe speed consistent with mission and safety. Ships and submarines need to be able to react to changing tactical situations in training as they would in actual combat. Placing arbitrary speed restrictions would not allow them to properly react to these situations, resulting in decreased training effectiveness and reduction the crew proficiency.
- Increasing power down and shut down zones:
  - The current power down zones of 457 and 914 m (500 and 1,000 yd), as well as the 183 m (200 yd) shut down zone were developed to minimize exposing marine

mammals to sound levels that could cause temporary threshold shift (TTS) or permanent threshold shift (PTS), levels that are supported by the scientific community. Implementation of the safety zones discussed above will prevent exposure to sound levels greater than 195 dB re 1µPa for animals sighted. The safety range the Navy has developed is also within a range sailors can realistically maintain situational awareness and achieve visually during most conditions at sea.

    - Although the three action alternatives were developed using marine mammal density data and areas believed to provide habitat features conducive to marine mammals, not all such areas could be avoided. ASW requires large areas of ocean space to provide realistic and meaningful training to the sailors. These areas were considered to the maximum extent practicable while ensuring Navy's ability to properly train its forces in accordance with federal law. Avoiding any area that has the potential for marine mammal populations is impractical and would impact the effectiveness of the military readiness activity.

- Using active sonar with output levels as low as possible consistent with mission requirements and use of active sonar only when necessary.
    - Operators of sonar equipment are always cognizant of the environmental variables affecting sound propagation. In this regard, the sonar equipment power levels are always set consistent with mission requirements.
    - Active sonar is only used when required by the mission since it has the potential to alert opposing forces to the sonar platform's presence. Passive sonar and all other sensors are used in concert with active sonar to the maximum extent practicable when available and when required by the mission.

6 ADDITIONAL REFERENCES

Abend, A.G., and T.D. Smith. 1999. Review of Distribution of the Long-finned Pilot Whale (*Globicephala melas*) in the North Atlantic and Mediterranean. NOAA Technical Memorandum NMFS-NE-117.

Aburto, A., D.J., Roundtry, and D.L. Danzer, 1997 Behavioral response of blue whales to active signals. Technical Report, Naval Command, Control and Ocean Surveillance Center, San Diego, CA.

Acevedo-Gutierrez, A, D.A. Croll and B.R. Tershy. 2002. High feeding costs limit dive time in the largest whales. Journal of Experimental Biology. 205:1747-1753.

Addison, R. F., S. R. Kerr and J. Dale. 1973. Variation of organochlorine residue levels with age in Gulf of St. Lawrence harp seals. *Pagophilus groenlandicus*. Journal of the Fisheries Research Board of Canada. 30: 595-600.

Addison, R. F. and W. T. Stobo. 2001. Trends in Organochlorine Residue Concentrations and Burdens in Grey Seals (*Halichoerus grypus*) from Sable Island, NS, Canada between 1974 and 1994. Environmental Pollution. 112(3): 505-513.

Aguilar, A. 2000. Population biology, conservation threats and status of Mediterranean striped dolphins. *Stenella coeruleoalba*. Journal of Cetacean Research and Management. 2(1): 17-26.

Aguilar, N., M. Carrillo, I. Delgado, F. Diaz and A. Brito. 2000. Fast Ferries Impact on Cetacean in Canary Islands: Collisions and Displacement. European Cetacean Society 14th Annual Conference, Cork, Ireland.

Alexander, J. W., M.A. Solangi, and L.S. Riegel. 1989. Vertebral osteomyelitis and suspected diskospondylitis in an Atlantic bottlenose dolphin (*Tursiops truncatus*). Journal of Wildlife Diseases. 25:118-121.

Amano, M., and M. Yoshioka. 2003. Sperm whale diving behavior monitored using a suction-cup attached TDR tag Marine Ecology Progress Series. 258:291-295.

Andrade, A. L. V., M. C. Pinedo and A. S. Barreto. 2001. Gastrointestinal Parasites and Prey Items from a Mass Stranding of False Killer Whales, *Pseudorca crassidens*, in Rio Grande do Sul, Southern Brazil. Revista Brasileira de Biologia. 61:55-61.

André, M., M. Terada, and Y. Watanabe. 1997. Sperm Whale (*Physeter macrocephalus*) Behavioral Response after the Playback of Artificial Sounds. Reports of the International Whaling Commission. 47:499-504.

Andrew, R.K., B.M. Howe,.and J.A. Mercer. 2002. Ocean ambient sound: Comparing the 1960s with the 1990s for a receiver off the California coast. Journal of the Acoustic Society of America. 3:65-70.

Angliss, R. P., and R. B. Outlaw. 2007. Alaska marine mammal stock assessments, 2006. U.S. Dep. Commer., NOAA Tech. Memo. NMFSAFSC-168, 244 p.

Anonymous. 2002. Baffling boing identified. Science. 298:2125.

ANSI. 1976. American National Standards Institute, Inc.. American National Standard Acoustical Terminology. New York.

ANSI. 1992. Engineering Method for the Determination of Sound Power Levels of Noise Sources Using Intensity. ANSI-S12.12-1992.

Antonelis, G.A. and C.H. Fiscus. 1980. The pinnipeds of the California Current. CalCOFI Reports. 21:68-78.

Antonelis, G.A., B.S. Stewart, and W.F. Perryman. 1990 Foraging characteristics of female northern fur seals (*Callorhinus ursinus*) and California sea lions (*Zalophus californianus*). Canadian Journal of Zoology. 68**:**150-158.

Arons, A.B. 1954. Underwater Explosion Shock Wave Parameters at Large Distances from the Charge. Journal of the Acoustical Society of America. 26:343.Asher, J. M. and C. Steve. 2001. Observations of the Interactions between Bottlenose Dolphins and the North Carolina Stop Net Fishery. First Annual Southeast and Mid-Atlantic Marine Mammal Symposium: 7.

Arruda, J., A. Costidis, S.Cramer, D.R. Ketten, W. McLellan, E.W. Montie, M. Moore, and S. Rommel. 2007. Odontocete Salvage, Necropsy, Ear Extraction, and Imaging Protocols, edited by N.M. Young (Ocean Research, Conservation and Solutions (ORCAS) and ONR), 171 pp.

Arveson, P.T. and D.J. Vendittis. 2006. Radiated noise characteristics of a modern cargo ship. Journal of the Acoustic Society of America. 107:118-129.

Au, W.W.L., J.K.B. Ford, J.K. Horne, K.A. Newman Allman. 2004. Echolocation signals of free-ranging killer whales (*Orcinus orca*) and modeling of foraging for Chinook salmon (*Oncorhynchus tshawytscha*). Journal of the Acoustical Society of America. 115:901-909.

Au, W.W.L. 1993. The sonar of dolphins. Springer-Verlag, New York. 277 pp.

Au, W.W.L, A.A. Pack, M.O. Lammers, L.H. Herman, M.H. Deakos, and K. Andrews. 2006. Acoustic properties of humpback whale songs. Journal of the Acoustical Society of America. 120:1103-1110.

Augier, H. and e. al.. 2001. Evolution of the Metallic Contamination of the Striped Dolphins. *Stenella coeruleoalba*) on the French Mediterranean Coasts between 1990 and 1997. Toxicological and Environmental Chemistry 80(3-4): 189-201.

AUTEC ER. 1995. Environmental Review for the Atlantic Undersea Test and Evaluation Center (AUTEC), Department of the Navy, Naval Undersea Warfare Center, Key West, FL.

Awoodard, J. C., S. G. Zam, D. K. Caldwell and M. C. Caldwell. 1969. Some parasitic diseases of dolphins. Pathologia Veterinaria 6: 257-272.

Babushina, E.S., G.L. Zaslavsky, and L.I. Yurkevich, 1991. Air and underwater hearing of the northern fur seal audiograms and auditory frequency discrimination. Biofizika. 36:904-907. (In Russian with English abstract).

Baird, R.W. and P.J. Stacey. 1993. Sightings, Strandings and Incidental Catches of Short-Finned Pilot Whales, *Globicephala macrorhynchus*, off the British Columbia Coast. Biology of Northern Hemisphere Pilot Whales. G. P. Donovan, C. H. Lockyer and A. R. Martin. Cambridge, International Whaling Commission. 14: 475-479.

Baird, R. W. and T. Guenther. 1995. Account of Harbour Porpoise. *Phocoena phocoena*) Strandings and Bycatches Along the Coast of British Columbia. Reports of the International Whaling Commission Special Issue 16:159-168.

Baird, R. W., D. Nelson, J. Lien and D. W. Nagorsen. 1996. The status of the pygmy sperm whales, *Kogia breviceps*, in Canada. Canadian Field-Naturalist. 110:525-532.

Baird, R. W. and S. K. Hooker. 2000. Ingestion of plastic and unusual prey by a juvenile harbour porpoise. Marine Pollution Bulletin. 40:719-720.

Baird, R.W., P.J. Stacey, D.A. Duffus, and K.M. Langelier. 2002. An evaluation of gray whale (*Eschrichtius robustus*) mortality incidental to fishing operations in British Columbia, Canada. Journal of Cetacean Research and Management. 4:289-296.

Baird, R.W. and A.M. Gorgone. 2005. False Killer Whale Dorsal Fin Disfigurements as a Possible Indicator of Long-Line Fishery Interactions in Hawaiian Waters. Pacific Science. 59:593-601.

Baker, C.S., L. Medrano-Gonzalez, J. Calambokidis, A. Perry, F. Pichler, H. Rosenbaum, J.M. Straley, J. Urban-Ramirez, M. Yamaguchi, and O. Von Ziegesar. 1998. Population structure of nuclear and mitochondrial DNA variation among humpback whales in the North Pacific. Molecular Ecology. 7:695-707.

Baker, C.S. and P.J. Clapham. 2004. Modeling the past and future of whales and whaling. Trends in Ecology and Evolution. 19: 365-371.

Baker, C.S., V. Lukoschek, S. Lavery, M.L. Dalebout, M. Yong-un, T. Endo and N. Funahashi. 2006. Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets. Animal Conservation. 9:474-482.

Balcomb, K.C. and D.E. Claridge. 2001. A mass stranding of cetaceans caused by naval sonar in the Bahamas. Bahamas Journal of Science. 8:2-12.

Barco, S. G. and W. M. Swingle. 2002. A Review of *Tursiops* Strandings with Signs of Fishery Interaction in Virginia. Northeast Regional Stranding Network Annual Meeting & Conference, Mystic Aquarium, Mystic, CT, NOAA.

Bargu, S., C.L. Powell, Z. Wang, G.J. Doucette, and M.W. Silverc. 2008. Note on the occurrence of Pseudo-nitzschia australis and domoic acid in squid from Monterey Bay, CA (USA). Harmful Algae. 7:45-51.

Barlow, J., 1994. Abundance of large whales in California coastal waters: a comparison of ship surveys in 1979/80 and in 1991. Reports of the International Whaling Commission. 44:399-406.

Barlow, J. 1995. The abundance of cetaceans in th California waters. Part I: Ship surveys in summer and fall of 1991. Fishery Bulletin. 93:1-14.

Barlow, J. 1999. Trackline detection probability for long-diving whales. Pages 209-221 in G.W. Garner, S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald, and D.G. Robertson, eds. Marine mammal survey and assessment methods. Brookfield, Vermont: A.A. Balkema.

Barlow, J., and B.L. Taylor. 2005. Estimates of sperm whale abundance in the northeastern temperate Pacific from a combined acoustic and visual survey. Marine Mammal Science. 21:429-445.

Barlow, J. and R. Gisiner. 2006. Mitigating, monitoring and assessing the effects of anthropogenic sound on beaked whales. Journal of Cetacean Management and Research. 7: 239–249.

Barlow, J. 2007. Recalculation of Southern California cetacean density estimates based on NMFS survey data through 2005. Unpublished report prepared by the NMFS-South West Fisheries Science Center for the Comander, Pacific Fleet, Department of the Navy.

Barlow, J. and K.A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. Fisheries Bulletin. 105:509–526.

Barros, N. B., D. K. Odell and G. W. Patton. 1989. Ingestion of Plastic Debris by Stranded Marine Mammals from Florida. Proceedings of the Second International Conference on Marine Debris, NOAA/NMFS, NOAA-TM-NMFS-SWFSC-154.

Bartholomew, G.A., and C.L. Hubbs. 1960. Population growth and seasonal movements of the northern elephant seal, *Mirounga angustirostris* (1). Mammalia. 24:313-324.

Bartholomew, G.A., and N.E. Collias. 1962. The role of vocalization in the social behavior of the northern elephant seal. Animal Behaviour. 10:7-14.

Bauer, G.B., M. Fuller, A. Perry, J.R. Dunn, and J. Zoeger. 1985. Magnetoreception and biomineralization of magnetite in cetaceans. IN: J.L. Kirschvink, D.S. Jones and B.J. MacFadden, eds. Magnetite Biomineralization and Magnetoreception in Organisms. Plenum Press, New York. pp. 489-507.

Bauer, G. B., J. R. Mobley and L. M. Herman. 1993. Responses of Wintering Humpback Whales to Vessel Traffic. 126th Meeting: Acoustical Society of America, The Journal of the Acoustical Society of America.

Baumgartner, M.F., K.D. Mullin, L.N. May, and T.D. Leming. 2001. Cetacean habitats in the northern Gulf of Mexico. Fishery Bulletin. 99:219-239.

Baumgartner, M.F., and B.R. Mate. 2003. Summertime foraging ecology of North Atlantic right whales. Marine Ecology Progress Series. 264:123-135.

Beamish, P., and E. Mitchell. 1973. Short pulse length audio frequency sounds recorded in the presence of a minke whale (*Balaenoptera acutorostrata*). Deep-Sea Research. 20:375-386.

Beddington, J. R., R. J. H. Beverton and D. M. Lavigne. 1985. Marine mammals and fisheries. London ; Boston, G. Allen & Unwin.

Bejder, L., S. M. Dawson and J. A. Harraway. 1999. Responses by Hector's Dolphins to Boats and Swimmers in Porpoise Bay, New Zealand. Marine Mammal Science. 15(3): 738-750.

Bell, J. T., A. A. Hohn, W. A. McLellan, S. G. Barco, D. Borggaard, A. Friedlander, S. Knowles, D. A. Pabst and K. M. Touhey. 2001. Effects of *Tursiops* Abundance and Gillnet Fishing Activity on *Tursiops* Strandings Along the Coasts of North Carolina, Virginia, and Maryland. First Annual Southeast and Mid-Atlantic Marine Mammal Symposium: 8.

Benoit-Bird, K.J. 2004. Prey caloric value and predator energy needs: foraging predictions for wild spinner dolphins. Marine Biology. 45:435–444.

Benoit-Bird, K. J., W. W. L. Au, R. E. Brainard and M. O. Lammers. 2001. Diel horizontal migration of the Hawaiian mesopelagic boundary community observed acoustically. Marine Ecology Progress Series. 217:1-14.

Benoit-Bird, K.J. and W.W.L. Au. 2003. Prey dynamics affect foraging by a pelagic predator (*Stenella longirotris*) over a range of spatial and temporal scales. Behavioral Ecology and Sociobiology. 53:364-373.

Beranek, L.L. 1986. Acoustics. American Institute of Physics, Inc., New York.

Bergman, A., A. Bergstrand, and A. Bignert. 2001. Renal lesions in Baltic grey seals (*Halichoerus grypus*) and ringed seals (*Phoca hispida botnica*). Ambio. 30:397-409.

Berkes, F. 1977. Turkish dolphin fisheries. Oryx. 14:163-167.

Bernard, H.J., and S.B. Reilly. 1999. Pilot whales Globicephala Lesson, 1828. Pages 245-279 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises. San Diego: Academic Press.

Berrow, S. D. and E. Rogan. 1997. Review of Cetaceans Stranded on the Irish Coast, 1901-95. Mammal Review. 27(1): 51-76.

Best, P.B., D.S. Butterworth, and L.H. Rickett. 1984. An assessment cruise for the South African inshore stock of Bryde's whales (*Balaenoptera edeni*). Reports of the International Whaling Commission. 34:403-423.

Bjorndal, K. A., A. B. Bolten and C. J. Lagueux. 1994. Ingestion of Marine Debris by Juvenile Sea Turtles in Coastal Florida Habitats. Marine Pollution Bulletin. 28(3): 154-198.

Boreman, J. and S. Brady. 1992. Sea Turtle Sightings, Strandings, and Entanglements in the Northeast Region of the United States. Amherst, Department of Forestry and Wildlife Management-University of Massachusetts: 7.

Borggaard, D., J. Lien, and P. Stevick. 1999. Assessing the effects of industrial activity on large cetaceans in Trinity Bay, Newfoundland (1992-1995). Aquatic Mammals. 25:149-161.

Borell, A. 1993. PCB and DDTs in blubber of cetaceans from the northeastern North Atlantic. Marine Pollution Bulletin. 26:146-151.

Borrell, A. and A. Aguilar. 1990. Loss of organochlorine compounds in the tissues of a decomposing stranded dolphin. Bull. Environ. Contam. Toxicol. 45: 46-53.Borrooah, V. K. 2002. Logit and probit. Ordered and multinomial models. SAGE Publications, Inc., Newbury Park, California.

Bossart, G., G. Hensley, J.D. Goldstein, K. Kroll, C.A. Manire, R.H. Defran and J.S. Reif. 2007. Cardiomyopathy and myocardial degeneration in stranded pygmy sperm whales (*Kogia breviceps*) and dwarf (*Kogia sima*) sperm whales. Aquatic Mammals. 3:214-222.

Bowen, W.D., C.A. Beck, and D.A. Austin. 2002. Pinniped ecology. Pages 911-921 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego: Academic Press.

Brabyn, M.W. and I.G. McLean. 1992. Oceanography and Coastal Topography of Herd-Stranding Sites for Whales in New Zealand. Journal of Mammalogy. 73:469-476.

Brabyn, M.W. and R.V.C. Frew. 1994. New Zealand Herd Stranding Sites Do Not Relate to Geomagnetic Topography. Marine Mammal Science. 10:195-207.

Bradshaw, C.J.A., K. Evans and M.A. Hindell. 2006. Mass Cetacean Strandings—a Plea for Empiricism. Conservation Biology. 20:584-586.

Braun, R. 2005. Robert Braun, DVM., description of the Hanalai Bay melon-headed whale unusual event on 4 July, 2004, sent to Robert Brownell, NOAA-NMFS.

Bright, D. B. 1972. Stranding of 28 *Globicephala macrorhyncha* Gray at Pyramid Cove, San Clemente Id., Calif., 8 I/71. Bulletin of the Southern California Academy of Science. 70:.

Brimley, H.H. 1937. The false killer whale on the North Carolina coast. Journal of Mammalogy. 18:71-73.

Brodie, E.C., F.M.D. Gulland, D.J. Greig, M. Hunter, J. Jaakola, J.S. Leger, T.A. Leighfield, and F.M.V. Dolah. 2006. Domoic acid causes reproductive failure in California sea lions (*Zalophus californianus*). Marine Mammal Science. 22:700–707.

Brody, A.J., K. Ralls and D.B. Siniff. 1996. Potential impact of oil spills on California sea otters: implications of the Exxon Valdez spill in Alaska. Marine Mammal Science. 12:38-53.

Brooks, R.J. 1979. Lemming behavior: a possible parallel to strandings? Biology of Marine Mammals: Insights through strandings. Marine Mammal Commission Technical Report MMC-77/13:114-128.

Brownell, R.L., P.J. Clapham, T. Miyashita, and T. Kasuya. 2001. Conservation status of North Pacific right whales. Journal of Cetacean Research and Management, Special Issue. 2:269-286.

Brownell, J., R.L., T. Yamada, J.G. Mead and A.L. van Helden. 2004. Mass Strandings of Cuvier's Beaked Whales in Japan: U.S. Naval Acoustic Link? Unpublished Report to the Scientific Committee of the International Whaling Commission. Sorrento, Italy. SC/56E37: 10 pp.

Brownell, R.L., T.K. Yamada, J.G. Mead and B.M. Allen. 2006. Mass stranding of melon-headed whales, *Peponocephala electra*: A worldwide review. Unpublished Report to the Scientific Committee of the International Whaling Commission.: 12 pp.

Brownell, R.L., J.G. Mead, A.L.V. Helden, T.K. Yamada and A. Frantzis. 2005. Worldwide mass strandings of beaked whales: retrospective review and causes. 19th Annual Conference Of The European Cetacean Society And Associated Workshops: Marine mammals and food: from organisms to ecosystems, La Rochelle, France.

Buck, J.D., P.M. Bubucis and S. Spotte. 1988. Microbiological characterization of three Atlantic whiteside dolphins. *Lagenorhynchus acutus*) from stranding through captivity with subsequent rehabilitation and release of one animal. Zoo Biology. 7:133-138.

Buck, J.D. and S. Spotte. 1986. The occurrence of potentially pathogenic vibrios in marine mammals. Marine Mammal Science. 2:319-324.

Buckland, S.T., D.R. Anderson, K.P. Burnham, and J.L. Laake. 1993. Distance sampling. Chapman and Hall: London. 446 p.

Bugoni, L., L. Krause and M.V. Petry. 2001. Marine Debris and Human Impacts on Sea Turtles in Southern Brazil. Marine Pollution Bulletin. 42:1330-1334.

Burgess, W.C., P.L. Tyack, B.J. Le Boeuf, and D.P. Costa. 1998. A programmable acoustic recording tag and first results from free-ranging northern elephant seals. Deep-Sea Research II. 45:1327-1351.

Caddy, J. F., J. Csirke, S. M. Garcia and R. J. R. Grainger. 1998. How pervasive is fishing down marine food webs? Science 282: 1383.

Calambokidis, J., 1995. Blue whales off California. Whalewatcher, Journal of the American Cetacean Society. 29:3-7.

Calambokidis, J. 1997. Humpback whales and the California - Costa Rica connection. Whales. *Journal of the Oceanic Society*. Fall 1997: 4-10.

Calambokidis, J. and J. Barlow. 1991. Chlorinated Hydrocarbon Concentrations and their Use for Describing Population Discreteness in Harbor Porpoises from Washington, Oregon, and California. Marine Mammal Strandings in the United States, Miami, FL, NMFS.

Calambokidis, J. and United States. National Ocean Service. 1984. Chemical contaminants in marine mammals from Washington state. Rockville, Md., U.S. Dept. of Commerce National Oceanic and Atmospheric Administration National Ocean Service.

Calambokidis, J., G.H. Steiger, J.C. Cubbage, K.C. Balcomb, C. Ewald, S. Kruse, R. Wells, and R. Sears, 1990. Sightings and movements of blue whales off central California, 1986–88 from photo-identification of individuals. Reports of the International Whaling Commission, Special Issue 12:343-348.

Calambokidis, J., G.H. Steiger, and J. Barlow, 1993. Estimates of humpback and blue whale abundance along the U.S. west coast using mark-recapture of identified individuals. Abstract *in Abstracts of the 10th Biennial Conference on the Biology of Marine Mammals*; 1993 November; Galveston, TX. p. 34.

Calambokidis, J,; G.H. Steiger, J.M. Straley, L.M. Herman, S. Cerchio, D.R. Salden, J. Urbán R., J.K. Jacobsen, O. Von Ziegesar, K.C. Balcomb, C.M. Gabriele, M.E. Dahlheim, S. Uchida, G. Ellis, Y. Mlyamura, P. Ladrón de guevara P., M. Yamaguchi, F. Sato, S.A. Mizroch, L. Schlender, K. Rasmussen, J. Barlow. 2001. Movements and population structure of humpback whales in the North Pacific. Marine Mammal Science. 17:769–794.

Calambokidis, J., E. Oleson, M. McDonald, B. Burgess, J. Francis, G. Marshall, M. Bakhtiari, and J. Hildebrand. 2003. Feeding and vocal behavior of blue whales determined through simultaneous visual-acoustic monitoring and deployment of suction-cap attached tags. Page 27 in Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals. 14–19 December 2003. Greensboro, North Carolina.

Caldwell, D.K. and M.C. Caldwell. 1980. An Early Mass Stranding of Sperm Whales, *Physeter macrocephalus*, in Northeastern Florida. Cetology. 40: 1-3.

Calzada, N., C.H. Lockyer and A. Aguilar. 1994. Age and Sex Composition of the Striped Dolphin Die-Off in the Western Mediterranean. Marine Mammal Science. 10:299-310.

Campagna, C., V. Falabella and M. Lewis. 2007. Entanglement of southern elephant seals in squid fishing gear. Marine Mammal Science. 23:414-418.

Cannon, A.C., C.T. Fontaine, T.D. Williams, D.B. Revera and C.W. Caillouet. 1994. Incidental Catch of Kemp's Ridley Sea Turtles (*Lepidochelys kempi*), By Hook and Line, Along the Texas Coast, 1980-1992. Thirteenth Annual Symposium on Sea Turtle Biology and Conservation, Jekyll Island, GA. NOAA Technical Memorandum NMFS-SEFSC-341.

Carr, A. 1987. Impact of Nondegradable Marine Debris on the Ecology and Survival Outlook of Sea Turtles. Marine Pollution Bulletin. 18:352-356.

Carretta, J.V., J. Barlow, K.A. Forney, M.M. Muto, and J.Baker. 2001. U.S. Pacific marine mammal stock assessments: 2001. NOAA Technical Memorandum NOAA-TM-NMFS-SWFWC-317.

Carretta, J.V., S.J. Chivers and K. Danil. 2005. Preliminary estimates of marine mammal bycatch, mortality, and biological sampling of cetaceans in California gillnet fisheries for 2004, NOAA, U.S. National Marine Fisheries Service, Southwest Fisheries Science Center.

Carretta, J.V., T. Price, D. Petersen and R. Reid. 2005. Estimates of Marine Mammal, Sea Turtle, and Seabird Mortality in the California Drift Gillnet Fishery for Swordfish and Thresher Shark, 1996-2002. Marine Fisheries Review. 66:21-30.

Carretta, J.V., K.A. Forney, M.M. Muto, J. Barlow, J. Baker, B. Hanson and M.S. Lowry. 2007. U.S. Pacific Marine Mammal Stock Assessments: 2006, National Marine Fisheries Service, Southwest Fisheries Science Center, NOAA-TM-NMFS-SWFSC-398: 321 pp.

Chaloupka, M. and C.J. Limpus. 1998. Simulation Modeling of Trawl Fishery Impacts on SGBR Loggerhead Population Dynamics. Seventeenth Annual Sea Turtle Symposium, Orlando, FL, NOAA Technical Memorandum NMFS-SEFSC-415.

Chambers, S. and R.N. James. 2005. Sonar termination as a cause of mass cetacean strandings in Geographe Bay, south-western Australia. Acoustics 2005, Acoustics in a Changing Environment. Proceedings of the Annual Conference of the Australian Acoustical Society, November 9 - 11, 2005, Busselton, Western Australia.

Chapman, D. M.F. and D.D. Ellis. 1998. The Elusive Decibel: Thoughts on Sonars and Marine Mammals. Canadian Acoustics. 26:29-31.

Charif, R.A., D.K. Mellinger, K.J. Dunsmore, K.M. Fristrup, and C.W. Clark. 2002. Estimated source levels of fin whale (*Balaenoptera physalus*) vocalizations: Adjustments for surface interference. Marine Mammal Science. 18:81-98.

Chatto, R., M. L. Guinea and S. Conway. 1995. Sea Turtles Killed By Flotsam in Northern Australia. Marine Turtle Newsletter 69: 17-18.

Chivers, S.J., R.G. LeDuc, and R.W. Baird. 2003. Hawaiian island populations of false killer whales and short-finned pilot whales revealed by genetic analysis. Page 32 in Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals. 14-1 9 December 2003. Greensboro, North Carolina.

Christian, E.A. and J.B. Gaspin. 1974. Swimmer Safe Standoffs from Underwater Explosions. NSAP Project PHP-11-73, Naval Ordnance Laboratory, Report NOLX-89, 1 July.

Clapham, P.J., S. Leatherwood, I. Szczepaniak, and R.L. Brownell. 1997. Catches of humpback and other whales from shore stations at Moss Landing and Trinidad, California, 1919-1926. Marine Mammal Science. 13:368-394.

Clapham, P.J. and J.G. Mead. 1999. *Megaptera novaeangliae*. Mammalian Species. 604:1-9.

Clapham, P.J., C. Good, S.E. Quinn, R.R. Reeves, J.E. Scarff, and R.L. Brownell. 2004. Distribution of North Pacific right whales (*Eubalaena japonica*) as shown by 19th and 20th century whaling catch and sighting records. Journal of Cetacean Research and Management. 6:1-6.

Clark, C.W. and K.M. Fristrup. 1997. Whales '95: A combined visual and acoustic survey of blue and fin whales off southern California. Reports of the International Whaling Commission. 47:583-600.

Clark, C.W. and P.J. Clapham. 2004. Acoustic monitoring on a humpback whale (*Megaptera novaeangliae*) feeding ground shows continual singing into late spring. Proceedings of the Royal Society of London, Part B. 271:1051-1057.

Clarke, M.R. 1996. Cephalopods as prey. III. Cetaceans. Philosophical Transactions of the Royal Society of London. 351:1053-1065.

Clyne, H. 1999. Computer simulations of interactions between the North Atlantic right whale (*Eubalaena glacialis*) and shipping.

Cockcroft, V.G., G. Cliff, and G.J.B. Ross. 1989. Shark predation on Indian Ocean bottlenose dolphins *Tursiops truncatus* off Natal, South Africa. South African Journal of Zoology. 24:305-310.

Conner, R.C. 2000. Group living in whales and dolphins. IN: J. Mann, R.C. Conner, P.L. Tyack, and H. Whitehead, eds. Cetacean Societies: Field Studies of Dolphins and Whales. University of Chicago Press, Chicago. pp. 199-218.

Consiglio, C., A. Arcangella, B. Cristo, L. Mariani, L. Marini and A. Torchio. 1992. Interactions between bottle-nosed dolphins, *Tursiops truncatus*, and fisheries along North-Eastern coasts of Sardinia, Italy. European Research on Cetaceans 6: 35-36.

Constantine, R., I. Visser, D. Buurman, R. Buurman, and B. McFadden. 1998. Killer whale (*Orcinus orca*) predation on dusky dolphins (*Lagenorhynchus obscurus*) in Kaikoura, New Zealand. Marine Mammal Science. 14:324-330.

Constantine, R. 2001. Increased avoidance of swimmers by wild bottlenose dolphins (*Tursiops truncatus*) due to long-term exposure to swim-with-dolphin tourism. Marine Mammal Sciences 17(4): 689–702.

Cook, M.L.H., R.A. Varela, J.D. Goldstein, S.D. McCulloch, G.D. Bossart, J.J. Finneran, D. Houser, D.A. Mann. 2006. Beaked whale auditory evoked potential hearing measurements. Journal of Comparative Physiology A. 192:489–495.

Corkeron, P.J. and R.C. Connor. 1999. Why do baleen whales migrate? Marine Mammal Science. 15:1228-1245.

Corkeron, P.J. and A.R. Martin. 2004. Ranging and diving behaviour of two 'offshore' bottlenose dolphins, *Tursiops sp*., off eastern Australia. Journal of the Marine Biological Association of the United Kingdom. 84:465-468.

Corkeron, P.J., and S.M. Van Parijs. 2001. Vocalizations of eastern Australian Risso’s dolphins, *Grampus griseus*. Canadian Journal of Zoology. 79:160-164.

Cosens, S. E. and L. P. Dueck. 1987. Responses of Migrating Narwhal and Beluga to Icebreaker Traffic at the Admiralty Inlet Ice-edge, N.W.T. in 1986. Ninth International Conference on Port and Ocean Engineering Under Arctic Conditions, Fairbanks, AK.

Cox, T. M., T. J. Ragen, A. J. Read, E. Vos, R. W. Baird, K. C. Balcomb, J. Barlow, J. Caldwell, T. W. Cranford, L. Crum, A. D'Amico, G. D'Spain, A. Fernández, J. J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. A. Hildebrand, D. Houser, T. Hullar, P. D. Jepson, D. R. Ketten, C. D. MacLeod, P. Miller, S. E. Moore, D. C. Mountain, D. L. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. L. Tyack, D. Wartzok, R. Gisiner, J. G. Mead and L. Benner. 2006. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Management and Research. 7:177–187.

Crocker, D.E., D.P. Costa, B.J. Le Boeuf, P.M. Webb, and D.S. Houser. 2006. Impacts of El Niño on the foraging behavior of female northern elephant seals. Marine Ecology Progress Series. 309:

Crocker, M.J. 1997. Editor, Encyclopedia of Acoustics, John Wiley & Sons, Inc., New York.

Crocker, M.J. and F. Jacobsen. 1997. Sound Intensity. In, Crocker, M. J.. Editor, Encyclopedia of Acoustics. John Wiley & Sons, Inc., New York.

Croll, D.A., A. Acevedo-Gutiérrez, B.R. Tershy, and J. Urbán-Ramírez. 2001a. The diving behavior of blue and fin whales: Is dive duration shorter than expected based on oxygen stores? Comparative Biochemistry and Physiology, Part A. 129:797-809.

Croll D.A., C.W. Clark., J. Calambokidis., W.T. Ellison., and B.R. Tershy. 2001b. Effect of anthropogenic low-frequency noise on the foraging ecology of *Balaenoptera* whales. Animal Conservation. 4:13-27.

Croll, D.A., C.W. Clark, A. Acevedo, B. Tershy, S. Flores, J. Gedamke, and J. Urban. 2002. Only male fin whales sing loud songs. Nature. 417:809.

Crum, L.A., and Y. Mao. 1996. Acoustically enhanced bubble growth at low frequencies and its implications for human diver and marine mammal safety. Journal of the Acoustical Society of America. 99:2898-2907.

Crum, L., S. Kargl and T. Matula. 2004. A potential explanation for marine mammal strandings. Journal of the Acoustical Society of America. 116:2533.

Crum, L.A., M.R. Bailey, J. Guan, P.R. Hilmo, S.G. Kargl, T.J. Matula and O.A. Sapozhnikov. 2005. Monitoring bubble growth in supersaturated blood and tissue ex vivo and the relevance to marine mammal bioeffects. Acoustics Research Letters Online. 6:214-220.

Culik, B.M. 2002. Review on Small Cetaceans: Distribution, Behaviour, Migration and Threats, United Nations Environment Programme, Convention on Migratory Species. Marine Mammal Action Plan/Regional Seas Reports and Studies. No. 177: 343 pp.

Cummings, W.C. 1985. Bryde's whale *Balaenoptera edeni* Anderson, 1878. Pages 137-154 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 3: The sirenians and baleen whales. San Diego: Academic Press.

Curry, B.E. 1999. Stress in mammals: The potential influence of fishery-induced stress on dolphins in the eastern tropical Pacific Ocean. NOAA Technical Memorandum NOAA-TMNMFS-SWFSC-260: 1-121.

D'Amico, A. 1998. Summary Record and Report, SACLANTCEN Bioacoustics Panel, La Spezia, Italy, 15-17 June 1998. La Spezia, Italy, SACLANTCEN: 100.

D'Amico, A., and W.Verboom. 1998. Report of the Bioacoustics Panel, NATO/SACLANT. Pp. 2-1-2-60.

D'Spain, G. and D. Wartzok. 2004. Ocean Noise and Marine Mammals. Acoustic Society of America Tutorial, San Diego, CA, Acoustic Society of America.

D'Spain, G.L., A.D'Amico, and D.M. Fromm. 2006. Properties of the underwater sound fields during some well documented beaked whale mass stranding events. Journal of Cetacean Research and Management. 7:223-238.

Dahlheim, M.E., S. Leatherwood, and W.F. Perrin. 1982. Distribution of killer whales in the warm temperate and tropical eastern Pacific. Reports of the International Whaling Commission. 32:647-653.

Dahlheim, M.E., and J.E. Heyning. 1999. Killer whale *Orcinus orca* (Linnaeus, 1758). Pages 281-322 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises. San Diego: Academic Press.

Daily, M.D. and W.A. Walker. 1978. Parasitism as a factor. ?) in single strandings of southern California cetaceans. Journal of Parasitology 64:593-596.

Dailey, M., M. Walsh, D. Odell and T. Campbell. 1991. Evidence of prenatal infection in the bottlenose dolphin. *Tursiops truncatus*) with the lungworm. *Halocercus lagenorhynchi*. Nematoda: Pseudaliidae. Journal of Wildlife Diseases. 27:164-165.

Dalecki, D., S.Z. Child, and C.H. Raeman. 2002. Lung damage from exposure to low-frequency underwater sound. Journal of the Acoustical Society of America. 111:2462A.

Dalton, R. 2004. Push to protect whales leaves seafloor research high and dry. Nature. 428:681.

Dammerman, K.W. 1924. On Globicephala and some other *Delphinidae* from the Indo-Australian Archipelago. Treubia. 5:340-352.

Darling, J.D. and S. Cerchio. 1993. Movement of a humpback whale (*Megaptera novaeangliae*) between Japan and Hawaii. Marine Mammal Science. 9:84-91.

Das, K., Debacker, V., Pillet, S., and Bouquegneau, J.-M. 2003. Heavy metals in marine mammals, in Toxicology of Marine Mammals, edited by J. G. Vos, G.D. Bossart, M. Fournier, and T.J. O'Shea. Taylor and Francis, London. Pp. 135-167.

Davis, R.W., G.S. Fargion, N. May, T.D. Leming, M. Baumgartner, W.E. Evans, L.J. Hansen, and K. Mullin. 1998. Physical habitat of cetaceans along the continental slope in the north-central and western Gulf of Mexico. Marine Mammal Science. 14:490-507.

De Stephanis, R. and E. Urquiola. 2006. Collisions between ships and cetaceans in Spain, Report to the Scientific Committee of the International Whaling Commission Annual Meeting St Kitts SC/58/BC5: 6 pp.

DeAlteris, J., L. Skrobe and C. Lipsky. 1999. The Significance of Seabed Disturbance by Mobile Fishing Gear Relative to Natural Processes: A Case Study in Narragansett Bay, Rhode Island. Fish Habitat: Essential Fish Habitat and Rehabilitation. L. R. Benaka. Bethesda, MD, American Fisheries Society, Symposium 22: 224-237.

De Guise, S., K.B. Beckmen, and S.D. Holladay. 2003. Contaminants and marine mammal immunotoxicology and pathology, in Toxicology of Marine Mammals, edited by J. G. Vos, G. D. Bossart, M. Fournier, and T. J. O'Shea. Taylor and Francis, London. Pp. 38-54.

DeLong R.L., W.G. Gilmartin, and J.G. Simpson. 1973. Premature births in California sea lions: association with high organochlorine pollutant residue levels. Science. 181:1168-1170.

DeMaster, D., C.W. Fowler, S.L. Perry, and M.F. Richlen. 2001. Predation and competition: The impact of fisheries on marine-mammal populations over the next one hundred years. Journal of Mammalogy. 82:641-651.

De Stephasis, R. and E. Urquiola. 2006. Collisions between ships and cetaceans in Spain. Report to the Scientific Committee, International Whaling Commission. SC/58/BC5

Department of Commerce and Department of the Navy. 2001. Joint Interim Report, Bahamas Marine Mammal Stranding Event of 15-16 March 2000. December.

Department of the Navy. 1997. Environmental Impact Statement for Shock Testing the Seawolf Submarine.

Department of the Navy. 1998. Final Environmental Impact Statement, Shock Testing the SEAWOLF Submarine. U.S. Department of the Navy, Southern Division, Naval Facilities ngineering Command, North Charleston, SC, 637 pp.

Department of the Navy. 1999. Environmental Assessment/Overseas Environmental Assessment of the SH-60R Helicopter/ALFS Test Program, October.

Department of the Navy. 2001a. Environmental Impact Statement for the Shock Trial of the *Winston S. Churchill*, (DDG-81), Department of the Navy.

Department of the Navy. 2001b. Final Environmental Impact Statement for the North Pacific Acoustic Laboratory. Volumes I and II, Department of the Navy.

Department of the Navy. 2001c. Final Overseas Environmental Impact Statement and Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar. Department of the Navy, Chief of Naval Operations. January 2001.

Department of the Navy. 2002a. Marine resource assessment for the Cherry Point Operating Area. Contract Number N62470-95-D-1160. Prepared for the Commander, U.S. Atlantic Fleet, Norfolk, Virginia by Geo-Marine, Inc., Plano, Texas.

Department of the Navy. 2002b. National Oceanic and Atmospheric Administration/National Marine Fisheries Service, Taking Marine Mammals Incidental to Navy Operations of Surveillance Towed Array Sensor System Low Frequency Active Sonar; Final Rule. Federal Register: July 16, 2002 (Volume 67, Number 136, Page 46711-46789).

Department of the Navy. 2005a. *Marine Resources* Assessment for the Hawaiian Islands Operating Area, Draft Report, Department of the Navy, Commander. U.S. Pacific Fleet . July.

Department of the Navy. 2005b. Draft *Overseas Environmental Impact Statement/Environmental Impact Statement (OEIS/EIS), Undersea Warfare Training Range.* Department of the Navy, Commander, U.S. Atlantic Fleet.

Department of the Navy. 2006a. 2006 Supplement to the 2002 RIMPAC Programmatic Environmental Assessment. Department of the Navy, Commander, Third Fleet.

Department of the Navy. 2006b. Undersea Warfare Exercise (USWEX) EA/OEA. Department of the Navy, Commander, Third Fleet.

Department of Navy/Department of Commerce. 2001. Joint Interim Report Bahamas Marine Mammal Stranding Event of 15-16 March 2000. D.L. Evans, U.S. Dept. of Commerce, Secretary; G.R. England, Secretary of the Navy. December, 2001.

De Swart, R.L., T.C. Harder, P.S. Ross, H.W. Vos, and A.D.M.E. Osterhaus. 1995. Morbilliviruses and morbillivirus diseases of marine mammals. Infectious Agents and Disease. 4:125-130.

Dierauf, L.A. and F.M.D. Gulland. 2001. Marine Mammal Unusual Mortality Events. IN: L.A. Dierauf and F.M.D. Gulland, eds. Handbook of Marine Mammal Medicine. CRC Press, Boca Raton. pp. 69-81.

Dietz, R., J. Teilmann, M.-P.H. Jørgensen, and M.V. Jensen. 2002. Satellite tracking of humpback whales in West Greenland. National Environmental Research Institute Technical Report 411:1-38. Copenhagen, Denmark: National Environmental Research Institute.

Di Guardo, G., and G. Marruchella. 2005. Sonars, Gas Bubbles, and Cetacean Deaths. Letters to the Editor. Veterinary Pathology. 42:517 – 518.

Di Guardo, G., M. Castagnaro, G. Marruchella, S. Mazzariol, W. Mignone, V. Olivieri, P. Ponzio and B. Cozzi. 2006. Human-Induced Mortality in Cetaceans Found Stranded on the Italian Coastline. 1995-2005), Report to the Scientific Committee of the International Whaling Commission Annual Meeting St Kitts SC/58/BC1: 3 pp.

Di Natale, A. 1992. Impact of fisheries on cetaceans in the Mediterranean Sea. European Research on Cetaceans 6: 18.

Dierauf, L. A. and F. M. D. Gulland. 2001. Marine Mammal Unusual Mortality Events. CRC Handbook of Marine Mammal Medicine. Boca Raton, FL, CRC Press.

Dobson, A. J. 2002. An introduction to generalized linear models. Second Edition. Chapman and Hall, CRC Press. Boca Raton, Florida.

Dohl, T.P., R.C. Guess, M.L. Duman, and R.C. Helm, 1983. Cetaceans of central and northern California, 1980-1983: status, abundance and distribution. *OCS Study MMS 84-0045*. Report from the Center for Marine Studies, University of California, Santa Cruz, CA, for U.S. Minerals Management Service, Pacific Region OCS, Los Angeles, CA. 284 pp. NTIS PB85-183861

Dolar, M.L.L., W.A. Walker, G.L. Kooyman and W.F. Perrin. 2003. Comparative feeding ecology of spinner dolphins (*Stenella longirostris*) and Fraser's dolphins (*Lagenodelphis hosei*) in the Sulu Sea. Marine Mammal Science. 19:1-19.

Dolphin, W.F. 1987. Ventilation and dive patterns of humpback whales, *Megaptera novaeangliae*, on their Alaskan feeding grounds. Canadian Journal of Zoology. 65:83-90.

Domingo, M., M. Vilafranca, J. Vista, N. Prats, A. Trudgett, and I. Visser. 1992. Pathologic and immunocytochemical studies of morbillivirus infection in striped dolphin. *Stenella coeruleoalba*. Veterinary Pathology 29:1-10.

Donovan, G.P. 1991. A review of IWC stock boundaries. Reports of the International Whaling Commission, Special Issue. 13:39-63.

Dorne, J. L. C. M., and A. G. Renwick. 2005. The refinement of uncertainty/safety factors in risk assessment by the incorporation of data on toxicokinetic variability in humans. Toxicological Sciences. 86:20-26.

Dorsey, E. M. 1983. Exclusive adjoining ranges in individually identified minke whales (*Balaenoptera acutorostrata*) in Washington state. Canadian Journal of Zoology. 61:174-181.

Dudok van Heel, W.H. 1966. Navigation in Cetaceans. IN: K.S. Norris, eds. Whales, Dolphins, and Porpoises. University of California Press, Berkeley, CA. pp. 597-606.

Duignan, P.J., C. House, J.R. Geraci, G. Early, H.G. Copland, M.T. Walsh, G.D. Bossart, C. Cray, S. Sadove, D.J. St. Aubin and M. Moore. 1995. Morbillivirus Infection in Two Species of Pilot Whales. *Globicephala* sp.) from the Western Atlantic. Marine Mammal Science. 11:150-162.

Duignan, P.J., C. House, D.K. Odell, R.S. Wells, L.J. Hansen, M.T. Walsh, D.J. St. Aubin, B.K. Rima and J.R. Geraci. 1996. Morbillivirus Infection in Bottlenose Dolphins: Evidence for Recurrent Epizootics in the Western Atlantic and Gulf of Mexico. Marine Mammal Science. 12:499-515.

Dunn, J.L., J.D. Buck, and T.R. Robeck. 2001. Bacterial diseases of cetaceans and pinnipeds. IN: L.A. Dierauf and F.M.D. Gulland, eds. CRC Handbook of Marine Mammal Medicine. CRC Press, Boca Raton, FL.

Durban, E., G.J. Teegarden, R. Campbell, A. Cembella, M.F. Baumgartner and B.R. Mate. 2002. North Atlantic right whale, *Eubalaena glacialis*, exposed to paralytic shellfish poisoning (PSP) toxins via a zooplankton vector, *Calanus finmarchincus*. Harmful Algae. 1:243-251.

Edds, P.L. and J.A.F. Macfarlane. 1987. Occurrence and general behavior of balaenopterid cetaceans summering in the St. Lawrence Estuary, Canada. Bioacoustics. 1:131-149.

Eliason, S.R. 1993. Maximum likelihood estimation. Logic and practice. SAGE Publications, Inc., Newbury Park, California.

Ellis, R. 1987. Why do Whales Strand? Oceans: 24-29.

Endo, T., O. Kimura, Y. Hisamichi, Y. Minoshima and K. Haraguchi. 2007. Age-dependent accumulation of heavy metals in a pod of killer whales. *Orcinus orca*) stranded in the northern area of Japan. Chemosphere. 67:51-59.

England, D. L. and G. R. Evans. 2001. Joint Interim Report Bahamas Marine Mammal Stranding Event of 15-16 March 2000, Report to US Department of Commerce. National Oceanic and Atmospheric Administration) and Secretary of the Navy: 59 pp.

Environmental Protection Agency. 1998. Guidelines for ecological risk assessment. Federal Register 63:26846 – 26924; OSHA occupational noise regulations at 29 CFR 1910.95.

Estes, J.A., B.B. Hatfield, K. Ralls and J. Ames. 2003. Causes of mortality in California sea otters during periods of population growth and decline. Marine Mammal Science. 19:198-216.

Evans, D.L. 2002. Report of the Workshop on Acoustic Resonance as a Source of Tissue Trauma in Cetaceans. Silver Spring, MD.

Evans, D.L. and G.R. England. 2001. Joint Interim Report Bahamas Marine Mammal Stranding Event of 15-16 March 2000. Department of Commerce. 66 pp.

Evans, G.H., and L.A. Miller. 2004. Proceedings of the Workshop on Active Sonar and Cetaceans. European Cetacean Society Newsletter. No. 42 Special Issue – February 2004.

Evans, K., R. Thresher, R.M. Warneke, C.J.A. Bradshaw, M. Pook, D. Thiele and M.A. Hindell. 2005. Periodic variability in cetacean strandings: links to large-scale climate events. Biology Letter. 1:147-150.

Fahlman, A., A. Olszowka, B. Bostrom, and D.R. Jones. 2006. Deep diving mammals: dive behavior and circulatory adjustments contribute to bends avoidance. Respiratory Physiology and Neurobiology. 153:66-77.

Fahy, F.J. 1995. Sound Intensity. E and FN Spon, London.

Fair, P. and P.R. Becker. 2000. Review of Stress in Marine Mammals. Journal of Aquatic Ecosystem Stress and Recovery. 7:335-354.

Feldkamp, S.D., R.L. DeLong, and G.A. Antonelis. 1989. Diving patterns of California sea lions, *Zalophuscalifornianus*. Canadian Journal of Zoology. 67:872-883.

Ferguson, M.C., and J. Barlow. 2001. Spatial distribution and density of cetaceans in the eastern tropical Pacific Ocean based on summer/fall research vessel surveys in 1986-1996. Southwest Fisheries Science Center Administrative Report LJ-01-04. La Jolla, California: National Marine Fisheries Service.

Fernández, A., M. Arbelo, E. Sierra, M. Méndez, F. Rodríguez and P. Herráez. 2004. Pathological study of a mass stranding of beaked whales associated with military naval exercises. Canary Islands, 2002. Policy on Sound and Marine Mammals: An International Workshop, London, England, U.S. Marine Mammal Commission-Joint Nature Conservation Committee, U.K.

Fernández, A., J.F. Edwards, F. Rodreguez, A. Espinosa de los Monteros, P. Herreez, P. Castro, J. R. Jaber, V. Marten and M. Arbelo. 2005. Gas and Fat Embolic Syndrome Involving a Mass Stranding of Beaked Whales. Family Ziphiidae) Exposed to Anthropogenic Sonar Signals. Veterinary Pathology. 42:446-457.

Fernández, M., J. Aznar, J.A. Balbuena and J.A. Raga. 1991. Parasites collected in the striped dolphin die-off in the Spanish Mediterranean. 5:101-104.

Fertl, D. and S. Leatherwood. 1997. Cetacean interactions with trawls: A preliminary review. Journal of Northwest Atlantic Fishery Science. 22: 219-248.

Fiedler, P.C., S.B. Reilly, R.P. Hewitt, D. Demer, V.A. Philbrick, S. Smith, W. Armstrong, D.A. Croll, B.R. Tershy, and B.R. Mate, 1998. Blue whale habitat and prey in the California Channel Islands. *Deep-Sea Research II* 45:1781-1801.

Fillmann, G., L. Hermanns, T.W. Fileman and J.W. Readman. 2007. Accumulation patterns of organochlorines in juveniles of Arctocephalus australis found stranded along the coast of Southern Brazil. Environmental Pollution. 146: 262-267.

Finneran, J.J., and C.E. Schlundt. 2004. Effects of intense pure tones on the behavior of trained odontocetes. Space and Naval Warfare Systems Center, San Diego, Technical Document. September.

Finneran, J.J., C.E. Schlundt, D.A. Carder, J.A. Clark, J.A. Young, J.B. Gaspin, and S.H. Ridgway. 2000. Auditory and behavioral responses of bottlenose dolphins (*Tursiops truncatus*) and a beluga whale (*Delphinapterus leucas*) to impulsive sounds resembling distant signatures of underwater explosions. Journal of the Acoustical Society of America. 108:417-431.

Finneran, J.J., D.A. Carder, and S.H. Ridgway. 2001. Temporary threshold shift (TTS) in bottlenose dolphins *Tursiops truncatus* exposed to tonal signals. Journal of the Acoustical Society of America. 1105:2749(A), 142nd Meeting of the Acoustical Society of America, Fort Lauderdale, FL. December.

Finneran, J.J., R. Dear, D.A. Carder, and S.H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. Journal of the Acoustical Society of America. 111:2929-2940.

Finneran, J.J., D.A. Carder, and S.H. Ridgway. 2003. Temporary threshold shift measurements in bottlenose dolphins *Tursiops truncatus*, belugas *Delphinapterus leucas*, and California sea lions *Zalophus californianus*. Environmental Consequences of Underwater Sound (ECOUS) Symposium, San Antonio, TX, 12-16 May 2003.

Finneran, J.J., R. Dear, D.A. Carder, and S.H. Ridgway. 2003. Auditory and behavioral responses of California sea lions (*Zalophus californianus*) to single underwater impulses from an arc-gap transducer. Journal of the Acoustical Society of America. 114:1667-1677.

Finneran, J.J., D.A. Carder, C.E. Schlundt and S.H. Ridgway. 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. Journal of Acoustical Society of America. 118:2696-2705.

Finneran, J.J. and C.E. Schlundt. 2007. Underwater sound pressure variation and bottlenose dolphin (*Tursiops truncatus*) hearing thresholds in a small pool. The Journal of the Acoustical Society of America. 122:606-614.

Finneran, J.J., and D.S. Houser. 2006. Comparison of in-air evoked potential and underwater behavioral hearing thresholds in four bottlenose dolphins (*Tursiops truncatus*). Journal of the Acoustical Society of America. 119:3181-3192.

Finneran, J.J., D.A. Carder, C.E. Schlundt, B. Branstetter, and R.L. Dear. 2007. Assessing temporary threshold shift in a bottlenose dolphin (*Tursiops truncatus*) using multiple simultaneous auditory evoked potentials. The Journal of the Acoustical Society of America. 122:1249-1264.

Finney, D.J. 1971. Probit Analysis, Third Edition. London: Cambridge University Press.

Fiedler, P.C. 2002. Ocean environment. Pages 824-830 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego: Academic Press.

Fish, J.F. and C.W. Turl. 1976. Acoustic source levels of four species of small whales. Naval Undersea Center Report, NUC-TP 547.

Fletcher, S., B.J. Le Boeuf, D.P. Costa, P.L. Tyack, and S.B. Blackwell. 1996. Onboard acoustic recording from diving northern elephant seals. Journal of the Acoustical Society of America. 100:2531-2539.

Flewelling, L. J., J. P. Naar, J. P. Abbott, D. G. Baden, N. B. Barros, G. D. Bossart, M.-Y. D. Bottein, D. G. Hammond, E. M. Haubold, C. A. Heil, M. S. Henry, H. M. Jacocks, T. A. Leighfield, R. H. Pierce, T. D. Pitchford, S. A. Rommel, P. S. Scott, K. A. Steidinger, E. W. Truby, F. M. Van Dolah and J. H. Landsberg. 2005. Brevetoxicosis: Red tides and marine mammal mortalities. Nature. 435: 755-756.

Food and Drug Administration, U.S. Department of Agriculture, and Centers for Disease Control and Prevention. 2001. Draft assessment of the relative risk to public health from foodborne *Listeria monocytogenes* among selected categories of ready-to-eat foods. Food and Drug Administration, Center for Food Safety and Applied Nutrition; U.S. Department of Agriculture, Food Safety and Inspection Service; and Centers for Disease Control and Prevention. Rockville, Maryland and Washington, D.C.

Forcada, J. 2002. Distribution. Pages 327-333 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego: Academic Press.

Ford, J.K.B. 2002. Killer whale *Orcinus orca*. Pages 669-676 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego: Academic Press.

Forney, K.A., D.J. St. Aubin and S.J. Chivers. 2002. Chase encirclement stress studies on dolphins involved in eastern tropical pacific ocean purse-seine operations during 2001. NMFS-SWFSC. Administrative Report LJ-02-32. 27 pp.

Forney, K.A. 2004. Estimates of cetacean mortality and injury in two U.S. Pacific longline fisheries, 1994- 2002. Southwest Fisheries Science Center Administrative Report LJ-04-07. La Jolla, California: National Marine Fisheries Service.

Frankel, A.S. and C.W. Clark. 2002. Behavioral responses of humpback whales (*Megaptera novaeangliae*) to full-scale ATOC signals. Journal of the Acoustical Society of America. 108:1930-1937.

Frankel, A.S. and C.W. Clark. 2002. ATOC and other factors affecting the distribution and abundance of humpback whales (*Megaptera novaeangliae*) off the north shore of Kauai. Marine Mammal Science. 18: 644–662

Frantzis, A. 1998. Does acoustic testing strand whales? Nature. 392:29.

Frantzis, A. 2004. The first mass stranding that was associated with the use of active sonar (Kyparissiakos Gulf, Greece, 1996). In: Proceedings of the workshop. Active sonar and cetaceans. 8 March 2003, Las Palmas, Gran Canaria. ECS newsletter 42(Special Issue):14 – 20.

Friedlander, A., W.A. McLellan and D.A. Pabst. 2001. Characterizing an Interaction Between Coastal Bottlenose Dolphins and the Spot Gillnet Fishery in Southeastern North Carolina. First Annual Southeast and Mid-Atlantic Marine Mammal Symposium: 10.

Freitas, L. 2004. The stranding of three Cuvier's beaked whales *Ziphius caviostris* in Madeira archipelago- May 2000. European Cetacean Society Newsletter 42(Special Issue):28-32.

Frodello, J.P. and B. Marchand. 2001. Cadmium, copper, lead, and zinc in five toothed whale species of the Mediterranean Sea. International Journal of Toxicology. 20:339-343.

Fromm, D. 2004a. Acoustic Modeling Results of the Haro Strait For 5 May 2003. Naval Research Laboratory Report, Office of Naval Research, 30 January 2004.

Fromm, D. 2004b. EEEL Analysis of U.S.S. SHOUP Transmissions in the Haro Strait on 5 May 2003. Naval Research Laboratory briefing of 2 September 2004.

Fuentes, A.L., V.H. Garduno and C. Delgado. 2000. Possible effects of El Nino-southern oscillation on the black turtle nesting population at Michoacan, Mexico. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation, NOAA Technical Memorandum NMFS-SEFSC 443.

Fujii, K., C. Kakumoto, M. Kobayashi, S. Saito, T. Kariya, Y. Watanabe, Y. Sakoda, H. Kida and M. Suzuki. 2007. Serological evidence of influenza A virus infection in Kuril Harbor seals. *Phoca vitulina stejnegeri*) of Hokkaido, Japan. Journal of Vet Medicine and Science 69:259-263.

Gallo-Reynoso, J.-P. 1994. Factors affecting the population status of Guadalupe fur seal, *Arctocephalus townsendi* (Merriam, 1897), at Isla de Guadalupe, Baja California, Mexico. Ph.D. Dissertation, University of California, Santa Cruz, CA. 199 pp.

Gambell, R. 1985. Sei whale *Balaenoptera borealis* Lesson, 1828. Pages 155-170 *in* S.H. Ridgway and R. Harrison (eds.), *Handbook of marine mammals. Volume 3: The Sirenians and baleen whales*. San Diego: Academic Press. 362 pp.

Gannier, A. 2000. Distribution of cetaceans off the Society Islands (French Polynesia) as obtained from dedicated surveys. Aquatic Mammals. 26:111-126.

Gardner, S.C., G. Ylitalo and U. Varanasi. 2007. NOTES: Comparative assessment of organochlorine concentrations in porpoise melon and blubber. Marine Mammal Science 23:434-444.

Gaskin, D.E. 1982. The ecology of whales and dolphins. Portsmouth, New Hampshire: Heinemann.

Gedamke, J., D.P. Costa, and A. Dunstan. 2001. Localization and visual verification of a complex minke whale vocalization. Journal of the Acoustical Society of America. 109:3038-3047.

Geraci, J.R. 1978. The enigma of marine mammal strandings. Oceanus. 21:38-47

Geraci, J. R. 1989. Clinical investigation of the 1987-88 mass mortality of bottlenose dolphins along the U.S. central and south Atlantic coast. Final report to the National Marine

Fisheries Service, U. S. Navy, Office of Naval Research, and Marine Mammal Commission: 63.

Geraci, J.R. and V.J. Lounsbury. 1993. Marine Mammals Ashore: A Field Guide for Strandings. Texas A&M University Sea Grant College Program, Galveston, TX.

Geraci, J. R. and V.J. Lounsbury. 2005. Marine Mammals Ashore: A Field Guide for Strandings (Second Edition) National Aquarium in Baltimore, Baltimore, MD.

Geraci, J. R. and S. H. Ridgway. 1991. On disease transmission between cetaceans and humans. Marine Mammal Science. 7:191-194.

Geraci, J. R. and D. J. St. Aubin. 1979. Stranding Workshop Summary Report: Analysis of Marine Mammal Strandings and Recommendations for a Nationwide Stranding Salvage Program. Marine Mammal Stranding Workshop, Athens, GA, U.S. Marine Mammal Commission.

Geraci, J.R. and D.J. St. Aubin. 1979. Biology of Marine Mammals: Insights Through Strandings. Washington, DC, Marine Mammal Commission: 343.

Geraci, J.R. and D.J. St. Aubin. 1987. Effects of parasites on marine mammals. International Journal of Parasitology. 17:407-414.

Geraci, J.R., J. Harwood and V.J. Lounsbury. 1999. Marine Mammal Die-offs: Causes, Investigations, and Issues. IN: J.R. Twiss and R.R. Reeves, eds., Conservation and Management of Marine Mammals. Washington, DC, Smithsonian Institution Press: 367-395.

Geraci, J.R. and V.J. Lounsbury. 2005. Marine Mammals Ashore: A Field Guide for Strandings. Second Edition), National Aquarium in Baltimore, Baltimore, MD.

Gibson-Hill, C.A. 1950. A note on the Cetacea stranded on the Cocos-Keeling Islands. Bull. Raffles Mus. 22:278-279.

Gilfillan, E. S. 1990. Toxic Effects of Oil and Chemically Dispersed Oil on Marine Animals and Plants. Synthesis of Available Biological, Geological, Chemical, Socioeconomic, and Cultural Resource Information for the South Florida Area. N. W. Phillips and K. S. Larson. Jupiter, FL, Continental Shelf Associates, Inc.: 537-557.

Gillespie, D., and R. Leaper. 2001. Right whale acoustics: Practical applications in conservations. Workshop report. Yarmouth Port, Massachusetts: International Fund for Animal Welfare.Gilman, E., N. Brothers, G. R. McPherson and P. J. Dalzell. 2006. A review of cetacean interactions with longline gear. Journal of Cetacean Management and Research 8:215-223.

Gilmartin WG, R.L. DeLong, A.W. Smith, J.C. Sweeny, B.W. De Lappe, R.W. Risebrough, L.A. Griner, M.D. Dailey, and D.B. Peakall. 1976 Premature parturition in the California sea lion. Journal of Wildlife Diseases. 12**:**104-114.

Gilmore, R. M.. 1957. Whales aground in Cortes' Sea. Pacific Discovery 10:22-27.

Goertner, J.F. 1982. Prediction of underwater explosion safe ranges for sea mammals. NSWC/WOL TR-82-188. Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, MD. 25 pp.

Goertner, J.F. 1982. Prediction of Underwater Explosion Save Ranges for Sea Mammals. Naval Surface Warfare Center (NSWC) Report NSCW TR 82-188, NSWC, Dahlgren, VA.

Goldbogen, J.A., J. Calambokidis, R.E. Shadwick, E.M. Oleson, M.A. McDonald, and J.A Hildebrand. 2006. Kinematics of foraging dives and lunge-feeding in fin whales. The Journal of Experimental Biology. 209:1231-1244.

Goldstein, T., S.P. Johnson, A.V. Phillips, K. D. Hanni, D.A. Fauquier and F.M.D. Gulland. 1999. Human-Related Injuries Observed in Live Stranded Pinnipeds Along the Central California Coast 1986-1998. Aquatic Mammals. 25:43-51.

Goldstein, T.2, J.A. K. Mazet, T.S. Zabka, G. Langlois, K.M. Colegrove, M. Silver, S. Bargu, F. Van Dolah, T. Leighfield, P.A. Conrad, J. Barakos, D.C. Williams, S. Dennison, M. Haulena, and F.M.D. Gulland. 2008. Novel symptomatology and changing epidemiology of domoic acid toxicosis in California sea lions (*Zalophus californianus*): an increasing risk to marine mammal health. Proceedings of the Royal Society B. 275:267–276.

Goodson, A.D. 1997. Developing deterrent devices designed to reduce the mortality of small cetaceans in commercial fishing nets. Marine and Freshwater Behaviour and Physiology. 29:211-236.

Goold, J.C. and Jones, S.E. 1995. Time and frequency domain characteristics of sperm whale clicks. Journal of the Acoustical Society of America. 98:1279-1291.

Gorzelany, J.F. 1998. Unusual deaths of two free-ranging Atlantic bottlenose dolphins (*Tursiops truncatus*) related to ingestion of recreational fishing gear. Marine Mammal Science. 14:614-617.

Gorzelany, J.F. 1998. Unusual deaths of two free-ranging Atlantic bottlenose dolphins (*Tursiops truncatus*) related to ingestion of recreational fishing gear. Marine Mammal Science. 14.614-617.

Grachev, M.A. V.P. Kumarev, L.Mamaev, V.L. Zorin, L.V. Baranova, N.N. Denikina, S.I. Belikov, E.A. Petrov, V.S. Kolesnik, R.S. Kolesnik, V.M. Dorofeev, A.M.Beim, V.N. Kudelin, F.G. Nagieva, and V.N. Sidorov. 1989. Distemper virus in Baikal seals. Nature 338:209.

Green, D.M. and J.A. Swets. 1974. Signal Detection Theory and Psychophysics. Robert E. Krieger Publishing, Huntington

Greig, D. J., F. M. D. Gulland and C. Kreuder. 2005. A decade of live California sea lion. *Zalophus californianus*) strandings along the central California coast: Causes and trends, 1991-2000. Aquatic Mammals 31:11-22.

Guinet, C., L.G. Barrett-Lennard, and B. Loyer, 2000. Co-ordinated attack behavior and prey sharing by killer whales at Crozet Archipelago:strategies for feeding on negatively-buoyant prey. Marine Mammal Science. 16:829-834.

Gulland, F.M.D. 2006. Review of the Marine Mammal Unusual Mortality Event Response Program of the National Marine Fisheries Service. Report to the Office of Protected Resources, NOAA/National Marine Fisheries Service, Silver Springs, MD. 32 pp.

Gulland, F.M.D. and A.J. Hall. 2005. The Role of Infectious Disease in Influencing Status and Trends. IN: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery, T.J. Ragen. Marine Mammal Research. John Hopkins University Press, Baltimore. pp. 47-61.

Gulland, F.M.D. and A.J. Hall. 2007. Is marine mammal health deteriorating? Trends in global reporting of marine mammal disease. EcoHealth. 4:135-150.

Gulland, F.M.D., M. Koski, L.J. Lowenstine, A. Colagross, L. Morgan, and T. Spraker. 1996. Leptospirosis in California sea lions (*Zalophus californianus*) stranded in central California, 1981-1994. Journal of Wildlife Diseases 32:572-580.

Gunther, E.R. 1949. The habits of fin whales. Discovery Reports. 24:115-141.

Haast, J. 1870. Preliminary notice of a ziphioid whale, probably *Berardius arnuxii*, stranded on the 16th of December 1868, on the sea-beach, near New Brighton, Canterbury, New Zealand Annual Magazine Natural History. 6:348-351.

Haines, M. M., S. A. Stansfeld, J. Head, and R. F. S. Job. 2002. Multilevel modeling of aircraft noise on performance tests in schools around Heathrow Airport London. Journal of Epidemiological and Community Health. 56:139-144.

Hanson, M.T., and R.H. Defran. 1993. The behavior and feeding ecology of the Pacific coast bottlenose dolphin, *Tursiops truncatus*. Aquatic Mammals. 19:127-142.

Harvell, C.D., K. Kim, J.M. Burkholder, R.R. Colwell, P.R. Epstein, D.J. Grimes, E.E. Hofmann, E. K. Lipp, A.D.M.E. Osterhaus, R.M. Overstreet, J.W. Porter, G.W. Smith and G.R. Vasta. 1999. Emerging marine diseases-climate links and anthropogenic factors. Science. 285:1505-1510.

Harwood, J. 2002. Mass Die-offs. IN: W.F. Perrin, B. Würsig and J.G.M. Thewissen. Encyclopedia of Marine Mammals. Academic Press, San Diego: pp. 724-726.

Hastie, G.D., B. Wilson and P.M. Thompson. 2005. Diving deep in a foraging hotspot: acoustic insights into bottlenose dolphin dive depths and feeding behaviour. Marine Biology. 148:1181-1188.

Heithaus, M.R. 2001. Shark attacks on bottlenose dolphins (*Tursiops aduncus*) in Shark Bay, Western Australia: Attack rate, bite scar frequencies and attack seasonality. Marine Mammal Science. 17:526-539.

Heimlich, S.L., D.K. Mellinger, S.L. Nieukirk, and C.G. Fox. 2005. Types, distribution, and seasonal occurrence of sounds attributed to Bryde's whales (*Balaenoptera edeni*) recorded in the eastern tropical Pacific, 1999-2001. Journal of the Acoustical Society of America. 118:1830-1837.

Helweg, D.A., A.S. Frankel, J.R. Mobley, and L.H. Herman. 1992. Humpback whale song: Our current understanding. In J.A. Thomas, R.A. Kastelein and Y.A. Supin (eds.), Marine mammal sensory systems. Plenum, New York, NY. 773 pp.

Hersh, SL., and D.A. Duffield. 1990. Distinction between Northwest Atlantic offshore and coastal bottlenose dolphins based on hemoglobin profile and morphometry. Pages 129-139 *in* S. Leatherwood and R. R. Reeves, eds. The bottlenose dolphin. Academic Press, San Diego, CA.

Heyning, J.E. and T.D. Lewis. 1990. Entanglements of baleen whales in fishing gear of southern California, Report to the International Whaling Commission. 40:427-431.

Hildebrand, J. 2004. Impacts of Anthropogenic Sound on Cetaceans, Report to the Scientific Committee of the International Whaling Commission, Sorrento, Italy.

Hildebrand, J., D. Houserp, T. Hullar, P. D. Jepson, D. Ketten, C. D. Macleod, P. Miller, S. Moore, D. C. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Meads and L. Benner. 2005/2006. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Management and Research. 7:177-187.

Hiruki, L.M., M.K. Schwartz, and P.L. Boveng. 1999. Hunting and social behaviour of leopard seals (*Hydrurga leptonyx*) at Seal Island, South Shetland Islands, Antarctica. Journal of Zoology. 249:97-109.

Hoelzel, A.R.E. 2002. Marine Mammal Biology: An Evolutionary Approach. New York, NY, Blackwell.

Hoffman, R.J. 1991. History, goals, and achievements of the regional marine mammal stranding networks in the United States. Pages 7-15. IN: J.E. Reynolds and D.K. Odell, eds. Marine Mammal Strandings in the United States: Proceedings of the Second Marine Mammal Stranding Workshop, 3-5 December 1987, Miami, FL. NOAA Technical ReportNMFS 98.

Hohn, A.A., D.S. Rotstein, C.A. Harms and B.L. Southall. 2006. Report on marine mammal unusual mortality event UMESE0501Sp: Multispecies mass stranding of pilot whales. *Globicephala macrorhynchus*), minke whale. B*alaenoptera acutorostrata*), and dwarf sperm whales. *Kogia sima*) in North Carolina on 15-16 January 2005: 222 pp.

Hooker, S.K. and R.W. Baird. 1999. Deep-diving behaviour of the northern bottlenose whale, *Hyperoodon ampullatus* (Cetacean: Ziphiidae). Proceedings of the Royal Society, London B. 266:671-676.

Hoover-Miller, A., K. R. Parker and J. J. Burns. 2001. A Reassessment of the Impact of the Exxon Valdez Oil Spill on Harbor Seals. *Phoca vitulina richardsi*) in Prince William Sound, Alaska. Marine Mammal Science. 17:111-135.

Holsbeek, L., C. R. Joiris, V. Debacker, I. B. Ali, P. Roose, J.-P. Nellissen, S. Gobert, J. M. Bouquegneau and M. Bossicart. 1999. Heavy metals, organochlorines and polycyclic aromatic hydrocarbons in sperm whales stranded in the southern North Sea during the 1994/1995 winter. Marine Pollution Bulletin. 38:304-313.

Horwood, J. 1987. The sei whale: Population biology, ecology and management. London: Croom Helm.

Horwood, J. 1990. Biology and exploitation of the minke whale. Boca Raton, Florida: CRC Press.

Houser, D. 2007. Evaluation of Harbor Porpoise Behavioral Response Thresholds, U.S. Navy Marine Mammal Program, SPAWAR Systems Center, San Diego.

Houser, D.S., D.A. Helweg, and P.W.B. Moore. 2001. A bandpass filter-bank model of auditory sensitivity in the humpback whale. Aquatic Mammals. 27:82–91.

Houser, D.S., A. Gomez-Rubio, and J.J. Finneran. 2008. Evoked potential audiometry of 13 Pacific bottlenose dolphins (*Tursiops truncates gilli*). Marine Mammal Science. 24:28-41

Huber, H.R., A.C. Rovetta, L.A. Fry, and S. Johnston. 1991. Age-specific natality of northern elephant seals at the South Farallon Islands, California. Journal of Mammalogy. 72:525-534.

International Council for the Exploration of the Seas (ICES). 2005a. Ad-Hoc Group on the Impact of Sonar on Cetaceans- By Correspondence, International Council for the Exploration of the Seas. (ICES) CM 2006/ACE: 25 pp.

ICES. 2005b. Answer to DG Environment request on scientific information concerning impact of sonar activities on cetacean populations. International Council for the Exploration of the Sea. 5 pp.

ICES. 2005c. Interaction of common dolphins *Delphinus delphis* and fisheries in the Northeast Atlantic, International Council for Exploration of the Seas.Irwin, L.-J. 2005. Marine toxins: adverse health effects and biomonitoring with resident coastal dolphins. Aquatic Mammals. 31:195-225.

IWC (International Whaling Commission). 2001. Report of the Workshop on the Comprehensive Assessment of Right Whales: A worldwide comparison. Journal of Cetacean Research and Management, Special Issue. 2:1-60.

Jansen, G. 1998. Physiological effects of noise. In Handbook of Acoustical Measurements and Noise Control, 3rd Edition. New York: Acoustical Society of America.

Jaqiet. N., S. Dawson, and E. Slooten. 2000. Seasonal distribution and diving behaviour of male sperm whales off Kaikoura: Foraging implications. Canadian Journal of Zoology. 78:407-419.

Jasny, M., J. Reynolds, C. Horowitz, and A.Wetzler. 2005. Sounding the Depths II: The rising toll of sonar, shipping, and industrial ocean noise on marine life. Natural Resources Defense Council. 84 pp.

Jauniaux, T., G. Boseret, M. Desmecht, J. Haelters, C. Manteca, J. Tavernier, J. Van Gompel and F. Coignoul. 2001. Morbillivirus in Common Seals Stranded on the Coasts of Belgium and Northern France During Summer 1998. Veterinary Record: 587-591.

Jefferson, T.A., S. Leatherwood, and M.A. Webber. 1993. FAO species identification guide. Marine mammals of the world. Rome: Food and Agriculture Organization of the United Nations.

Jefferson, T. A., S. K. Hung and P. K. S. Lam. 2006. Strandings, mortality and morbidity of Indo-Pacific humpback dolphins in Hong Kong, with emphasis on the role of organochlorine contaminants. Journal of Cetacean Management and Research. 8:181-193.

Jefferson, T.A., D. Fertl, M. Michael, and T.D. Fagin. 2006. An unusual encounter with a mixed school of melon-headed whales (*Peponocephala electra*) and rough-toothed dolphins (*Steno bredanesis*) at Rota, Northern Mariana Islands. Micronesica. 38:239-244.

Jensen, A.S. and G.K. Silber. 2004. Large whale ship strike database. NOAA Technical Memorandum NMFS-OPR-25, January 2004.

Jepson, P. D., M. Arbelo, R.Deaville, I. A. P. Patterson, P. Castro, J. R. Bakers, E. Degollada, H. M. Ross, P. Herraez, A. M. Pocknell, F.Rodriguez, F. E. Howie, A. Espinsoa, R. J. Reid, J. R. Jaber, V.Martin, A. A. Cunningham and A. Fernandez. 2003. Gas-bubble lesions in stranded cetaceans. Nature. 425:575-576.

Jepson, P. D., R. Deaville, T. Patterson, J. R. Baker, H. R. Ross, A. Pocknell, F. Howie, R. J. Reid and A. A. Cunningham. 2003. Novel cetacean gas bubble injuries: acoustically induced decompression sickness? Marine Mammals and Sound: 17th Conference of the European Cetacean Society, Las Palmas de Gran Canaria, Gobierno De Canarias Consejeria De Politica Territorial Y Medio Ambiente Viceconsejería De Medio Ambiente Dirección General de Política Ambiental.

Jepson, P.D., P.M. Bennett, R. Deaville, C.R Allchin, J.R., Baker and R.J. Law. 2005. Relationships between polychlorinated biphenyls and health status in harbor porpoises (*Phocoena phocoena*) stranded in the United kingdom. Environmental Toxicology and Chemistry. 24:238-248.

Johnson, J.H. and T.H. Woodley. 1998. A survey of acoustic harassment device (AHD) use in the Bay of Fundy, NB, Canada. Aquatic Mammals. 24:51-61.

Johnson, T. 2005. Entanglements: the intertwined fates of whales and fishermen. Gainesville, University Press of Florida.

Jones, D. M., and D. E. Broadbent. 1998. Chapter 24. Human peformance and noise. Pages 21 - 24 In: C. M. Harris (ed.). Handbook of acoustical measurements and noise control. Acoustical Society of America, Woodbury, New York.

Jonsgard, A. and P. Hoidal. 1957. Strandings of Sowerby's whale. *Mesoplodon bidens*) on the west coast of Norway. The Norwegian Whaling Gazette. 46:507-512.

Kastak, D., and R. J. Schusterman. 1996. Temporary threshold shift in a harbor seal (*Phoca vitulina*). Journal of the Acoustical Society of America. 100:1905-1908.

Kastak, D., and R. J. Schusterman. 1998. Low-frequency amphibious hearing in pinnipeds: methods, measurements, noise, and ecology. Journal of the Acoustical Society of America. 103:2216-2228.

Kastak, D., and R.J. Schusterman. 1999. In-air and underwater hearing sensitivity of a northern elephant seal (*Mirounga angustirostris*). Canadian Journal of Zoology. 77:1751-1758.

Kastak, D., R. J. Schusterman, B. L. Southall, and C. J. Reichmuth. 1999a. Underwater temporary threshold shift induced by octave-band noise in three species of pinniped. Journal of Acoustical Society of America. 106:1142-1148.

Kastak, D., R. J. Schusterman, B. L. Southall, and C. J. Reichmuth. 1999b. Underwater temporary threshold shift induced by octave-band noise in three species of pinniped. Journal of the Acoustical Society of America. 106:1142-1148.

Kastak D., B.L. Southall, R.J. Schusterman, and C.R. Kastak. 2005. Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration. Journal of the Acoustical Society of America. 118:3154–3163.

Kasuya, T. 1975. Past occurrence of *Globicephala melaena* in the western North Pacific. Scientific Reports of the Whales Research Institute. 27:95-110.

Kasuya, T. 2002. Giant beaked whales *Berardius bairdii* and *B. arnuxii*. Pages 519-522 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego: Academic Press.

Kasuya, T., T. Miyashita, and F. Kasamatsu. 1988. Segregation of two forms of short-finned pilot whales off the Pacific Coast of Japan. Scientific Reports of the Whales Research Institute. 39:77-90.

Kasuya, T. 2007. Japanese whaling and other cetacean fisheries. Environmental Science and Pollution Research 14:39-48.

Kato, H. 2002. Bryde's whales *Balaenoptera edeni* and *B. brydei*. Pages 171 -176 in W.F. Perrin, B. Wursig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego: Academic Press.

Katona, S.K., and S.D. Kraus. 1999. Efforts to conserve the North Atlantic right whale. In Conservation and Management of Marine Mammals, eds. J.R. Twiss, Jr. and R.R. Reeves, 311–331. Washington, DC: Smithsonian Institution Press.

Keeler, J.S. 1976. Models for noise-induced hearing loss. In Effects of Noise on Hearing, ed. Henderson et al., 361–381. New York: Raven Press.

Keenan, R.E. 2000. An Introduction to GRAB Eigenrays and CASS Reverberation and Signal Excess. Science Applications International Corporation, MA.

Kennedy, S. 1996. Infectious Diseases of Cetacean Populations. The Conservation of Whales and Dolphins: Science and Practice. M.P. Simmonds and J. D. Hutchinson. New York, John Wiley & Sons: 333-354.

Kennedy, S., T. Kuiken, P.D. Jepson, R. Deaville, M. Forsyth, T. Barrett, M.W.G. vande Bildt, A.D.M.E. Osterhaus, T. Eybatov, C. Duck, A. Kydyrmanov, I. Mitrofanov, and S. Wilson. 2000. Mass die-off of Caspian seals caused by canine distemper virus. Emerging Infectious Diseases. 6:637-639.

Kennett, J.P. 1982. Marine geology. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Kenney, R.D., and H.E. Winn. 1987. Cetacean biomass densities near submarine canyons compared to adjacent shelf/slope areas. Continental Shelf Research. 7:107-114.

Kenney, R.D., P.M. Payne, D.W. Heinemann, and H.E. Winn. 1996. Shifts in northeast shelf cetacean distributions relative to trends in Gulf of Maine/Georges Bank finfish abundance. Pages 169-196 in K. Sherman, N.A. Jaworski, and T.J. Smayda, eds. The northeast shelf ecosystem: assessment, sustainability, and management. Boston: Blackwell Science.

Ketten, D.R. 1992. The marine mammal ear: Specializations for aquatic audition and echolocation. Pages 717-750 in D. Webster, R. Fay, and A. Popper, eds. The evolutionary biology of hearing. Berlin: Springer-Verlag.

Ketten, D.R. 1997. Structure and functions in whale ears. Bioacoustics. 8:103-135.

Ketten, D.R. 1998. Marine mammal auditory systems: A summary of audiometric and anatomical data and its implications for underwater acoustic impacts. NOAA-TM-NMFS-SWFSC-256, Department of Commerce.

Ketten, D. 2005. Beaked whale necropsy findings for strandings in the Bahamas, Puerto Rico, and Madeira, 1999-2002. Woods Hole Oceanographic Institution, Woods Hole, MA. Pp. 36.

Kinsler, L.E. and A.R. Frey. 1962. Fundamentals of Acoustics. John Wiley and Sons, New York

Kirkwood, J. K., P. M. Bennett, T. Kuiken, V. R. Simpson and J. R. Baker. 1997. Entanglement in fishing gear and other causes of death in cetaceans stranded on the coasts of England and Wales. The Veterinary Record 141:94-98.

Kirshvink, J.L. 1990. Geomagnetic sensitivity in cetaceans: an update with live stranding records in the United States. Sensory Abilities of Cetaceans: Laboratory and Field Evidence (ed. J.A. Thomas and R.A. Kastelein), pp 639-649. Plenum Press, NY.

Kirshvink, J.L., A.E. Dizon, and J.A. Westphal. 1986. Evidence from strandings for geomagnetic sensitivity in cetaceans. Journal of Experimental Biology. 120:1-24.

Kishiro, T. 1996. Movements of marked Bryde's whales in the western North Pacific. Reports of the International Whaling Commission. 46:421-428.

Kiyota, M., N. Baba, and M. Mouri. 1992. Occurrence of an elephant seal in Japan. Marine Mammal Science. 8:433.

Klatsky, L.J., R.S. Wells, and J.C. Sweeney. 2007. Offshore bottlenose dolphins (*Tursiops truncatus*): movement and dive behavior near the bermuda pedestal. Journal of Mammalogy**.** 88:59-66.

Klinowska, M. 1985. Cetacean Live Stranding Sites Relate to Geomagnetic Topography. Aquatic Mammals. 11:27-32.

Klinowska, M. 1986. Cetacean Live Stranding Dates Relate to Geomagnetic Disturbances. Aquatic Mammals. 11:109-119.

Kirschvink, J.L., A.E. Dizon, J.A. Westphal. 1986. Evidence from strandings for geomagnetic sensitivity in cetaceans. Journal of Experimental Biology. 120:1-24.

Knap, A. H. and T. D. Jickells. 1983. Trace Metals and Organochlorides in the Goosebeaked Whale. Marine Pollution Bulletin. 14:271-274.

Knowlton, A.R., and Kraus, S.D. 2001. Mortality and serious injury of northern right whales (Eubalaena glacialis) in the western North Atlantic Ocean. Journal of Cetacean Research and Management (Special Issue). 2:193-208.

Knowlton, A.R., C.W. Clark, and S.D. Kruse. 1991. Sounds recorded in the presence of sei whales, *Balaenoptera borealis*. Abstract. Ninth Biennial Conference on the Biology of Marine Mammals, Chicago, IL. pp. 76.

Knowlton, A.R., F.T. Korsmeyer, J.E. Kerwin, H.Y.Wu, and B. Hynes. 1995. The hydrodynamic effects of large vessels on right whales. Final Report to NOAA Fisheries. NMFS Contract No. 40EANFF400534. 81 p.

Kompanje, E.J.O. 1995. On the occurrence of spondylosis deformans in white-beaked dolphins Lagenorhynchus albirostris (Gray, 1846) stranded on the Dutch coast. Zooligische Mededekingen Leiden. 69:231-250.

Kooyman, G.L., D.D. Hammond, and J.P. Schroeder. 1970. Brochogramks and tracheograms of seals under pressure. Science. 169:82-84.

Kopelman, A.H., and S.S. Sadove. 1995. Ventilatory rate differences between surface-feeding and nonsurface-feeding fin whales (*Balaenoptera physalus*) in the waters off eastern Long Island, New York, U.S.A., 1981-1987. Marine Mammal Science. 11:200-208.

Krausman, P. R., L. K. Harris, C. L. Blasch, K. K. G. Koenen, and J. Francine. 2004. Effects of military operations on behavior and hearing of endangered Sonoran pronghorn. Wildlife Monographs. 1-41.

Krewski, D., C. Brown, and D. Murdoch. 1984. Determining "safe" levels of exposure: safety factors or mathematical models? Toxicological Sciences 4:383-394.

Kruse, S., D.K. Caldwell, and M.C. Caldwell. 1999. Risso's dolphin *Grampus griseus* (G. Cuvier, 1812). Pages 183-212 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises. San Diego: Academic Press.

Kryter, K.D. W.D. Ward, J.D. Miller, and D.H. Eldredge. 1966. Hazardous exposure to intermittent and steady-state noise. Journal of the Acoustical Society of America. 48:513-523.

Kryter, K.D. 1970. The Effects of Noise on Man. Academic Press, New York.

Krysl, P., T.W. Cranford, S.M. Wiggins and J.A. Hildebrand. 2006. Simulating the effect of high-intensity sound on cetaceans: Modeling approach and a case study for Cuvier's beaked whale. *Ziphius cavirostris*. Journal of Acoustic Society of America. 120:2328-2339.

Lahvis, G.P., R.S., Wells, D.W. Kuehl, J.L. Stewart, H.L Rhinehart, and C.S. Via. 1995. Decreased lymphocyte responses in free-ranging bottlenose dolphins (*Tursiops truncatus*) are associated with increased concentrations of PCBs and DDT in peripheral blood," Environmental Health Perspectives. 103:67-72.

Laist, D.W. 1997. Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. Marine Debris: Sources, Impacts, and Solutions: 99-139.

Laist, D.W., J.M. Coe and K.J. O'Hara. 1999. Marine Debris Pollution. Conservation and Management of Marine Mammals. J.R. Twiss, Jr. and R.R. Reeves. Washington, DC, Smithsonian Institution Press: 342-366.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science. 17:35–75.

Lagerquist, B.A., K.M. Stafford, and B.R. Mate. 2000. Dive characteristics of satellite-monitored blue whales (*Balaenoptera musculus*) off the central California coast. Marine Mammal Science. 16:375-391.

Laurinolli, M.H., A.E. Hay, F. Desharnais, and C.T. Taggart. 2003. Localization of North Atlantic right whale sounds in the Bay of Fundy using a sonobuoy array. Marine Mammal Science. 19:708-723.

Leatherwood, S., T.A. Jefferson, J.C. Norris, W.E. Stevens, L.J. Hansen, and K.D. Mullin. 1993. Occurrence and sounds of Fraser's dolphin (*Lagenodelphis hosei*) in the Gulf of Mexico. Texas Journal of Science. 45:349-354. 17

Le Boeuf, B.J., R.J. Whiting, and R.F. Gannt. 1972. Perinatal behavior of northern elephant seal females and their young. Behaviour. 43:121-156.

Le Boeuf, B. J. and M. L. Bonnell. 1971. DDT in California Sea Lions. Nature 234:108-110.

Le Boeuf, B.J. and M.L. Bonnell. 1980. Pinnipeds of the California islands: abundance and distribution. Pages 475-493 *in* D.M. Power (ed.), *The California Islands: Proceedings of a multidisciplinary symposium*. Santa Barbara Museum of Natural History, Santa Barbara, CA. 787 pp.

Le Boeuf, B.J. and J. Reiter. 1991. Biological effects associated with El Nino Southern Oscillation, 1982-83m on northern elephant seals breeding at Ano Nuevo, California. IN: F. Trillmich and K.A. Ono, eds. Pinnipeds and El Nino: Responses to Environmental Stress, Springer-Verlag, Berlin. Pp. 206-218.

Le Boeuf, B.J., J.P. Giesy, K. Kannan, N. Kajiwara, S. Tanabe, and C. Debier. 2002. Organochloride pesticides in California sea lions revisited. BMC Ecology. 2:11.

Le Boeuf, B.J. and L.F. Petrinovich. 1974. Dialects of northern elephant seals, *Mirounga angustirostris*: Origin and reliability. Animal Behavior. 22:656-663.

Le Boeuf, B.J., Y. Naito, A.C. Huntley, and T. Asaga. 1989. Prolonged, continuous, deep diving by northern elephant seals. Canadian Journal of Zoology. 67:2514-2519.

Le Boeuf, B.J., D.E. Crocker, D.P. Costa, S.B. Blackwell, P.M. Webb, and D.S. Houser. 2000. Foraging ecology of northern elephant seals. Ecological Monographs. 70:353-382.

LeDuc, R.G., W.L. Perryman, Gilpatrick, Jr., J.W., J. Hyde, C. Stinchcomb, J.V. Carretta, and R.L. Brownell. 2001. A note on recent surveys for right whales in the southeastern Bering Sea. Journal of Cetacean Research and Management, Special Issue. 2:287-289.

Learmonth, J.A., C.D. MacLeod, M.B. Santos, G.J. Pierce, H.Q.P. Crick and R.A. Robinson. 2006. Potential effects of climate change on marine mammals. Oceanography and Marine Biology. 44:431-464.

Lee, T. 1993. Summary of cetacean survey data collected between the years of 1974 and 1985. NOAA Technical Memorandum NMFS-SWFSC-181. 85 pp.

Lewison, R. L., S. A. Freeman and L. B. Crowder. 2004. Quantifying the effects of fisheries on threatened species: The impact of pelagic longlines on loggerhead and leatherback sea turtles. Ecology Letters. 7: 221-231.

Lien, J., F. Barry, K. Breeck and U. Zuschlag. 1990. Multiple Strandings of Sowerby’s Beaked Whales, *Mesoplodon bidens*, in Newfoundland. Canadian Field-Naturalist 104(3): 414-420.

Liao, T.F. 1994. Interpreting probability models. Logit, probit, and other generalized linear models. SAGE Publications, Inc. Newbury Park, California.

Littnan, C.L., B.S. Stewart, P.K. Yochem and R. Braum. 2007. Survey for Selected Pathogens and Evaluation of Disease Risk Factors for Endangered Hawaiian Monk Seals in the Main Hawaiian Islands. EcoHealth. 3:232-244.

Ljungblad, D.K., B. Würsig, S.L. Swartz, and J.M. Keene. 1988. Observations on the behavioral responses of Bowhead whales (*Balaena mysticetes*) to active geophysical vessels in the Alaskan Beaufort Sea. Arctic. 41:183-194.

López, A., M. B. Santos, G. J. Pierce, A. F. Gonzales, X. Valeiras and A. Guerra. 2002. Trends in strandings and by-catch of marine mammals in north-west Spain during the 1990s. Journal of the Marine Biological Association of the U.K. 82:513-521.

Loughlin, T. R. and Exxon Valdez Oil Spill Trustee Council. 1994. Marine mammals and the Exxon Valdez. San Diego, Academic Press.

Lowry, M.S. 2002. Counts of northern elephant seals at rookeries in the Southern California Bight - 1981-2001. NOAA-TM-NMFS-SWFSC-345. 68 pp.

Lowry, M.S. and J.V. Carretta. 2003. Pacific harbor seal, *Phoca vifulina richardii,* Census in California during May-July 2002. NOAA-TM-NMFS-SWFSC-353. 55 pp.

Lowry, M. S., and O. Maravilla-Chavez. 2005. Recent abundance of California sea lions in western Baja California, Mexico and the United States. In Proceedings 6th California Islands symposium, Ventura, California, U.S., December 1-3, 2003. Pp. 485-497. National Park Service Tech Publ. CHIS-05-01, Institute for Wildlife Studies, Arcata, CA.

Lusseau, D. 2006. The short-term behavioral reactions of bottlenose dolphins to interactions with boats in Doubtful Sound, New Zealand. Marine Mammal Science. 22:802.

Lutcavage, M. E., P. Plotkin, B. E. Witherington and P. L. Lutz. 1997. Human Impacts on Sea Turtle Survival. The Biology of Sea Turtles. P. L. Lutz and J. A. Musick. New York, CRC Press: 387-410.

Luttenberg, D., K. Sellner, D. Anderson and D. Turgeon. 2000. National assessment of harmful algal blooms in US waters: October 2000. Washington, D.C., National Science and Technology Council, Committee on Environment and Natural Resources.

Macfarlane, J.A.F. 1981. Reactions of whales to boat traffic in the area of the confluence of the Saguenay and St. Lawrence rivers, Quebec. Manuscript cited in Richardson et al. 1995. 50 pp.

MacLeod, C.D. 1999. A review of beaked whale acoustics, with inferences on potential interactions with military activities. European Research on Cetaceans. 13:35-38.

MacLeod, C.D. 2000. Review of the distribution of *Mesoplodon* species (Order Cetacea, Family Ziphiidae) in the North Atlantic. Mammal Review. 30:1-8.

MacLeod, C.D., N. Hauser, and H. Peckham. 2004. Diversity, relative density and structure of the cetacean community in summer months east of Great Abaco, Bahamas. Journal of the Marine Biological Association of the U.K. 84:469-474.

MacLeod, C. D., G. J. Pierce and M. Begoña Santos. 2004. Geographic and temporal variations in strandings of beaked whales. Ziphiidae) on the coasts of the UK and the Republic of Ireland from 1800-2002. Journal of Cetacean Management and Research 6(1): 79-86.

Madsen, P.T., D.A. Carder, W.W.L. Au, P.E. Nachtigall, B. Møhl, and S.H. Ridgway. 2003. Sound production in neonate sperm whales (L). Journal of the Acoustical Society of America. 113:2988-2991.

Madsen, P.T., I. Kerr, and R. Payne. 2004. Echolocation clicks of tow free-ranging delphinids with different food preferences: false killer whales (*Pseudorca crassidens*) and Risso's dolphin (*Grampus griseus*). Journal of Experimental Biology. 207:1811-1823.

Madsen, P.T., M.A. Johnson, P.J. Miller, A.N. Soto, J. Lynch, and P.L. Tyack. 2006. Quantitative measures of air-gun pulses recorded on sperm whales (*Physeter macrocephalus*) using acoustic tags during controlled exposure experiments. Journal of the Acoustic Society of America. 120:2366-2379.

Magrab, E.B. 1975. Environmental Noise Control. John Wiley and Sons, New York

Maldini, D. 2003. Abundance and distribution patterns of Hawaiian odontocetes: Focus on Oahu. Ph.D dissertation, University of Hawaii, Manoa.

Maldini, D., L. Mazzuca and S. Atkinson. 2005. Odontocete Stranding Patterns in the Main Hawaiian Islands. 19372002): How Do They Compare with Live Animal Surveys? Pacific Science. 59:55-67.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack and J.E. Bird. 1983. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. BBN Rep. 5366. Rep. from Bolt Beranek & Newman Inc., Cambridge, MA, for U.S. Minerals Management Service, Anchorage, AK. NTIS PB86-174174. Var. p.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack and J.E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration. BBN Rep. 5586. Report from Bolt Beranek & Newman Inc., Cambridge, MA, for U.S. Minerals Management Service, Anchorage, AK. NTIS PB86-218377.

Malme, C.I., B. Würsig, J.E. Bird, and P. Tyack. 1988. Observations of feeding gray whale responses to controlled industrial noise exposure. Pp. 55-73 in Port and Ocean Engineering Under Arctic Conditions, Volume III (W.M. Sackinger, M.O. Jeffries, J.L. Imm, and S.D. Treacy eds.) (University of Alaska, Fairbanks).

Mangels, K.F. and T. Gerrodette, 1994. Report of cetacean sightings during a marine mammal survey in the eastern Pacific Ocean and the Gulf of California aboard the NOAA ships *McArthur* and *David Starr Jordan*, July 28–November 6, 1993. *NOAA Technical Memorandum NMFS-SWFSC-211*. Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA.

Mann, J., R.A. Smolker and B.B. Smuts. 1995. Responses to calf entanglement in free-ranging bottlenose dolphins. Marine Mammal Science 11:100-106.

Maravilla-Chavez, M.O. and M.S Lowry, 1999. Incipient breeding colony of Guadalupe fur seals at Isla Benito del Este, Baja California, Mexico. Marine Mammal Science 15:239-241.

Marsh, H. E. 1989. Mass stranding of dugongs by a tropical cyclone in northern Australia. Marine Mammal Science. 5:78-84.

Marten, K., and S. Psarakos. 1999. Long-term site fidelity and possible long-term associations of wild spinner dolphins (*Stenella longirostris*) seen off Oahu, Hawaii. Marine Mammal Science. 15: 329-336.

Mate, B.R., S.L. Nieukirk, and S.D. Kraus. 1997. Satellite-monitored movements of the northern right whale. Journal of Wildlife Management. 61:1393-1405.

Mate, B.R., B.A. Lagerquist, and J. Calambokidis. 1999. Movements of North Pacific blue whales during the feeding season off southern California and their southern fall migration. Marine Mammal Science. 15:1246-1257.

Matkin, C. O., F. H. Fay, United States. Marine Mammal Commission. and University of Alaska Fairbanks. Institute of Marine Science.. 1980. Marine mammal-fishery interactions on the Copper River and in Prince William Sound, Alaska, 1978. Washington, D.C. Springfield, VA, The Commission ;National Technical Information Service.

Matthews, J.N., S. Brown, D. Gillespie, M. Johnson, R. McLanaghan, A. Moscrop, D. Nowacek, R. Leaper, T. Lewis, and P. Tyack. 2001. Vocalisation rates of the North Atlantic right whale (*Eubalaena glacialis*). Journal of Cetacean Research and Management. 3:271-282.

Mattila, D.K., L.N. Guinee, and C.A. Mayo. 1987. Humpback whale songs on a North Atlantic feeding ground. Journal of Mammalogy. 68:880-883.

May-Collado, L.J., I. Agnarsson, D. Wartzok. 2007. Reexamining the relationship between body size and tonal signals frequency in whales: a comparative approach using a novel phylogeny. Marine Mammal Science 23 (3):524-552.

Maybaum, H.L. 1989. Effects of a 3.3 kHz sonar system on humpback whales, *Megaptera novaeangliae*, in Hawaiian waters. M.S. Thesis, University of Hawaii, Manoa. 112 pp.

Maybaum, H.L. 1990. Effects of a 3.3 kHz sonar system on humpback whales, *Megaptera novaeangliae*, in Hawaiian waters. Eos 71:92.

Maybaum, H.L. 1993. Responses of humpback whales to sonar sounds. Journal of the Acoustical Society of America. 94:1848-1849.

Mazzuca, L., S. Atkinson, B. Keating and E. Nitta. 1999. Cetacean Mass Strandings in the Hawaiian Archipelago, 1957-1998. Aquatic Mammals. 25:105-114.

McAlpine, D.F. 2002. Pygmy and dwarf sperm whales Kogia breviceps and K. sima. Pages 1007-1009 in W.F. Perrin, B. Wursig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego: Academic Press.

McCullagh, P. and J.A. Nedler. 1989. Generalized linear models. Second Edition. Chapman and Hall; London, United Kingdom.

McCulloch, C.E. and S.R. Searle. 2001. Generalized, linear, and mixed models. John Wiley and Sons, Inc.; New York, New York.

McDonald, M. A., J. A. Hildebrand, S. M. Wiggins, D. Thiele, D. Glasgow, S. E. Moore. 2005. Sei whale sounds recorded in the Antarctic. Journal of the Acoustical Society of America. 118:3941-3945.

McDonald, M.A. and C.G. Fox. 1999. Passive acoustic methods applied to fin whale population density estimation. Journal of the Acoustical Society of America. 105:2643-2651.

McDonald, M.A., J. Calambokidis, A.M. Teranishi, and J.A. Hildebrand. 2001. The acoustic calls of blue whales off California with gender data. Journal of the Acoustical Society of America 109:1728-1735.

McDonald, M.A., and S.E. Moore. 2002. Calls recorded from North Pacific right whales (*Eubalaena japonica*) in the eastern Bering Sea. Journal of Cetacean Research and Management. 4:261-266.

McDonald, M.A., J.A Hildebrand, and S.M. Wiggins. 2006. Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California. Journal of the Acoustical Society of America. 120:711-718.

McFee, W. E., S. R. Hopkins-Murphy and L. H. Schwacke. 2006. Trends in bottlenose dolphin. *Tursiops truncatus*) strandings in South Carolina, USA, 1997-2003: implications for the Southern North Carolina and South Carolina Management Units. Journal of Cetacean Management and Research 8(2): 195-201.

McGrath, J.R. 1971. Scaling Laws for Underwater Exploding Wires. Journal of the Acoustical Society of America. 50:1030-1033.

McSweeney, D.J., R.W. Baird and S.D. Mahaffy. 2007. Site fidelity, associations and movements of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales off the island of Hawai'i. Marine Mammal Science. 23:666-687.

Mead, J.G. 1979. An analysis of cetacean strandings along the east coast of the United States. Pages 54-68. IN: J.R. Geraci and D.J. St. Aubin, eds. Biology of Marine Mammals: Insights Through Strandings. National Technical Information Service, Springfield, VA. NTIS pB-293 890.

Mead, J.G. 1989. Beaked whales of the genus - *Mesoplodon*. Pages 349-430 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 4: River dolphins and the larger toothed whales. London: Academic Press.

Melin, S. R. and R.L. DeLong. 1999. Observations of a Guadalupe Fur Seal (*Arctocephalus townsendi*) Female and pup at San Miguel Island, California. Marine Mammal Science. 15:885-888.

Mellinger, D.K., C.D. Carson, and C.W. Clark. 2000. Characteristics of minke whale (*Balaenoptera acutorostrata*) pulse trains recorded near Puerto Rico. Marine Mammal Science. 16:739-756.

Mellinger, D.K., and C.W. Clark. 2003. Blue whale (*Balaenoptera musculus*) sounds from the North Atlantic. Journal of the Acoustical Society of America. 114:1108-1119.

Mellinger, D.K., K.M. Stafford, S.E. Moore, L. Munger, and C.G. Fox. 2004. Detection of North Pacific right whale (*Eubalaena japonica*) calls in the Gulf of Alaska. Marine Mammal Science. 20:872-879.

Mesnick, S.L., B.L. Taylor, B. Nachenberg, A. Rosenberg, S. Peterson, J. Hyde, and A.E. Dizon. 1999. Genetic relatedness within groups and the definition of sperm whale stock boundaries from the coastal waters off California, Oregon and Washington. Southwest Fisheries Center Administrative Report LJ-99-12:1-10. La Jolla, California: National Marine Fisheries Service.

MHDPM. 1978. McGraw-Hill Dictionary of Physics and Mathematics. D.N. Lapedes (Editor in Chief), McGraw-Hill Book Company, New York.

Michel, J, R Nairn,.J.A. Johnson, and D Hardin. 2001. Development and design of biological and physical monitoring protocals to evaluate the long-term impacts of offshore dredging operations on the marine environment. Final Report to the U.S. Department of Interior, Minerals Management Service, International Activities and Marine Minerals Divisions (INTERMAR), Herndon, CA. Contract No. 14-35-0001-31051. 116 p.

Mignucci-Giannoni, A.A., Toyos-Gonzalez, G.M., Perez-Padilla, J., Rodriguez-Lopez, M.A., and Overing, J. 2000. Mass stranding of pygmy killer whales (*Feresa attenuata*) in the British Virgin Islands. Journal of the Marine Biology Association. U.K. 80:759-760.

Miksis J.L., Grund, M.D., Nowacek, D.P., Solow, A.R., Connor R.C. and Tyack, P.L. 2001. Cardiac Responses to Acoustic Playback Experiments in the Captive Bottlenose Dolphin, *Tursiops truncatus*. Journal of Comparative Psychology. 115:227-232.

Miller, E.H. and D.A. Job. 1992. Airborne acoustic communication in the Hawaiian monk seal, *Monachus schauinslandi*. Pages 485-531 in J.A. Thomas, R.A. Kastelein and A.Y. Supin, eds. Marine mammal sensory systems. New York, New York. Plenum Press.

Miller, J.D., C.S. Watson, and W.P. Covell. 1963. Deafening effects of noise on the cat. Acta Oto-Laryngologica Supplement. 176:1–91.

Miller, J.D. 1974. Effects of noise on people. Journal of the Acoustical Society of America. 56:729–764.

Miller, P.J.O., M.P. Johnson, and P.L. Tyack. 2004. Sperm whale behaviour indicates the use of echolocation click buzzes ‘creaks’ in prey capture. Proceedings of the Royal Society of London, Part B: 271:2239-2247.

Mills, J.H., R.M. Gilbert, and W.Y. Adkins. 1979. Temporary threshold shifts in humans exposed to octave bands of noise for 16 to 24 hours. Journal of the Acoustical Society of America. 65:1238–1248.

Mitchell, E. 1965. Evidence for mass strandings of the false killer whale. *Pseudorca crassidens*) in the eastern North Pacific Ocean. Norsk. Hvalfangst-Tidende. 54:172-177.

Mitchell, E. 1975. Report of the meeting on smaller cetaceans, Montreal, April 1-11, 1974. Subcommittee on small cetaceans, Scientific Committee, International Whaling Commission. Journal of the Fisheries Research Board of Canada. 32:889-983.

Miyazaki, N. and S. Wada. 1978. Observation of Cetacea during whale marking cruise in the western tropical Pacific. Scientific Reports of the Whales Research Institute. 30:179-195.

Miyazaki, N. and W.F. Perrin. 1994. Rough-toothed dolphin-*Steno bredanensis* (Lesson, 1828). Pages 1-21 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego, California: Academic Press.

Mizroch, S.A., D.W. Rice, D. Zwiefelhofer, J. Waite, and W.L. Perryman. 1999. Distribution and movements of fin whales (*Balaenoptera physalus*) in the Pacific Ocean. Page 127 in Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals. 28 November-3 December 1999. Wailea, Maui.

Marine Mammal Commission (MMC). 1999. Marine Mammals and Persistent Ocean Contaminants: Proceedings of the Marine Mammal Commission Workshop Keystone, Colorado, 12-15 October 1998.

MMC. 2004. Annual Report to Congress. 2003. Marine Mammal Commission, Bethesda, MD.

Mignucci-Giannoni, A.A., G.M. Toyos-González, J. Pérez-Padilla, M.A. Rodríguez-López and J. Overing. 2000. Mass stranding of pygmy killer whales. (*Feresa attenuata*) in the British Virgin Islands. Journal of the Marine Biological Association of the UK. 80:759-760.

Moberg, G.P. 2000. Biological response to stress: implications for animal welfare. Pages 1 - 21 In: G.P. Moberg and J.A. Mench, editors. The biology of animal stress. Basic principles and implications for animal welfare. Oxford University Press, Oxford, United Kingdom.

Mobley, J.R., S.W. Martin, D. Fromm, and P. Nachtigall. 2007. Lunar influences as possible causes for simultaneous aggregations of melon-headed whales in Hanalei Bay, Kauai and Sasanhaya Bay, Rota. Abstract for oral presentation at the Seventeeth Biennial Conference on the Biology of Marine Mammals. Cape Town, South Africa, 29 November -3 December 2007.

Moeller, J.R.B. 2003. Pathology of marine mammals with special reference to infectious diseases. in Toxicology of Marine Mammals, edited by J.G. Vos, G.D. Bossart, M. Fournier, and T.J. O'Shea (Taylor & Francis, London). Pp. 3-37.

Monteiro-Neto, C., T. T. Alves-Júnior, F. J. Capibaribe Ávila, A. Alves Campos, A. Fernandes Costa, C. P. Negrão Silva and M. A. A. Furtado-Neto. 2000. Impact of Fisheries on the Tucuxi. *Sotalia fluviatilis*) and Rough-Toothed Dolphin. *Steno bredanensis*) Populations off Ceará state, Northeastern Brazil. Aquatic Mammals. 26:49-56.

Moore, M. and G. A. Early. 2004. Cumulative sperm whale bone damage and the bends. Science 306:2215.

Moore, M.J., B. Rubinstein, S.A. Norman, and T. Lipscomb. 2004. A note on the most northerly record of Gervais' beaked whale from the western North Atlantic Ocean. Journal of Cetacean Research and Management. 6:279-281.

Moore, P.W.B., and R.J. Schusterman, 1987. Audiometric assessment of northern fur seals, *Callorhinus ursinus*. *Marine Mammal Science* 3:31-53.

Moore, S.E. and J.T. Clarke. 2002. Potential impact of offshore human activities on gray whales. *Eschrichtius robustus*. J. Cetacean Res. Manag. 4:19-25.

Moore, S. E. 2005. Long-term Environmental Change and Marine Mammals. IN: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery, T.J. Ragen. Marine Mammal Research: Conservation Beyond Crisis. John Hopkins University Press, Baltimore. pp 137-147.

Morimitsu, T., T. Nagai, M. Ide, H. Kawano, A. Naichuu, M. Koono, and A. Ishii. 1987. Mass stranding of Odontoceti caused by parasitongenic eighth cranial neuropathy. Journal of Wildlife Diseases. 28:656-658.

Nachtigall, P.E., W.W.L. Au, J.L. Pawloski, and P.W.B. Moore. 1995. Risso's dolphin (*Grampus griseus*) hearing thresholds in Kaneohe Bay, Hawaii. Pages 49-53 in R.A. Kastelein, J.A. Thomas, and P.E. Nachtigall, eds. Sensory systems of aquatic mammals. Woerden, The Netherlands: De Spil Publishers.

Nachtigall, P.E., D.W. Lemonds, and H.L. Roitblat. 2000. Psychoacoustic studies of dolphins and whales in Hearing by Dolphins and Whales, W.W.L. Au, A.N. Popper, and R.R. Fay, eds. Springer, New York. Pp. 330-363.

Nachtigall, P.E., J.L. Pawloski, and W.W.L. Au. 2003. Temporary threshold shift and recovery following noise exposure in the Atlantic bottlenosed dolphin (*Tursiops truncatus*). Journal of the Acoustical Society of America. 113:3425-3429.

Nachtigall, P.E., A. Supin, J.L. Pawloski, and W.W.L. Au. 2004. Temporary threshold shift after noise exposure in bottlenosed dolphin (*Tursiops truncatus*) measured using evoked auditory potential. Marine Mammal Science. 20:673-687.

National Research Council. 2005. Marine mammal populations and ocean noise: determining when noise causes biologically significant effects. Washington, DC, National Academies Press.

Nieri, M., E. Grau, B. Lamarche, A. Aguilar. 1999. Mass mortality of Atlantic spotted dolphins. *Stenella frontalis*) caused by a fishing interaction in Mauritania. Marine Mammal Science. 15:847–854.

National Marine Fisheries Service (NMFS). 1998a. Recovery plan for the blue whale (*Balaenoptera musculus*). Prepared by R.R. Reeves, P.J. Clapham, R.L. Brownell, and G.K. Silber. Silver Spring, Maryland: National Marine Fisheries Service.

NMFS. 1998b. Draft recovery plan for the fin whale (*Balaenoptera physalus*) and sei whale (*Balaenoptera borealis*). Prepared by R.R. Reeves, G.K. Silber, and P.M. Payne for the Office of Protected Resources, National Marine Fisheries Service, Silver Spring, Maryland. 47 pp.

NMFS. 2001. Interim Findings on the Stranding of Beaked Whales in the Bahamas – December 20,2001. http://www.nmfs.noaa.gov/bahamasbeakedwhales.htm. Accessed 1/24/07.

NMFS. 2004. Interim Report on the Bottlenose Dolphin. *Tursiops truncates*) Unusual Mortality Event Along the Panhandle of Florida March-April 2004. National Marine Fisheries Service. 36 pp.

NMFS. 2002. Endangered and threatened species: Determination on a petition to revise critical habitat for northern right whales in the Pacific. Federal Register 67:7660-7665.

NMFS, Office of Protected Resources. 2005. Assessment of Acoustic Exposures on Marine Mammals in Conjunction with *U.S.S. SHOUP* Active Sonar Transmissions in the Eastern Strait of Juan de Fuca and Haro Strait, Washington, 5 May 2003.

NMFS. 2005b. Pygmy Sperm Whale (*Kogia breviceps*): Western North Atlantic Stock. Stock Assessment Report. December, 2005.

NMFS. 2005c. Long-Finned Pilot Whale (*Globicephala melas*): Western North Atlantic Stock. Stock Assessment Report. December, 2005.

NMFS. 2005d. False Killer Whale (*Pseudorca crassidens*): Northern Gulf of Mexico Stock. Stock Assessment Report. December, 2005.

NMFS. 2005e. Dwarf Sperm Whale (*Kogia sima*): Western North Atlantic Stock. Stock Assessment Report. December, 2005.

NMFS. 2005f. Harbor Porpoise (*Phocoena phocoena*): Gulf of Maine/Bay of Fundy Stock. Stock Assessment Report. December, 2005.

NMFS. 2005g. Bottlenose Dolphin (*Tursiops truncatus*): Gulf of Mexico Bay, Sound, and Estuarine Stocks. Stock Assessment Report. December, 2005.

NMFS. 2005h. Incidental Harassment Authorization for Conducting the Precision Strike Weapon (PSW) Testing and Training by Eglin Air Force Base. Federal Register 70, No. 160, 48675-48691.National Marine Fisheries Service. 2006a. "Endangered and threatened species: Revision of critical habitat for the northern right whale in the Pacific Ocean. Federal Register 71, No. 129, 38277-38297.

NMFS. 2006b. Final Rule, for Conducting the Precision Strike Weapon (PSW) Testing and Training by Eglin Air Force Base. Federal Register 71, No. 226, 67810-67824.

NMFS. 2006b. Notice; availability of new criteria for designation of marine mammal Unusual Mortality Events. UMEs. Federal Register 71 FR 75234 notice Dec. 14, 2006.

NMFS. 2006c. Report on Marine Mammal Unusual Mortality Event UMESE0501Sp: Multispecies Mass Stranding of Pilot Whales (*Globicephala macrorhynchus*), Minke Whale (*Balaenoptera acutorostrata*), and Dwarf Sperm Whales (*Kogia sima*) in North Carolina on 15-16 January 2005. NOAA Technical Memorandum NMFS-SEFSC-537.

NMFS. 2006d. Hawaiian Melon-headed Whale (*Peponacephala electra*) Mass Stranding Event of July 3-4, 2004. NOAA Technical Memorandum NMFS-OPR-31, April, 2006.

NMFS 2006e. Biennial Report to Congress on the Recovery Program for Threatened and Endangered Species- October 1, 2004 – September 30, 2006. Office of Protected Resources, National Marine Fisheries Service, Silver Springs, MD. 185 pp.

NMFS. 2007a. Biological Opinion on the U.S. Navy's proposed Composite Training Unit Exercises and Joint Task Force Exercises off Southern California from February 2007 to January 2009. National Marine Fisheries Service, Office of Protected Resources. 163 pp.

NMFS. 2007b. Draft Programmatic Environmental Impact Statement for the Marine Mammal Health and Stranding Response Program, March 2007, National Marine Fisheries Service, Office of Protected Resources: 1006 pp.

NMFS. 2007c. NMFS Marine Mammal Unusual Mortality Events website: http://www.nmfs.noaa.gov/pr/health/mmume/

NMFS. 2007a. http://www.nmfs.noaa.gov/pr/pdfs/health/stranding_fact_sheet.pdf. Accessed 1/29/07

NMFS. 2007b. http://www.nmfs.noaa.gov/pr/health/faq.htm. Accessed 1/30/07.

NMFS. 2007c, http://www.nmfs.noaa.gov/pr/health/. Accessed 1/30/07.

NMFS. 2007e. http://seahorse.nmfs.noaa.gov/msdbs/class/seahorse_public.htm. Accessed 2/2/07.

NMFS. 2007f. National Marine Fisheries Service, Office of Protected Resources. Hawaii Viewing Guidelines. Accessed 2/14/07. http://www.nmfs.noaa.gov/pr/education/hawaii/guidelines.htm

NMFS. 2007g. http://www.afsc.noaa.gov/NMML/education/cetaceans/cetaceastrand.htm Accessed 1/31/07.

NMFS. 2007h. National Marine Fisheries Service, Office of Protected Resources. 2005 Multispecies Mass Stranding in North Carolina. Accessed 2/16/07. http://www.nmfs.noaa.gov/pr/health/mmume/event2005jan.htm.

NMFS. 2007i. Multi-species Unusual Mortality Event in North Carolina Fact Sheet. Accessed 2/16/07. http://www.nmfs.noaa.gov/pr/pdfs/health/ume_jan_2005_fact_sheet.pdf

NMFS. 2007j. National Marine Fisheries Service, Office of Protected Resources. July 2004 mass Stranding of Melon-Headed Whales in Hawai'i. Accessed 2/16/07. http:www.nmfs.noaa.gov/pr/health/mmume/event2004jul.html.

NMFS. 2007k. July 2004 Mass Stranding of Melon-Headed Whales in Hawai'I Fact Sheet for Final Report. Accessed 2/16/07. http://www.nmfs.noaa.gov/pr/pdfs/health/stranding_melonheadedwhales_july2004.pdf.

NMFS. 2007l. Brevetoxin & Florida Red Tides. Accesed 2/16/07. http://www.nmfs.noaa.gov/pr/pdfs/health/brevetoxin.pdf.

NMFS. 2007m. 2004 Bottlenose Dolphin Unusual Mortality Event Along the Florida Panhandle. Accessed 2/16/07. http://www.nmfs.noaa.gov/pr/health/mmume/event2004.htm

NMFS. 2007n. STRANDINGS Newsletter of the Southeast United States Marine Mammal Health and Stranding Network. Winter 2006/Spring 2007. NOAA Tech Memo NMFS-SEFSC-545. Accessed 2/16/07. http://www.sefsc.noaa.gov/PDFdocs/SNewsletter112806.pdf.

National Oceanic and Atmospheric Administration (NOAA). 2001. Final Rule for the Shock Trial of the *WINSTON S. CHURCHILL* (DDG-81), Federal Register, Department of Commerce; NMFS, FR 66, No. 87, 22450-67.

NOAA. 2002a. Final Rule SURTASS LFA Sonar. *Federal Register*, Department of Commerce; NMFS, FR 67, 136, 46712-89, 16 July.

NOAA. 2002b. Report of the workshop on acoustic resonance as a source of tissue trauma in cetaceans. NOAA Fisheries, Silver Spring, Maryland. April 2002.

NOAA. 2006a. National Marine Fisheries Service Biological Opinion for RIMPAC, 2006.

NOAA. 2006b. Incidental Harassment Authorization for RIMPAC 2006 issued by NOAA-NMFS.

NOAA. 2006c. NOAA Fisheries Service Releases Necropsy Report: Cause of 2005 Marine Mammal Strandings Unclear. NOAA News NOAA06-030, March 29, 2006.

NOAA. 2006d. NOAA Fisheries Service Releases Final Report on 2004 Stranding of Melon-headed Whales in Hawaii. NOAA News NOAA06-046, April 27, 2006.

NOAA. 2006e. Hawaiian Melon-headed Whale (*Peponacephala electra*) Mass Stranding Event of July 3-4, 2004. NOAA Technical Memorandum NMFS-OPR-31, April, 2006.

NOAA-NMFS. 2007. Biological Opinion for the AUTEC Behavioral Response Study issued by NOAA-NMFS. 51pp.

National Research Council (NRC). 2003. Ocean noise and marine mammals. The National Academic Press, Washington D.C. 208 pp.

NRC. 2005. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. The National Academic Press, Washington D.C. 126 pp.

Naval Sea Systems Command, NAVSEA Instruction 3150.2: Safe Diving Distances from Transmitting Sonar.

NSWC/Anteon Corp., Inc. 2005. Very shallow water explosion tests at Naval Amphibious Base, Coronado, CA and San Clemente Island, CA: Conditions, results, and model predictions.

Nawojchik, R., D.J. St. Aubin and A. Johnson. 2003. Movements and dive behavior of two stranded, rehabilitated long-finned pilot whales (*Globicephala melas*) in the Northwest Atlantic. Marine Mammal Science. 19:232-239.

Nedler, J.A. and T.W.M. Wedderburn. 1972. Generalized linear models. Journal of the Royal Statistical Society, Series A, 135: 370 – 384.

Nedwell, J.R., B. Edwards, A.W.H. Turnpenny, and J. Gordon. 2004. Fish and marine mammal audiograms: A summary of available information. Subacoustech Ltd. Report, Ref. 19534R0213.

Nemoto, T., and A. Kawamura. 1977. Characteristics of food habits and distribution of baleen whales with special reference to the abundance of North Pacific sei and Bryde's whales. Reports of the International Whaling Commission, Special Issue. 1:80-87.

Nielsen, J. B., Nielsen, F., Jorgensen, P., and Grandjean, P. 2000. Toxic metals and selenium in blood from pilot whales (*Globicephala melas*) and sperm whales (*Physeter catodon*). Marine Pollution Bulletin. 40: 348-351.

Nieri, M. E. Grau, B. Lamarch, A. Aguilar. 1999. Mass mortality of Atlantic spotted dolphin (*Stenella frontalis*) caused by a fishing interaction in Mauritania. Marine Mammal Science 15:847-854.

Norman, S.A. and J.G. Mead. 2001. *Mesoplodon europaeus*. Mammalian Species. 688:1-5.

Norman, S.A., Raverty, S., McLellan, B., Pabst, A., Ketten, D., Fleetwood, M., Gaydos, J.K., Norberg, B., Barre, L., Cox, T., Hanson, B., and Jeffries, S. 2004. Multidisciplinary investigation of stranded harbor porpoises (*Phocoena phocoena*) in Washington State with an assessment of acoustic trauma as a contributory factor (2 May – 2 June 2003). U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-NWR-34, 120 pp.

Norman, A. A., C. E. Bowlby, M. S. Brancato, J. Calambokidis, D. Duffield, P. J. Gearin, T. A. Gornall, M. E. Gosho, B. Hanson, J. Hodder, S. J. Jeffries, B. Lagerquist, D. M. Lambourn, B. Mate, B. Norberg, R. W. Osborne, J. A. Rash, S. Riemer and J. Scordino. 2004. Cetacean strandings in Oregon and Washington between 1930 and 2002. Journal of Cetacean Research and Management. 6:87-99.

Norris, K.S., and J.H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican waters. University of California Publications in Zoology. 63:291-402.

Norse, E. A. and L. Watling. 1999. Impacts of Mobile Fishing Gear: The Biodiversity Perspective. Fish Habitat: Essential Fish Habitat and Rehabilitation. L. R. Benaka. Bethesda, MD, American Fisheries Society, Symposium. 22: 31-40.

Northridge, S. P. and R. J. Hofman. 1999. Marine Mammal Interactions with Fisheries. Conservation and Management of Marine Mammals. J. R. Twiss, Jr. and R. R. Reeves. Washington, DC, Smithsonian Institution Press: 99-119.

Northrop, J., W.C. Cummings, and M.F. Morrison. 1971. Underwater 20-Hz signals recorded near Midway Island. Journal of the Acoustical Society of America. 49:1909-1910.

Northwest and Alaska Fisheries Center. 1978. Northern elephant seal appears on one of the Northwestern Hawaiian Islands.

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

North Pacific Acoustic Laboratory (NPAL). 2001. Office of Naval Research, Final Environmental Impact Statement for the North Pacific Acoustic Laboratory. Volumes I and II, January 2001.

NPAL. 2002a. National Oceanic and Atmospheric Administration/National Marine Fisheries Service, Office of Protected Resources. Notice of Issuance of a Letter of Authorization, Taking of Marine Mammals Incidental to Operation of a Low Frequency Sound Source by the North Pacific Acoustic Laboratory. Federal Register, January 22, 2002, (Vol 67, Number 14, Notices, Page 2857-2858).

NPAL. 2002b. Department of the Navy. Record of Decision for the Final Environmental Impact Statement for North Pacific Acoustic Laboratory Project. Federal Register, February 11, 2002, (Vol 67, Number 28, Notices, Page 6237-6239).

NRC. 2003. Ocean Noise and Marine Mammals. Washington, DC, The National Academies Press, Ocean Studies Board, Division of Earth and Life Sciences, National Research Council of the National Academies.

NRC. 2006. Dynamic Changes in Marine Ecosystems: Fishing, Food Webs, and Future Options, Committee on Ecosystem Effects of Fishing: Phase II - Assessments of the Extent of Change and the Implications for Policy, National Research Council.

Nuclear Regulatory Commission. 1997. Proceedings of a dose-modeling workshop. November 13 – 14, 1997. Washington, D.C.

Odell, D.K. 1987. The mysteries of marine mammal strandings. Cetus 7:2.

Odell, D.K., and K.M. McClune. 1999. False killer whale *Pseudorca crassidens* (Owen, 1846). Pages 213-243 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises. San Diego: Academic Press.

Office of Naval Research (ONR) Workshop. 1998. Effects of Manmade Sound on the Marine Environment. 10-12 February 1998, Bethesda, MD, R. Gisiner (Workshop Sponsor and Organizer, ONR Code 335).

OSHA. 1996. Occupational noise exposure in OSHA safety and health standards 29 CFR 1910.95 Federal Register. 61. 9227, 7 March 1996.

Okamura, H., K. Matsuoka, T. Hakamada, M. Okazaki, and T. Miyashita. 2001. Spatial and temporal structure of the western North Pacific minke whale distribution inferred from JARPN sightings data. Journal of Cetacean Research and Management. 3:193-200.

Oleson, E., J. Barlow, C. Clark, J. Gordon, S. Rankin, and J. Hildebrand. 2003. Low frequency calls of Bryde's whales. Marine Mammal Science. 19:407-419.

Omura, H., S. Ohsumi, T. Nemoto, K. Nasu, and T. Kasuya. 1969. Black right whales in the North Pacific. Scientific Reports of the Whales Research Institute. 21:I-78.

Orr, R.T. and C.Helm, 1989. *Marine mammals of California, revised edition*. Berkeley, CA: University of California Press. 93 pp.

Oswald, J.N., S. Rankin, J. Barlow, and M.O. Lammers. 2007. A tool for real-time acoustic species identification of delphinid whistles. The Journal of the Acoustical Society of America 122: 587-595.

Ortega-Argueta, A., C. E. Perez-Sanchez, G. Gordillo-Morales, O. G. Gordillo, D. G. Perez and H. Alafita. 2005. Cetacean Strandings on the Southwestern Coast of the Gulf of Mexico. Gulf of Mexico Science 2: 179-185.

Pampel, F. C. 2000. Logistic regression. A primer. SAGE Publications, Inc. Newbury Park, California.

Palacios, D.M., S.K. Salazar and D.Day. 2004. Cetacean remains and strandings in the Galopagos Islands, 1923-2003. Latin American Journal of Aquatic Mammals 3:127-150.

Panigada, S., G. Pesante, M. Zanardelli, F. Capoulade, A. Gannier and M. T. Weinrich. 2006. Mediterranean fin whales at risk from fatal ship strikes. Marine Pollution Bulletin 52: 1287-1298.

Panigada, S., M. Podesta, S. Greco and M. Rosso. 2006. Update on ship strikes events in Italian waters between 2002 and 2005, Report to the Scientific Committee of the International Whaling Commission Annual Meeting St Kitts SC/58/BC4: 3 pp.

Parks, S.E., D.R. Ketten, J. Trehey O'Malley, and J. Arruda. 2004. Hearing in the North Atlantic right whale: Anatomical predictions. Journal of the Acoustical Society of America. 115:2442.

Payne, K., P. Tyack, and R. Payne. 1983. Progressive changes in the songs of humpback whales (*Megaptera novaengliae*): A detailed analysis of two seasons in Hawaii. Pp. 9-57 in R. Payne, ed. Communication and behavior in whales. Washington, D.C.: American Association for the Advancement of Science.

Payne, K. and R. Payne. 1985. Large scale changes over 19 years in songs of humpback whales in Bermuda. Zeitschrift fur Tierpsychologie. 68:89-114.

Payne, P.M., J.R. Nicolas, L. O'Brien, and K.D. Powers. 1986. The distribution of the humpback whale, *Megaptera novaeangliae*, on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel, *Ammodytes americanus*. Fishery Bulletin. 84:271-277.

Perrin, W. F. and J. R. Geraci. 2002. Stranding. IN: W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego, Academic Press: pp. 1192-1197.

Perrin, W.F., and J.W. Gilpatrick. 1994. Spinner dolphin--*Stenella longirostris* (Gray, 1828). Pages 99-128 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego: Academic Press.

Perrin, W.F., and A.A. Hohn. 1994. Pantropical spotted dolphin.*Stenella attenuata*. Pages 71-98 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego: Academic Press.

Perrin, W.F., C.E. Wilson, and F.I. Archer. 1994a. Striped dolphin.*Stenella coeruleoalba* (Meyen, 1833). Pages 129-159 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego: Academic Press.

Perrin, W.F., S. Leatherwood, and A. Collet. 1994b. Fraser's dolphin-*Lagenodelphis hosei* (Fraser, 1956). Pages 225-240 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego: Academic Press.

Perrin, W.F., and R.L. Brownell. 2002. Minke whales *Balaenoptera acutorostrata* and *B. bonaerensis*. Pages 750-754 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego: Academic Press.

Perry, S.L., D.P. DeMaster, and G.K. Silber. 1999. The great whales: History and status of six species listed as endangered under the U.S. Endangered Species Act of 1973. Marine Fisheries Review. 61:1-74.

Perryman, W.L., and T.C. Foster. 1980. Preliminary report on predation by small whales, mainly the false killer whale, *Pseudorca crassidens*, on dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern tropical Pacific. Southwest Fisheries Science Center Administrative Report LJ-80-05. La Jolla, California: National Marine Fisheries Service.

Perryman, W.L., D.W.K. Au, S. Leatherwood, and T.A. Jefferson. 1994. Melon-headed whale. *Peponocephala electra* (Gray, 1846). Pages 363-386 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego: Academic Press.

Philips, J.D., P.E. Nachtigall, W.W.L. Au, J.L. Pawloski, and H.L. Roitblat. 2003. Echolocation in the Risso's dolphin, *Grampus griseus*. Journal of the Acoustical Society of America 113:605-616.

Piantadosi, C. A. and E. D. Thalmann. 2004. Whales, sonar and decompression sickness arising from: Jepson, P. D. et al. Nature 425, 575-576. 2003. Nature. (15 April2004.

Pierce, A.D. 1989. <u>Acoustics, An Introduction to Its Physical Principles and Applications</u>. Acoustical Society of America. Woodbury, NY

Pivorunas, A. 1979. The feeding mechanisms of baleen whales. American Scientist. 67:432-440.

Poole, M.M. 1995. Aspects of the behavioral ecology of spinner dolphins (*Stenella longirostris*) in the nearshore waters of Moorea, French Polynesia. Ph.D. dissertation., University of California, Santa Cruz.

Quaranta, A., P. Portalatini, and D. Henderson. 1998. Temporary and permanent threshold shift: An overview. Scandinavian Audiology. 27:75–86.

Raga, J. A. and A. Aguilar. 1992. Mass mortality of striped dolphins in Spanish Mediterranean waters. The Mediterranean striped dolphin die-off: 21-25.

Rankin, J.J. 1953. First record of the rare beaked whale, *Mesoplodon europaeus*, Gervais, from the West Indies. Nature 172: 873-874.

Rankin, S., and J. Barlow. 2003. Discovery of the minke whale “boing” vocalization, and implications for the seasonal distribution of the North Pacific minke whale. Page 134 in Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals. 14–19 December 2003. Greensboro, North Carolina.

Rankin, S. and J. Barlow. 2007. Sounds recorded in the presence of Blainville's beaked whales, *Mesoplodon densirostris*, near Hawai'i. The Journal of the Acoustical Society of America. 122:42-45.

Read, A.J. 1996. Incidental Catches of Small Cetaceans. The Conservation of Whales and Dolphins: Science and Practice. M. P. Simmonds and J. D. Hutchinson. New York, John Wiley and Sons. Pp. 108-128.

Read, A.J., P. Drinker and S. Northridge. 2006. Bycatch of Marine Mammals in U.S. and Global Fisheries. Conservation Biology. 20:163-169.

Reeves, R.R., B.S. Stewart, and S. Leatherwood, 1992. *The Sierra Club handbook of seals and sirenians*. San Francisco, CA: Sierra Club. 359 pp

Reeves, R.R., B.S. Stewart, P.J. Clapham, and J.A. Powell. 2002. National Audubon Society guide to marine mammals of the world. New York: Alfred A. Knopf.

Reeves, R.R., B.D. Smith, E.A. Crespo, and G. Notarbartolo di Sciara. 2003. 2002-2010 conservation plan for the world’s cetaceans: Dolphins, whales, and porpoises. Gland, Switzerland: IUCN.

Reeves, R.R., W.F. Perrin, B.L. Taylor, C.S. Baker, and S.L. Mesnick. 2004. Report of the Workshop on Shortcomings of Cetacean Taxonomy in Relation to Needs of Conservation and Management, April 30 - May 2, 2004, La Jolla, California. NOAA Technical Memorandum NMFS-SWFSC. 363:l- 94.

Reijnders, P.J.H. 1996. Organohalogen and Heavy Metal Contamination in Cetaceans: Observed Effects, Potential Impact and Future Prospects. The Conservation of Whales and Dolphins: Science and Practice. M. P. Simmonds and J. D. Hutchinson. New York, John Wiley and Sons. Pp. 205-218.

Reilly, S., and V.G. Thayer. 1990. Blue whale (*Balaenoptera musculus*) distribution in the eastern tropical Pacific. Marine Mammal Science. 6:265-277.

Rendell, L., and H. Whitehead. 2004. Do sperm whales share coda vocalizations? Insights into coda usage from acoustic size measurement. Animal Behaviour. 67:865-874.

Rice, D.W. 1960. Distribution of the bottle-nosed dolphin in the Leeward Hawaiian Islands. Journal of Mammalogy. 41:407-408.

Rice, D. W., 1977. Synopsis of biological data on the sei whale and Bryde's whale in the eastern north Pacific. *Reports of the International Whaling Commission* Special Issue 1:92-97.

Rice, D.W. 1998. Marine mammals of the world: Systematics and distribution. Society for Marine Mammalogy Special Publication. 4:1-231.

Richardson, W. J., C. R. J. Green, C. I. Malme and D. H. Thomson. 1995. Marine Mammals and Noise. San Diego, CA, Academic Press.

Richardson, W. J., C. R. Greene Jr., C. I. Malme and D. H. Thomson. 1991. Effects of Noise on Marine Mammals. Herndon, VA, U.S. Department of the Interior, Minerals Management Service, Atlantic OCS Region: 462.

Ridgway, S.H. and M.D. Dailey. 1972. Cerebral and cerebellar involvement of trematode parasites in dolphins and their possible role in stranding. Journal of Wildlife Diseases. 8:33-43.

Ridgway, S.H., and R. Howard. 1979. Dolphin lung collapse and intramuscular circulation during free diving: evidence from nitrogen washout. Science. 206:1182–1183.

Ridgway, S.H. 2000. The auditory central nervous system. Pages 273-293 in W.W.L. Au, A.N. Popper, and R.R. Fay, eds. Hearing by whales and dolphins. New York: Springer-Verlag.

Ridgway, S.H., B.L. Scronce, and J. Kanwisher. 1969. Respiration and deep diving in the bottlenose porpoise. Science. 166:1651-1654.

Ridgway, S.H., D.A. Carder, R.R. Smith, T. Kamolnick, C.E. Schlundt, and W.R. Elsberry. 1997. Behavioral responses and temporary shift in masked hearing threshold of bottlenose dolphins, *Tursiops truncatus*, to 1-second tones of 141 to 201 dB re 1 µPa. Technical Report 1751, Revision 1. San Diego: Naval Sea Systems Command.

Ridgway, S.H., and D.A. Carder. 2001. Assessing hearing and sound production in cetaceans not available for behavioral audiograms: Experiences with sperm, pygmy sperm, and gray whales. Aquatic Mammals. 27:267-276.

Ritchie, J. 1924. Observations on a pilot whale stranded in the Firth of Forth. Scottish Naturalist. 146:37-43.

Rivers, J.A. 1997. Blue whale, *Balaenoptera musculus*, vocalizations from the waters off central California. Marine Mammal Science. 13:186-195.

Robertson, K.M., and S.J. Chivers. 1997. Prey occurrence in pantropical spotted dolphins, *Stenella attenuata*, from the eastern tropical Pacific. Fishery Bulletin. 95:334-348.

Rogan, E., J. R. Baker, P. D. Jepson, S. D. Berrow and O. Kiely. 1997. A Mass Stranding of White-Sided Dolphins. *Lagenorhynchus acutus*) in Ireland: Biological and Pathological Studies. Journal of Zoology. 242: 217-227.

Rogers, A.D. 1994. The biology of seamounts. Pages 306-350 in J.H. Blaxter, and A.J. Southward, eds. Advances in marine biology, volume. San Diego: Academic Press.

Romano, T.A., J.A. Olschowka, S.Y. Felten, V. Quaranta, S.H. Ridgway,and D.L. Felten. 2002. Immune response, stress, and environment: Implications for cetaceans. In: Cell and Molecular Biology of Marine Mammals. C.J. Pfeiffer (ed). Krieger Publishing Co., Inc. pp. 53-279.

Romano, T.A., M.J. Keogh, C. Kelly, P. Feng, L. Berk, C.E. Schlundt, D.A. Carder, and J.J. Finneran. 2004. Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure. Canadian Journal of Fisheries and Aquatic Science. 61:1124-1134.

Rosenbaum, H.C., R.L. Brownell, M.W. Brown, C. Schaeff, V. Portway, B.N. Whiate, S. Malik, L.A. Pastene, N.J. Patenaude, C.S. Baker, M. Goto, P.B. Best, P.J. Clapham, P. Hamilton, M. Moore, R. Payne, V. Rowntree, C.T. Tynan, J.L. Bannister, and R. DeSalle. 2000. World-wide genetic differentiation of *Eubalaena*: Questioning the number of right whale species. Molecular Ecology. 9:1793-1802.

Rosenbaum, H.C., M. Egan, P.J. Clapham, P.J. Brownell, R.L. Jr., Malik, S., Brown, M.W., White, B.N., Walsh, P., and DeSalle, R. 2000. Utility of North Atlantic right whale museum specimens for assessing changes in genetic diversity. Conservation Biology. 14:1837-1842.

Ross, D. 2005. Ship sources of ambient noise. IEEE Journal of Oceanic Engineering, 30:257-261.

Ross, W. G. 1993. Commercial Whaling in the North Atlantic Sector. The Bowhead Whale. J. J. Burns, J. J. Montague and C. J. Cowles. Lawrence, KS, Society for Marine Mammology. 2:511-561.

Rothschild, B. M., E. D. Mitchell, M. J. Moore and G. A. Early. 2005. What causes lesions in sperm whale bones? Science. 308: 631-632.

Rowntree, V., J. Darling, G. Silber, and M. Ferrari. 1980. Rare sighting of a right whale (*Eubalaena glacialis*) in Hawaii. Canadian Journal of Zoology. 58:309-312.

Rybitski, M. J., G. H. Balazs, R. C. Hale and J. A. Musick. 1994. Comparison of Organochlorine Contents in Atlantic Loggerheads. *Caretta caretta*) and Hawaiian Green Turtles. *Chelonia mydas*. Thirteenth Annual Symposium on Sea Turtle Biology and Conservation, Jekyll Island, GA, NOAA Technical Memorandum NMFS-SEFSC-341.

Salden, D. R. 1988. Humpback whale encounter rates offshore of Maui, Hawaii. Journal of Wildlife Management. 52:301-304.

Salden, D.R., and J. Mickelsen. 1999. Rare sighting of a North Pacific right whale (*Eubalaena glacialis*) in Hawaii. Pacific Science. 53:341-345.

Salden, D.R., L. M. Herman, M. Yamaguchi, and F. Sato. 1999. Multiple visits of individual humpback whales (*Megaptera novaeangliae*) between the Hawaiian and Japanese winter grounds. Canadian Journal of Zoology. 77:504-508.

Sanvito, S., and F. Galimberti. 2003. Source level of male vocalizations in the genus *Mirounga*: Repeatability and correlates. Bioacoustics. 14:47-59.

Sapolsky, R. M. 2005. The influence of social hierarchy on primate health. Science. 308: 648-652.

Saunders, J.C., J.H. Mills, and J.D. Miller. 1977. Threshold shift in the chinchilla from daily exposure to noise for six hours. Journal of the Acoustical Society of America. 61:558–570.

Scarff, J.E. 1986. Historic and present distribution of the right whale (*Eubalaena glacialis*) in the eastern North Pacific south of 50°N and east of 180°W. Reports of the International Whaling Commission, Special Issue. 10:43-63.

Scarff, J.E. 1991. Historic distribution and abundance of the right whale (*Eubalaena glacialis*) in the North Pacific, Bering Sea, Sea of Okhotsk and Sea of Japan from the Maury Whale Charts. Reports of the International Whaling Commission. 41:467-489.

SSC. 2004 See Finneran, J.J., and C.E. Schlundt. (2004). Effects of intense pure tones on the behavior of trained odontocetes. TR 1913, SPAWAR Systems Center (SSC) San Diego, San Diego, CA. [see body of SSC research as reported in papers by Ridgway et al., Schlundt et al., Carder et al., and Finneran et al. sampled within this reference list.].

Schilling, M.R., I. Seipt, M.T. Weinrich, S.E. Frohock, A.E. Kuhlberg, and P.J. Clapham. 1992. Behavior of individually-identified sei whales *Balaenoptera borealis* during an episodic influx into the southern Gulf of Maine in 1986. Fishery Bulletin. 90:749-755.

Schlundt, C.E., J.J. Finneran, D.A. Carder, and S.H. Ridgway. 2000. Temporary shift in masked hearing thresholds of bottlenose dolphins, *Tursiops truncatus*, and white whales, *Delphinapterous leucas*, after exposure to intense tones. Journal of the Acoustical Society of America. 107:3496-3508.

Schlundt, C.E., R.L. Dear, D.A. Carder, and J.J. Finneran. 2006. Growth and recovery of temporary threshold shifts in a dolphin exposed to mid-frequency tones with durations up to 128 s. Journal of the Acoustical Society of America. 120:3227A.

Schlundt, C.E. et al. 2007. Simultaneously measured behavioral and electrophysiological hearing thresholds in a bottlenose dolphin (*Tursiops truncatus*). The Journal of the Acoustical Society of America. 122:615-622.

Schoenherr, J.R. 1991. Blue whales feeding on high concentrations of euphausiids around Monterey Submarine Canyon. Canadian Journal of Zoology. 69:583-594.

Schotten, M., W.W.L. Au, M.O. Lammers, and R. Aubauer. 2004. Echolocation recordings and localization of wild spinner dolphins (*Stenella longirostris*) and pantropical spotted dolphins (S. *attenuata*) using a four-hydrophone array. Pages 393-400 in J.A. Thomas, C.F. Moss and M. Vater, eds. Echolocation in bats and dolphins. Chicago, Illinois: University of Chicago Press.

Schreer, J.F., K.M. Kovacs, and R.J.O. Hines. 2001. Comparative diving patterns of pinnipeds and seabirds. Ecological Monographs. 71:137-162.

Schwarz, L. K. 2002. The impact of anthropogentic activities on the behavior of migrating eastern North Pacific gray whales. *Eschrichtius robustus*.

Schwartz, M., A. Hohn, A. Bernard, S. Chivers, and K. Peltier. 1992. Stomach contents of beach cast cetaceans collected along the San Diego County coast of California, 1972-1991. Southwest Fisheries Science Center Adminstrative Report LJ-92-18. La Jolla, California: National Marine Fisheries Service.

Scott, M.D., and K.L. Cattanach. 1998. Diel patterns in aggregations of pelagic dolphins and tuna in the eastern Pacific. Marine Mammal Science. 14:401-428.

Scott M.D., A.A. Hohn., A.J. Westgate, J.R. Nicolas., B.R. Whitaker and W.B Campbell. 2001. A note on the release and tracking of a rehabilitated pygmy sperm whale (*Kogia breviceps*). Journal of Cetacean Research and Management. 3:87-94.

Seagars, D.J., 1984.The Guadalupe fur seal: a status review. *Administrative Report SWR-84-6*. Southwest Region, National Marine Fisheries Service, Terminal Island, CA.

Secchi, E. R., J. Y. Wang, L. D. Rosa, S.-C. Yang and R. R. Reeves. 2005. Global Review of Interactions Between Cetaceans and Longline Fisheries: Preliminary Data, Presented to Scientific Committee of the International Whaling Commission, 57th Meeting, Ulsan, ROK, 30 May-10 June, 2005: 8 pp.

Selzer, L.A. and P.M. Payne. 1988. The distribution of white-sided dolphins. *Lagenorhynchus acutus*) and common dolphins. *Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States. Marine Mammal Science. 4:141-153.

Sergeant, D.E. 1982. Some biological correlates of environmental conditions around Newfoundland during 1970-1979: harp seals, blue whales and fulmar petrels. North Atlantic Fisheries Organization. NAFO. Scientific Council Studies. 5:107-110.

Seyle, H. 1950. Stress and the general adaptation syndrome. British Medical Journal. 1383-1392.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Report prepared under Contract #MM7AC028 for the Marine Mammal Commission, Washington, D.C.

Shane, S.H. 1994. Occurrence and habitat use of marine mammals at Santa Catalina Island, California from 1983-91. Bulletin of the Southern California Academy of Sciences. 93:13-29.

Shane, S.H., and D. McSweeney. 1990. Using photo-identification to study pilot whale social organization. Reports of the International Whaling Commission, Special Issue. 12. 259-263.

Shelden, K.E.W., S.E. Moore, J.M. Waite, P.R. Wade, and D.J. Rugh. 2005. Historic and current habitat use by North Pacific right whales *Eubalaena japonica* in the Bering Sea and Gulf of Alaska. Mammal Review. 35:129-1 55.

Shipley, C., B.S. Stewart, and J. Bass. 1992. Seismic communication in northern elephant seals. Pages 553-562 in J.A. Thomas, R.A. Kastelein, and A.Y. Supin, eds. Marine mammal sensory systems. New York: Plenum Press.

SHOUP. 2004. See Fromm, D. (2004a) Acoustic Modeling Results of the Haro Strait For 5 May 2003. Naval Research Laboratory Report, Office of Naval Research, 30 January 2004.

SHOUP. 2004. See Fromm, D. (2004b) EEEL Analysis of *U.S.S. SHOUP* Transmissions in the Haro Strait on 5 May 2003. Naval Research Laboratory briefing of 2 September 2004.

SHOUP. 2004. See Department of the Navy, Commander U.S. Pacific Fleet (2003). Report on the Results of the Inquiry into Allegations of Marine Mammal Impacts Surrounding the Use of Active Sonar by *U.S.S. SHOUP* (DDG 86) in the Haro Strait on or about 5 May 2003. 9 February 2003.

Silber, G.K. 1986. The relationship of social vocalizations to surface behavior and aggression in the Hawaiian humpback whale (*Megaptera novaeangliae*). Canadian Journal of Zoology. 64:2075-2080.

Simão, S.M., and S.C. Moreira. 2005. Vocalizations of a female humpback whale in Arraial do Cabo (RJ, Brazil). Marine Mammal Science. 21:150-153.

Simmonds, M.P. and S.J. Mayer. 1997. An evaluation of environmental and other factors in some recent marine mammal mortalities in Europe: implication for conservation and management. Environmental Review. 5(2):89-98.

Simmonds, M.P. and L.F. Lopez-Jurado. 1991. Whales and the military. Nature. 351(6326):448.

Simpson, J.H., P.B. Tett, M.L. Argote-Espinoza, A. Edwards, K.J. Jones, and G. Savidge. 1982. Mixing and phytoplankton growth around an island in a stratified sea. Continental Shelf Research 1:15-31.

Širović, A., J.A. Hildebrand, and Sean M. Wiggins. 2007. J. Acoust. Soc. Am. 122:1208-1215**.**

Smith, M.E., A.S. Kane, and A.N. Popper. 2004. Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water?. Journal of Experimental Biology. 207:3591-3602.

Soto, N. A., M. A. Johnson, P. T. Madsen, P. L. Tyack, A. Bocconcelli and J. F. Borsani. 2006. Does intense ship noise disrupt foraging in deep-diving Cuvier's beaked whales. *Ziphius cavirostris*)? Marine Mammal Science. 22(3): 690-699.

Southall, B. 2006a. Declaration of Brandon L. Southall, Ph.D. Natural Resources Defense Council v Donald C. Winter (RIMPAC), June 30, 2006.

Southall, B.L., R. Braun, F.M. D. Gulland, A.D. Heard, R. Baird, S. Wilkin and T.K. Rowles. 2006. Hawaiian melon-headed whale (*Peponocephala electra*) mass stranding event of July 3-4, 2004. NOAA Technical Memorandum NMFS-OPR-31. 73 pp.

Stacey, P.J., and R.W. Baird. 1991. Status of the false killer whale, *Pseudorca crassidens*, in Canada. Canadian Field-Naturalist. 105:189-197.

Stafford, K.M. 2003. Two types of blue whale calls recorded in the Gulf of Alaska. Marine Mammal Science. 19:682-693.

Stafford, K.M., S.L. Nieukirk, and C.G. Fox. 2001. Geographic and seasonal variation of blue whale calls in the North Pacific. Journal of Cetacean Research and Management. 3:65-76.

Stafford, K.M., S.E. Moore, and C.G. Fox. 2005. Diel variation in blue whale calls recorded in the eastern tropical Pacific. Animal Behaviour. 69:951-958.

Standard EIGER, 1995. Environmental Assessment of the Use of Underwater Acoustic and Explosive Sources during Exercise Standard EIGER, Department of the Navy, SSBN Security Program Office, 27 July (Limited Distribution).

Steiger, G.H., J. Calambokidis, R. Sears, K.C. Balcomb, and J.C. Cubbage, 1991. Movement of humpback whales between California and Costa Rica. *Marine Mammal Science* 7:306-310.

Stern, J.S. 1992. Surfacing rates and surfacing patterns of minke whales (*Balaenoptera acutorostrata*) off central California, and the probability of a whale surfacing within visual range. Reports of the International Whaling Commission. 42:379-385.

Stevick, P.T., B.J. McConnell, and P.S. Hammond. 2002. Patterns of movement. Pages 185-216 in A.R. Hoelzel, ed. Marine mammal biology: An evolutionary approach. Oxford: Blackwell Science.

Stewart, B.S., P.K. Yochem, H.R. Huber, R.L. DeLong, R.J. Jameson, W.J. Sydeman, S.G. Allen, and B.J. Le Boeuf. 1994. History and present status of the northern elephant seal population. Pages 29-48 in B.J. Le Boeuf and R.M. Laws, eds. Elephant seals: Population ecology, behavior, and physiology. Berkeley: University of California Press.

Stewart, B.S., and R.L. DeLong. 1995. Double migrations of the northern elephant seal, *Mirounga angustirostris*. Journal of Mammalogy. 76:196-205

Stewart, B.S. 1997. Ontogeny of differential migration and sexual segregation in northern elephant seals. Journal of Mammalogy. 78:1101-1116.

Stone, G.S., S.K. Katona, A. Mainwaring, J.M. Allen, and H.D. Corbett. 1992. Respiration and surfacing rates for finback whales (*Balaenoptera physalus*) observed from a lighthouse tower. Reports of the International Whaling Commission. 42:739-745.

Stone, S., United States. National Oceanic and Atmospheric Administration. and United States. National Marine Fisheries Service. Southwest Region.. 1986. Annotated bibliography on impacts of gillnets on non-targeted species. [Terminal Island, Calif.?], U.S. Dept. of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service Southwest Region 1986.

Sugimoto, T., S. Kimura and K. Tadokoro. 2001. Impact of El Niño events and climate regime shift on living resources in the western North Pacific. Progress in Oceanography. 49:113-127.

Sullivan, M. J., and R. B. Conolly. 1988. Dose-response hearing loss for white noise in the Sprague-Dawley rat. Toxicological Sciences. 10:109-113

Summary Papers on Human and Animal Hearing Effects in Air. 1991. Special section in Journal of the Acoustical Society of America. 90:124-227.

Suter II, G. W., L. W. Barnthouse, S. M. Bartell, T. Mill, D. Mackay, and S. Paterson 1993. Ecological risk assessment. Lewis Publishers, Boca Raton, Florida.

Swartz, S.L., A. Martinez, J. Stamates, C. Burks, and A.A. Mignucci-Giannoni. 2002. Acoustic and visual survey of cetaceans in the waters of Puerto Rico and the Virgin Islands: February-March 2001. NOAA Technical Memorandum NMFS-SEFSC-463:l-62.

Sweeny, M. M., J. M. Price, G. S. Jones, T. W. French, G. A. Early and M. J. Moore. 2006. Spondylitic changes in long-finned pilot whales (*Globicephala melas*) stranded on cape cod, Massachusetts, USA, between 1982 and 2000. Journal of Wildlife Diseases. 41(4):717-727.

Swets, J.A. 1964. <u>Signal Detection and Recognition by Human Observers, Contemporary Readings</u>, John Wiley and Sons, New York.

Szymanski, M.D., D.E. Bain, K. Kiehl, S. Pennington, S. Wong, and K.R. Henry. 1999. Killer whale (*Orcinus orca*) hearing: auditory brainstem response and behavioral audiograms. Journal of the Acoustical Society of America. 106:1134-1141.

Taylor, B., J. Barlow, R. Pitman, L. Ballance, T. Klinger, D. P. DeMaster, J. A. Hildebrand, J. Urban, D. Palacios and J. G. Mead. 2004. A call for research to assess risk of acoustic impact on beaked whale populations: Unpublished Report to the Scientific Committee of the International Whaling Commission. SC/56/E36. 4 pp.

Thode, A., D.K. Mellinger, S. Stienessen, A. Martinez, and K. Mullin. 2002. Depth-dependent acoustic features of diving sperm whales (*Physeter macrocephalus*) in the Gulf of Mexico. Journal of the Acoustical Society of America. 112:308-321.

Thomas, J., N. Chun, W. Au, and K. Pugh. 1988. Underwater audiogram of a false killer whale (*Pseudorca crassidens*). Journal of the Acoustical Society of America. 84:936-940.

Thomas, J. and R. Kastelein. 1990. Sensory Abilities of Cetaceans. Plenum Press, New York.

Thomas, J., P. Moore, R. Withrow, and M. Stoermer. 1990. Underwater audiogram of a Hawaiian monk seal (*Monachus schauinslandi*). Journal of the Acoustical Society of America. 87:417-420.

Thompson, P.O., and W.A. Friedl. 1982. A long term study of low frequency sounds from several species of whales off Oahu, Hawaii. Cetology. 45:l -1 9.

Thompson, T.J., H.E. Winn, and P.J. Perkins. 1979. Mysticete sounds. In Behavior of marine animals, Volume 3. H.E. Winn and B.L. Olla, (eds.), Plenum, NY. 438 pp.

Thorson, P.H., J.K. Francine, E.A. Berg, L.E. Meyers, D.A. Eidson and G.W. Oliver. 1999. Quantitative Analysis of Behavioral Responses for Selected Pinnipeds on Vandenberg Air Force Base and San Miguel Island, California and Acoustic Measurement of the 24 September 1999 Athena 2 IKONOS-II Launch. SRS Technologies technical report submitted to Lockheed Martin Environmental Services and the National Marine Fisheries Service. 35 pp.

Thurman, H.V. 1997. Introductory oceanography. Upper Saddle River, New Jersey: Prentice Hall.

Tracey, R. 2000. Mass false killer whale beaching remains a mystery. Discovery Channel Canada's Website. Accessed 2/12/07. http://www.exn.ca/Stories/2000/06/05/56.asp

Tregenza, N., N. Aguilar, M. Carrillo, I. Delgado, F. Diaz, A. Brito and V. Martin. 2000. Potential Impact of Fast Ferries on Whale Populations: A Simple Model with Examples from the Canary Islands. European Cetacean Society 14th Annual Conference, Cork, Ireland.

Trimper, P. G., N. M. Standen, L. M. Lye, D. Lemon, T. E. Chubbs, and G. W. Humphries., 1998. Effects of lowlevel jet aircraft noise on the behaviour of nesting osprey. The Journal of Applied Ecology. 35:9.

Tyack, P.L., J. Gordon, and D. Thompson. 2004. Controlled Exposure Experiments to Determine the Effects of Noise on Marine Mammals. Marine Technology Society Journal. 37(4): 41-53.

Tyack, P.L., M.P. Johnson, W.M.X. Zimmer, P.T. Madsen, and M.A. de Soto. 2006a. Acoustic behavior of beaked whales, with implications for acoustic monitoring. Oceans. 2006. 1-6.

Tyack, P.L., M.P. Johnson, M.A. de Soto, A. Sturlese, and P.T. Madsen. 2006b. Extreme diving of beaked whales. Journal of Experimental Biology. 209:4238-4253.

Tynan, C.T., D.P. DeMaster, and W.T. Peterson. 2001. Endangered right whales on the southeastern Bering Sea shelf. Science. 294:1894.

United States Fish and Wildlife Service (USFWS). 2001. Notice of Policy Regarding Capture and Removal of Southern Sea Otters in a Designated Management Zone. Federal Register. Volume 66, Number 14. Pp. 6649-6652.

United States Fish and Wildlife Service (USFWS). 2003. Final Revised Recovery Plan for the Southern Sea Otter (*Enhydra lutris nereis*). Portland, Oregon. 165 pp.

Urick, R. J. 1983. Principles of Underwater Sound for Engineers, McGraw-Hill, NY, 1975.

Van Dolah, F.M., G.J. Doucette, F.M.D. Gulland, T.L. Rowles, and G.D. Bossart. 2003. Impacts of algal toxins on marine mammals. IN: J.G. Vos, G.D. Bossart, M. Fournier, and T.J. O'Shea, eds. Toxicology of Marine Mammals, Taylor & Francis, London and New York. pp. 247-269.

Van Dolah, F.M. 2005. Effects of Harmful Algal Blooms. IN: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery, T.J. Ragen. Marine Mammal Research. John Hopkins University Press, Baltimore. pp. 85-99.

Vanderlaan, A. S. M. and C. T. Taggart. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science. 23(1): 144-196.

Vanselow, K. H. and K. Ricklefs. 2005. Are solar activity and sperm whale *Physeter macrocephalus* strandings around the North Sea related? Journal of Sea Research. 53: 319-327.

Veirs, V. 2004. Source levels of free-ranging killer whale (*Orcinus orca*) social vocalizations. Journal of the Acoustical Society of America. 116:2615.

Vetter, W. and e. al.. 2001. Anthropogenic and Natural Organohalogen Compounds in Blubber of Dolphins and Dugongs. *Dugong dugon*) from Northeastern Australia. Archives of Environmental Contamination and Toxicology. 41(2): 221-231.

Viale, D. 1978. Evidence of metal pollution in cetacea of western Mediterranean. Ann. Inst. Oceanogr. 54(1): 5-16.

Vidal, O. and J.-P. Gallo-Reynoso. 1996. Die-offs of marine mammals and sea birds in the Gulf of California, Mexico. Marine Mammal Science. 12(4): 627-635.

Visser, I.K.G., J.S. Teppema, and A.D.M.E. Ostrhaus. 1991. Virus infections of seals and other pinnipeds. Reviews in Medical Microbiology. 2:105-114.

Von Saunder, A., and J. Barlow. 1999. A report of the Oregon, California and Washington line-transect experiment (ORCAWALE) conducted in West Coast waters during Summer/Fall 1996. NOAA Technical Memorandum NMFS-SWFSC-264:1-49.

Wade, L.S., and G.L. Friedrichsen. 1979. Recent sightings of the blue whale, *Balaenoptera musculus*, in the northeastern tropical Pacific. Fishery Bulletin. 76:915-919.

Wade, P.R, and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Reports of the International Whaling Commission. 43:477-493.

Wahlberg, M. 2002. The acoustic behaviour of diving sperm whales observed with a hydrophone array. Journal of Experimental Marine Biology and Ecology. 281:53-62.

Walker, M. M., J. L. Kirschvink, G. Ahmed and A. E. Dizon. 1992. Evidence that fin whales respond to the geomagnetic field during migration. Journal of Experimental Biology. 171(1): 67-78.

Walker, R. J., E. O. Keith, A. E. Yankovsky and D. K. Odell. 2005. Environmental correlates of cetacean mass stranding in sites in Florida. Marine Mammal Science. 21(2): 327-335.

Walker, W.A. 1981. Geographical variation in morphology and biology of bottlenose dolphins (*Tursiops*) in the eastern North Pacific. Southwest Fisheries Science Center Administrative Report LJ-81-03C. La Jolla, California: National Marine Fisheries Service.

Walker, W.A., J.G. Mead, and R.L. Brownell. 2002. Diets of Baird's beaked whales *Berardius bairdii*, in the southern Sea of Okhotsk and off the Pacific Coast of Honshu, Japan. Marine Mammal Science. 18:902-919.

Walsh, W.A., and D.R. Kobayashi. 2004. A description of the relationships between marine mammals and the Hawaii-based longline fishery from 1994 to 2003. Report prepared by the University of Hawaii and Pacific Islands Fisheries Science Center.

Walker, W.A., J.G. Mead, and R.L. Brownell. 2002. Diets of Baird's beaked whales *Berardius bairdii*, in the southern Sea of Okhotsk and off the Pacific Coast of Honshu, Japan. Marine Mammal Science. 18:902-919.

Walsh, M. T., R. Y. Ewing, D. K. Odell and G. D. Bossart. 2001. Mass Stranding of Cetaceans. CRC Handbook of Marine Mammals. L. A. Dierauf and F. M. D. Gulland, CRC Press: pp. 83-93.

Wang, M.-.C., W.A. Walker, K.T. Shao, and L.S. Chou. 2002. Comparative analysis of the diets of pygmy sperm whales and dwarf sperm whales in Taiwanese waters. Acta Zoologica Taiwanica. 13:53-62.

Ward, W.D. 1960. Recovery from high values of temporary threshold shift. Journal of the Acoustical Society of America. 32:497–500.

Ward, W.D. 1997. Effects of high-intensity sound. In Encyclopedia of Acoustics, ed. M.J. Crocker, 1497-1507. New York: Wiley.

Ward, W.D., A. Glorig, and DL. Sklar. 1958. Dependence of temporary threshold shift at 4 kc on intensity and time. Journal of the Acoustical Society of America. 30:944–954.

Ward, W.D., A. Glorig, and D.L. Sklar. 1959. Temporary threshold shift from octave-band noise: Applications to damage-risk criteria. Journal of the Acoustical Society of America. 31:522–528.

Ward-Geiger, L. I., G. K. Silber, R. D. Baumstark and T. L. Pulfer. 2005. Characterization of Ship Traffic in Right Whale Critical Habitat. Coastal Management. 33: 263-278.

Wartzok, D., and Ketten, D.. 1999. Marine mammal sensory systems. IN: J.E. Reynolds III and S. A. Rommel, eds. The Biology of Marine Mammals. Smithsonian Institution Press, Washington, DC.

Wartzok, D., A. N. Popper, J. Gordon, and J. Merrill. 2003. Factors affecting the responses of marine mammals to acoustic disturbance. Marine Technology Society Journal. 37:6–15.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-88. Fishery Bulletin. 88(2): 347-360.

Watkins, W.A., K.E. Moore, and P. Tyack. 1985. Sperm whale acoustic behaviors in the southeast Caribbean. Cetology. 49:1-15.

Watkins, W.A., P. Tyack, K.E. Moore, and J.E. Bird. 1987. The 20-Hz signals of finback whales (*Balaenoptera physalus*). Journal of the Acoustical Society of America. 82:1901-1912.

Watkins, W.A., M.A. Daher, A. Samuels, and D.P. Gannon. 1997. Observations of *Peponocephala electra*, the melon-headed whale, in the southeastern Caribbean. Caribbean Journal of Science. 33:34-40.

Watkins, W.A., M.A. Daher, K.M. Fristrup, and T.J. Howald. 1993. Sperm whales tagged with transponders and tracked underwater by sonar. Marine Mammal Science. 9:55-67.

Watkins, W.A., M.A. Daher, N.A. DiMarzio, A. Samuels, D. Wartzok, K.M. Fristrup, P.W. Howey, and R.R. Maiefski. 2002. Sperm whale dives tracked by radio tag telemetry. Marine Mammal Science. 18:55-68.

Watwood, S.L., P.J.O. Miller, M. Johnson, P.T. Madsen and P.L. Tyack. 2006. Deep-diving foraging behaviour of sperm whales (*Physeter macrocephalus*). Journal of Ecology. 75:814-825.

Weilgart, L. and H. Whitehead. 1993. Coda communication by sperm whales *(Physeter microcephalus)* off the Galapagos Islands. Canadian Journal of Zoology. 7 1:744-752.

Weilgart, L. and H. Whitehead. 1997. Group-specific dialects and geographical variation in coda repertoire in South Pacific sperm whales. Behavioral Ecology and Sociobiology 40:277-285.

Weise, M.J., D.P. Costa, and R.M. Kudela. 2006. Movement and diving behavior of male California sea lion (*Zalophus californianus*) during anomalous oceanographic conditions of 2005. Geophysical Research Letters. 33:L22S10.

Weinrich, M. T. 1999. Behavior of a Humpback Whale. *Megaptera novaeangliae*) Upon Entanglement in a Gill Net. Marine Mammal Science. 15(2): 559-563.

Welch, B. L. and A. S. Welch (eds.). 1970. Physiological effects of noise. Plenum Press, New York, NY.

Weller, D.W., B. Würsig, H. Whitehead, J.C. Norris, S.K. Lynn, R.W. Davis, N. Clauss, and P. Brown. 1996. Observations of an interaction between sperm whales and short-finned pilot whales in the Gulf of Mexico. Marine Mammal Science. 12:588-594.

Wells, R.S., D.J. Boness, and G.B. Rathbun. 1999. Behavior. Biology of Marine Mammals (ed. J.E. Reynolds III and S.A. Rommel), pp 117-175.

Westlake, R.L., and W.G. Gilmartin. 1990. Hawaiian monk seal pupping locations in the Northwestern Hawaiian Islands. Pacific Science. 44:366-383.

Weston, D.E. 1960. Underwater Explosions as Acoustic Sources. Proceedings of the Physics Society. 76: 233.

Whitehead, H. 2003. Sperm whales: Social evolution in the ocean. Chicago: University of Chicago Press.

Whitehead, H., and L. Weilgart. 1991. Patterns of visually observable behaviour and vocalizations in groups of female sperm whales. Behaviour. 118:276-296.

Whitehead, H, S. Brennan and D. Grover. 1992. Distribution and behaviour of male sperm whales on the Scotian Shelf, Canada. Canadian Journal of Zoology. 70:912-918.

Wiggins, S.M., M.A. McDonald, L.M. Munger, S.E. Moore, and J.A. Hildebrand. 2004. Waveguide propagation allows range estimates for North Pacific right whales in the Bering Sea. Canadian Acoustics. 32:146-154.

Wilkinson, D.M. 1991. Report to the Assistant Administrator for Fisheries, in Program Review of the Marine Mammal Stranding Network. U.S. Department of Commerce, National Oceanographic and Atmospheric Administrations, National Marine Fisheries Service, Silver Springs, MD. 171 pp.

Williams, N. 1998. Overfishing disrupts entire ecosystems. Science. 279: 809.

Willis, P.M., and R.W. Baird. 1998. Status of the dwarf sperm whale, *Kogia simus*, with special reference to Canada. Canadian Field-Naturalist. 112:114-125.

Winn, H.E., and P.J. Perkins. 1976. Distribution and sounds of the minke whale, with a review of mysticete sounds. Cetology. 19:1-12.

Winn, H.E., J.D. Goodyear, R.D. Kenney, and R.O. Petricig. 1995. Dive patterns of tagged right whales in the Great South Channel. Continental Shelf Research. 15:593-611.

Witham, R. 1995. Disruption of Sea Turtle Habitat with Emphasis on Human Influence. Biology and Conservation of Sea Turtles. K. A. Bjorndal. Washington, DC, Smithsonian Institution Press: 519-522.

Witteveen, B. H., J. M. Straley, O. Von Ziegesar, D. Steel, and C. S. Baker. 2004. Abundance and mtDNA differentiation of humpback whales (*Megaptera novaeangliae*) in the Shumagin Islands, Alaska. Canadian Journal of Zoology. 82:1352-1359.

Wolanski, E., R.H. Richmond, G. Davis, E. Deleersnijder, and R.R. Leben. 2003. Eddies around Guam, an island in the Mariana Islands group. Continental Shelf Research. 23:991-1003.

Woods Hole Oceanographic Institution. 2005. Beaked Whale Necropsy Findings for Strandings in the Bahamas, Puerto Rico, and Madiera, 1999 – 2002. Technical Report, WHOI-2005-09.

Woodward, B.L. and J.P. Winn. 2006. Apparent lateralized behavior in gray whales feeding off the central British Columbia coast. Marine Mammal Science. 22:64-73.

Würsig, B. 1989. Human Impacts on Cetaceans. Sea Turtles and Marine Mammals of the Gulf of Mexico, New Orleans, LA, US Department of the Interior, Minerals Management Service.

Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquatic Mammals. 24:41-50.

Yelverton, J.T. 1981, Underwater Explosion Damage Risk Criteria for Fish, Birds, and Mammals, Manuscript, presented at 102nd Meeting of the Acoustical Society of America, Miami Beach, FL, December, 1982. 32pp.

Yochem, P.K., and S. Leatherwood. 1985. Blue whale-*Balaenoptera musculus*. Pages 193-240 in S.H. Ridgway and R. Harrison, eds. Handbook of Marine Mammals. Volume 3: The sirenians and baleen whales. San Diego: Academic Press.

Yost, W.A. 1994. Fundamentals of Hearing: An Introduction. San Diego: Academic Press.

Yuen, M.E., Nachtigall, P.E., and Supin, A.Ya. 2005. Behavioral and AEP Audiograms of a false killer whale (*Pseudorca crassidens*). Journal of the Acoustical Society of America. 118: 2688-2695.

Yu, H-Y., H-K. Mok, R-C. Wei, and L-S., Chou. 2003. Vocalizations of a rehabilitated rough-toothed dolphin, *Steno bredanensis*. Page 183 in Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals. 14–19 December 2003. Greensboro, North Carolina.

Zeeberg, J., A. Corten and E. de Graaf. 2006. Bycatch and release of pelagic megafauna in industrial trawler fisheries off Northwest Africa. Fisheries Research. 78: 186-195.

Zimmerman, S. T. 1991. A History of Marine Mammal Stranding Networks in Alaska, with Notes on the Distribution of the Most Commonly Stranded Cetacean Species, 1975-1987. Marine Mammal Strandings in the United States, Miami, FL, NMFS.

Smith, M.E., A.S. Kane, and A.N. Popper. 2004. Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water?. Journal of Experimental Biology. 207:3591-3602.

Soto, N. A., M. A. Johnson, P. T. Madsen, P. L. Tyack, A. Bocconcelli and J. F. Borsani. 2006. Does intense ship noise disrupt foraging in deep-diving Cuvier's beaked whales. *Ziphius cavirostris*)? Marine Mammal Science. 22(3): 690-699.

Southall, B. 2006a. Declaration of Brandon L. Southall, Ph.D. Natural Resources Defense Council v Donald C. Winter (RIMPAC), June 30, 2006.

Southall, B.L., R. Braun, F.M. D. Gulland, A.D. Heard, R. Baird, S. Wilkin and T.K. Rowles. 2006. Hawaiian melon-headed whale (*Peponocephala electra*) mass stranding event of July 3-4, 2004. NOAA Technical Memorandum NMFS-OPR-31. 73 pp.

Stacey, P.J., and R.W. Baird. 1991. Status of the false killer whale, *Pseudorca crassidens*, in Canada. Canadian Field-Naturalist. 105:189-197.

Stafford, K.M. 2003. Two types of blue whale calls recorded in the Gulf of Alaska. Marine Mammal Science. 19:682-693.

Stafford, K.M., S.L. Nieukirk, and C.G. Fox. 2001. Geographic and seasonal variation of blue whale calls in the North Pacific. Journal of Cetacean Research and Management. 3:65-76.

Stafford, K.M., S.E. Moore, and C.G. Fox. 2005. Diel variation in blue whale calls recorded in the eastern tropical Pacific. Animal Behaviour. 69:951-958.

Standard EIGER, 1995. Environmental Assessment of the Use of Underwater Acoustic and Explosive Sources during Exercise Standard EIGER, Department of the Navy, SSBN Security Program Office, 27 July (Limited Distribution).

Steiger, G.H., J. Calambokidis, R. Sears, K.C. Balcomb, and J.C. Cubbage, 1991. Movement of humpback whales between California and Costa Rica. *Marine Mammal Science* 7:306-310.

Stern, J.S. 1992. Surfacing rates and surfacing patterns of minke whales (*Balaenoptera acutorostrata*) off central California, and the probability of a whale surfacing within visual range. Reports of the International Whaling Commission. 42:379-385.

Stevick, P.T., B.J. McConnell, and P.S. Hammond. 2002. Patterns of movement. Pages 185-216 in A.R. Hoelzel, ed. Marine mammal biology: An evolutionary approach. Oxford: Blackwell Science.

Stewart, B.S., P.K. Yochem, H.R. Huber, R.L. DeLong, R.J. Jameson, W.J. Sydeman, S.G. Allen, and B.J. Le Boeuf. 1994. History and present status of the northern elephant seal population. Pages 29-48 in B.J. Le Boeuf and R.M. Laws, eds. Elephant seals: Population ecology, behavior, and physiology. Berkeley: University of California Press.

Stewart, B.S., and R.L. DeLong. 1995. Double migrations of the northern elephant seal, *Mirounga angustirostris*. Journal of Mammalogy. 76:196-205

Stewart, B.S. 1997. Ontogeny of differential migration and sexual segregation in northern elephant seals. Journal of Mammalogy. 78:1101-1116.

Stone, G.S., S.K. Katona, A. Mainwaring, J.M. Allen, and H.D. Corbett. 1992. Respiration and surfacing rates for finback whales (*Balaenoptera physalus*) observed from a lighthouse tower. Reports of the International Whaling Commission. 42:739-745.

Stone, S., United States. National Oceanic and Atmospheric Administration. and United States. National Marine Fisheries Service. Southwest Region.. 1986. Annotated bibliography on impacts of gillnets on non-targeted species. [Terminal Island, Calif.?], U.S. Dept. of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service Southwest Region 1986.

Sugimoto, T., S. Kimura and K. Tadokoro. 2001. Impact of El Niño events and climate regime shift on living resources in the western North Pacific. Progress in Oceanography. 49:113-127.

Sullivan, M. J., and R. B. Conolly. 1988. Dose-response hearing loss for white noise in the Sprague-Dawley rat. Toxicological Sciences. 10:109-113

Summary Papers on Human and Animal Hearing Effects in Air. 1991. Special section in Journal of the Acoustical Society of America. 90:124-227.

Suter II, G. W., L. W. Barnthouse, S. M. Bartell, T. Mill, D. Mackay, and S. Paterson 1993. Ecological risk assessment. Lewis Publishers, Boca Raton, Florida.

Swartz, S.L., A. Martinez, J. Stamates, C. Burks, and A.A. Mignucci-Giannoni. 2002. Acoustic and visual survey of cetaceans in the waters of Puerto Rico and the Virgin Islands: February-March 2001. NOAA Technical Memorandum NMFS-SEFSC-463:l-62.

Sweeny, M. M., J. M. Price, G. S. Jones, T. W. French, G. A. Early and M. J. Moore. 2006. Spondylitic changes in long-finned pilot whales (*Globicephala melas*) stranded on cape cod, Massachusetts, USA, between 1982 and 2000. Journal of Wildlife Diseases. 41(4):717-727.

Swets, J.A. 1964. Signal Detection and Recognition by Human Observers, Contemporary Readings, John Wiley and Sons, New York.

Szymanski, M.D., D.E. Bain, K. Kiehl, S. Pennington, S. Wong, and K.R. Henry. 1999. Killer whale (*Orcinus orca*) hearing: auditory brainstem response and behavioral audiograms. Journal of the Acoustical Society of America. 106:1134-1141.

Taylor, B., J. Barlow, R. Pitman, L. Ballance, T. Klinger, D. P. DeMaster, J. A. Hildebrand, J. Urban, D. Palacios and J. G. Mead. 2004. A call for research to assess risk of acoustic impact on beaked whale populations: Unpublished Report to the Scientific Committee of the International Whaling Commission. SC/56/E36. 4 pp.

Thode, A., D.K. Mellinger, S. Stienessen, A. Martinez, and K. Mullin. 2002. Depth-dependent acoustic features of diving sperm whales (*Physeter macrocephalus*) in the Gulf of Mexico. Journal of the Acoustical Society of America. 112:308-321.

Thomas, J., N. Chun, W. Au, and K. Pugh. 1988. Underwater audiogram of a false killer whale (*Pseudorca crassidens*). Journal of the Acoustical Society of America. 84:936-940.

Thomas, J. and R. Kastelein. 1990. Sensory Abilities of Cetaceans. Plenum Press, New York.

Thomas, J., P. Moore, R. Withrow, and M. Stoermer. 1990. Underwater audiogram of a Hawaiian monk seal (*Monachus schauinslandi*). Journal of the Acoustical Society of America. 87:417-420.

Thompson, P.O., and W.A. Friedl. 1982. A long term study of low frequency sounds from several species of whales off Oahu, Hawaii. Cetology. 45:l -1 9.

Thompson, T.J., H.E. Winn, and P.J. Perkins. 1979. Mysticete sounds. In Behavior of marine animals, Volume 3. H.E. Winn and B.L. Olla, (eds.), Plenum, NY. 438 pp.

Thorson, P.H., J.K. Francine, E.A. Berg, L.E. Meyers, D.A. Eidson and G.W. Oliver. 1999. Quantitative Analysis of Behavioral Responses for Selected Pinnipeds on Vandenberg Air Force Base and San Miguel Island, California and Acoustic Measurement of the 24 September 1999 Athena 2 IKONOS-II Launch. SRS Technologies technical report submitted to Lockheed Martin Environmental Services and the National Marine Fisheries Service. 35 pp.

Thurman, H.V. 1997. Introductory oceanography. Upper Saddle River, New Jersey: Prentice Hall.

Tracey, R. 2000. Mass false killer whale beaching remains a mystery. Discovery Channel Canada's Website. Accessed 2/12/07. http://www.exn.ca/Stories/2000/06/05/56.asp

Tregenza, N., N. Aguilar, M. Carrillo, I. Delgado, F. Diaz, A. Brito and V. Martin. 2000. Potential Impact of Fast Ferries on Whale Populations: A Simple Model with Examples from the Canary Islands. European Cetacean Society 14th Annual Conference, Cork, Ireland.

Trimper, P. G., N. M. Standen, L. M. Lye, D. Lemon, T. E. Chubbs, and G. W. Humphries., 1998. Effects of lowlevel jet aircraft noise on the behaviour of nesting osprey. The Journal of Applied Ecology. 35:9.

Tyack, P.L., J. Gordon, and D. Thompson. 2004. Controlled Exposure Experiments to Determine the Effects of Noise on Marine Mammals. Marine Technology Society Journal. 37(4): 41-53.

Tyack, P.L., M.P. Johnson, W.M.X. Zimmer, P.T. Madsen, and M.A. de Soto. 2006a. Acoustic behavior of beaked whales, with implications for acoustic monitoring. Oceans. 2006. 1-6.

Tyack, P.L., M.P. Johnson, M.A. de Soto, A. Sturlese, and P.T. Madsen. 2006b. Extreme diving of beaked whales. Journal of Experimental Biology. 209:4238-4253.

Tynan, C.T., D.P. DeMaster, and W.T. Peterson. 2001. Endangered right whales on the southeastern Bering Sea shelf. Science. 294:1894.

United States Fish and Wildlife Service (USFWS). 2001. Notice of Policy Regarding Capture and Removal of Southern Sea Otters in a Designated Management Zone. Federal Register. Volume 66, Number 14. Pp. 6649-6652.

United States Fish and Wildlife Service (USFWS). 2003. Final Revised Recovery Plan for the Southern Sea Otter (*Enhydra lutris nereis*). Portland, Oregon. 165 pp.

Urick, R. J. 1983. Principles of Underwater Sound for Engineers, McGraw-Hill, NY, 1975.

Van Dolah, F.M., G.J. Doucette, F.M.D. Gulland, T.L. Rowles, and G.D. Bossart. 2003. Impacts of algal toxins on marine mammals. IN: J.G. Vos, G.D. Bossart, M. Fournier, and T.J. O'Shea, eds. Toxicology of Marine Mammals, Taylor & Francis, London and New York. pp. 247-269.

Van Dolah, F.M. 2005. Effects of Harmful Algal Blooms. IN: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery, T.J. Ragen. Marine Mammal Research. John Hopkins University Press, Baltimore. pp. 85-99.

Vanderlaan, A. S. M. and C. T. Taggart. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science. 23(1): 144-196.

Vanselow, K. H. and K. Ricklefs. 2005. Are solar activity and sperm whale *Physeter macrocephalus* strandings around the North Sea related? Journal of Sea Research. 53: 319-327.

Veirs, V. 2004. Source levels of free-ranging killer whale (*Orcinus orca*) social vocalizations. Journal of the Acoustical Society of America. 116:2615.

Vetter, W. and e. al.. 2001. Anthropogenic and Natural Organohalogen Compounds in Blubber of Dolphins and Dugongs. *Dugong dugon*) from Northeastern Australia. Archives of Environmental Contamination and Toxicology. 41(2): 221-231.

Viale, D. 1978. Evidence of metal pollution in cetacea of western Mediterranean. Ann. Inst. Oceanogr. 54(1): 5-16.

Vidal, O. and J.-P. Gallo-Reynoso. 1996. Die-offs of marine mammals and sea birds in the Gulf of California, Mexico. Marine Mammal Science. 12(4): 627-635.

Visser, I.K.G., J.S. Teppema, and A.D.M.E. Ostrhaus. 1991. Virus infections of seals and other pinnipeds. Reviews in Medical Microbiology. 2:105-114.

Von Saunder, A., and J. Barlow. 1999. A report of the Oregon, California and Washington line-transect experiment (ORCAWALE) conducted in West Coast waters during Summer/Fall 1996. NOAA Technical Memorandum NMFS-SWFSC-264:1-49.

Wade, L.S., and G.L. Friedrichsen. 1979. Recent sightings of the blue whale, *Balaenoptera musculus*, in the northeastern tropical Pacific. Fishery Bulletin. 76:915-919.

Wade, P.R, and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Reports of the International Whaling Commission. 43:477-493.

Wahlberg, M. 2002. The acoustic behaviour of diving sperm whales observed with a hydrophone array. Journal of Experimental Marine Biology and Ecology. 281:53-62.

Walker, M. M., J. L. Kirschvink, G. Ahmed and A. E. Dizon. 1992. Evidence that fin whales respond to the geomagnetic field during migration. Journal of Experimental Biology. 171(1): 67-78.

Walker, R. J., E. O. Keith, A. E. Yankovsky and D. K. Odell. 2005. Environmental correlates of cetacean mass stranding in sites in Florida. Marine Mammal Science. 21(2): 327-335.

Walker, W.A. 1981. Geographical variation in morphology and biology of bottlenose dolphins (*Tursiops*) in the eastern North Pacific. Southwest Fisheries Science Center Administrative Report LJ-81-03C. La Jolla, California: National Marine Fisheries Service.

Walker, W.A., J.G. Mead, and R.L. Brownell. 2002. Diets of Baird's beaked whales *Berardius bairdii*, in the southern Sea of Okhotsk and off the Pacific Coast of Honshu, Japan. Marine Mammal Science. 18:902-919.

Walsh, W.A., and D.R. Kobayashi. 2004. A description of the relationships between marine mammals and the Hawaii-based longline fishery from 1994 to 2003. Report prepared by the University of Hawaii and Pacific Islands Fisheries Science Center.

Walker, W.A., J.G. Mead, and R.L. Brownell. 2002. Diets of Baird's beaked whales *Berardius bairdii*, in the southern Sea of Okhotsk and off the Pacific Coast of Honshu, Japan. Marine Mammal Science. 18:902-919.

Walsh, M. T., R. Y. Ewing, D. K. Odell and G. D. Bossart. 2001. Mass Stranding of Cetaceans. CRC Handbook of Marine Mammals. L. A. Dierauf and F. M. D. Gulland, CRC Press: pp. 83-93.

Wang, M.-.C., W.A. Walker, K.T. Shao, and L.S. Chou. 2002. Comparative analysis of the diets of pygmy sperm whales and dwarf sperm whales in Taiwanese waters. Acta Zoologica Taiwanica. 13:53-62.

Ward, W.D. 1960. Recovery from high values of temporary threshold shift. Journal of the Acoustical Society of America. 32:497–500.

Ward, W.D. 1997. Effects of high-intensity sound. In Encyclopedia of Acoustics, ed. M.J. Crocker, 1497-1507. New York: Wiley.

Ward, W.D., A. Glorig, and DL. Sklar. 1958. Dependence of temporary threshold shift at 4 kc on intensity and time. Journal of the Acoustical Society of America. 30:944–954.

Ward, W.D., A. Glorig, and D.L. Sklar. 1959. Temporary threshold shift from octave-band noise: Applications to damage-risk criteria. Journal of the Acoustical Society of America. 31:522–528.

Ward-Geiger, L. I., G. K. Silber, R. D. Baumstark and T. L. Pulfer. 2005. Characterization of Ship Traffic in Right Whale Critical Habitat. Coastal Management. 33: 263-278.

Wartzok, D., and Ketten, D.. 1999. Marine mammal sensory systems. IN: J.E. Reynolds III and S. A. Rommel, eds. The Biology of Marine Mammals. Smithsonian Institution Press, Washington, DC.

Wartzok, D., A. N. Popper, J. Gordon, and J. Merrill. 2003. Factors affecting the responses of marine mammals to acoustic disturbance. Marine Technology Society Journal. 37:6–15.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-88. Fishery Bulletin. 88(2): 347-360.

Watkins, W.A., K.E. Moore, and P. Tyack. 1985. Sperm whale acoustic behaviors in the southeast Caribbean. Cetology. 49:1-15.

Watkins, W.A., P. Tyack, K.E. Moore, and J.E. Bird. 1987. The 20-Hz signals of finback whales (*Balaenoptera physalus*). Journal of the Acoustical Society of America. 82:1901-1912.

Watkins, W.A., M.A. Daher, A. Samuels, and D.P. Gannon. 1997. Observations of *Peponocephala electra*, the melon-headed whale, in the southeastern Caribbean. Caribbean Journal of Science. 33:34-40.

Watkins, W.A., M.A. Daher, K.M. Fristrup, and T.J. Howald. 1993. Sperm whales tagged with transponders and tracked underwater by sonar. Marine Mammal Science. 9:55-67.

Watkins, W.A., M.A. Daher, N.A. DiMarzio, A. Samuels, D. Wartzok, K.M. Fristrup, P.W. Howey, and R.R. Maiefski. 2002. Sperm whale dives tracked by radio tag telemetry. Marine Mammal Science. 18:55-68.

Watwood, S.L., P.J.O. Miller, M. Johnson, P.T. Madsen and P.L. Tyack. 2006. Deep-diving foraging behaviour of sperm whales (*Physeter macrocephalus*). Journal of Ecology. 75:814-825.

Weilgart, L. and H. Whitehead. 1993. Coda communication by sperm whales *(Physeter microcephalus)* off the Galapagos Islands. Canadian Journal of Zoology. 7 1:744-752.

Weilgart, L. and H. Whitehead. 1997. Group-specific dialects and geographical variation in coda repertoire in South Pacific sperm whales. Behavioral Ecology and Sociobiology 40:277-285.

Weise, M.J., D.P. Costa, and R.M. Kudela. 2006. Movement and diving behavior of male California sea lion (*Zalophus californianus*) during anomalous oceanographic conditions of 2005. Geophysical Research Letters. 33:L22S10.

Weinrich, M. T. 1999. Behavior of a Humpback Whale. *Megaptera novaeangliae*) Upon Entanglement in a Gill Net. Marine Mammal Science. 15(2): 559-563.

Welch, B. L. and A. S. Welch (eds.). 1970. Physiological effects of noise. Plenum Press, New York, NY.

Weller, D.W., B. Würsig, H. Whitehead, J.C. Norris, S.K. Lynn, R.W. Davis, N. Clauss, and P. Brown. 1996. Observations of an interaction between sperm whales and short-finned pilot whales in the Gulf of Mexico. Marine Mammal Science. 12:588-594.

Wells, R.S., D.J. Boness, and G.B. Rathbun. 1999. Behavior. Biology of Marine Mammals (ed. J.E. Reynolds III and S.A. Rommel), pp 117-175.

Westlake, R.L., and W.G. Gilmartin. 1990. Hawaiian monk seal pupping locations in the Northwestern Hawaiian Islands. Pacific Science. 44:366-383.

Weston, D.E. 1960. Underwater Explosions as Acoustic Sources. Proceedings of the Physics Society. 76: 233.

Whitehead, H. 2003. Sperm whales: Social evolution in the ocean. Chicago: University of Chicago Press.

Whitehead, H., and L. Weilgart. 1991. Patterns of visually observable behaviour and vocalizations in groups of female sperm whales. Behaviour. 118:276-296.

Whitehead, H, S. Brennan and D. Grover. 1992. Distribution and behaviour of male sperm whales on the Scotian Shelf, Canada. Canadian Journal of Zoology. 70:912-918.

Wiggins, S.M., M.A. McDonald, L.M. Munger, S.E. Moore, and J.A. Hildebrand. 2004. Waveguide propagation allows range estimates for North Pacific right whales in the Bering Sea. Canadian Acoustics. 32:146-154.

Wilkinson, D.M. 1991. Report to the Assistant Administrator for Fisheries, in Program Review of the Marine Mammal Stranding Network. U.S. Department of Commerce, National Oceanographic and Atmospheric Administrations, National Marine Fisheries Service, Silver Springs, MD. 171 pp.

Williams, N. 1998. Overfishing disrupts entire ecosystems. Science. 279: 809.

Willis, P.M., and R.W. Baird. 1998. Status of the dwarf sperm whale, *Kogia simus*, with special reference to Canada. Canadian Field-Naturalist. 112:114-125.

Winn, H.E., and P.J. Perkins. 1976. Distribution and sounds of the minke whale, with a review of mysticete sounds. Cetology. 19:1-12.

Winn, H.E., J.D. Goodyear, R.D. Kenney, and R.O. Petricig. 1995. Dive patterns of tagged right whales in the Great South Channel. Continental Shelf Research. 15:593-611.

Witham, R. 1995. Disruption of Sea Turtle Habitat with Emphasis on Human Influence. Biology and Conservation of Sea Turtles. K. A. Bjorndal. Washington, DC, Smithsonian Institution Press: 519-522.

Witteveen, B. H., J. M. Straley, O. Von Ziegesar, D. Steel, and C. S. Baker. 2004. Abundance and mtDNA differentiation of humpback whales (*Megaptera novaeangliae*) in the Shumagin Islands, Alaska. Canadian Journal of Zoology. 82:1352-1359.

Wolanski, E., R.H. Richmond, G. Davis, E. Deleersnijder, and R.R. Leben. 2003. Eddies around Guam, an island in the Mariana Islands group. Continental Shelf Research. 23:991-1003.

Woods Hole Oceanographic Institution. 2005. Beaked Whale Necropsy Findings for Strandings in the Bahamas, Puerto Rico, and Madiera, 1999 – 2002. Technical Report, WHOI-2005-09.

Woodward, B.L. and J.P. Winn. 2006. Apparent lateralized behavior in gray whales feeding off the central British Columbia coast. Marine Mammal Science. 22:64-73.

Würsig, B. 1989. Human Impacts on Cetaceans. Sea Turtles and Marine Mammals of the Gulf of Mexico, New Orleans, LA, US Department of the Interior, Minerals Management Service.

Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquatic Mammals. 24:41-50.

Yelverton, J.T. 1981, Underwater Explosion Damage Risk Criteria for Fish, Birds, and Mammals, Manuscript, presented at 102nd Meeting of the Acoustical Society of America, Miami Beach, FL, December, 1982. 32pp.

Yochem, P.K., and S. Leatherwood. 1985. Blue whale-*Balaenoptera musculus*. Pages 193-240 in S.H. Ridgway and R. Harrison, eds. Handbook of Marine Mammals. Volume 3: The sirenians and baleen whales. San Diego: Academic Press.

Yost, W.A. 1994. Fundamentals of Hearing: An Introduction. San Diego: Academic Press.

Yuen, M.E., Nachtigall, P.E., and Supin, A.Ya. 2005. Behavioral and AEP Audiograms of a false killer whale (*Pseudorca crassidens*). Journal of the Acoustical Society of America. 118: 2688-2695.

Yu, H-Y., H-K. Mok, R-C. Wei, and L-S., Chou. 2003. Vocalizations of a rehabilitated rough-toothed dolphin, *Steno bredanensis*. Page 183 in Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals. 14–19 December 2003. Greensboro, North Carolina.

Zeeberg, J., A. Corten and E. de Graaf. 2006. Bycatch and release of pelagic megafauna in industrial trawler fisheries off Northwest Africa. Fisheries Research. 78: 186-195.

Zimmerman, S. T. 1991. A History of Marine Mammal Stranding Networks in Alaska, with Notes on the Distribution of the Most Commonly Stranded Cetacean Species, 1975-1987. Marine Mammal Strandings in the United States, Miami, FL, NMFS.