
3.8 Marine Mammals

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MARINE MAMMALS SYNOPSIS

The United States Department of the Navy previously considered training in the Alaska Training Areas and the Gulf of Alaska for all potential stressors and their potential impacts to marine mammals in the analysis as presented in the 2011 Environmental Impact Statement (EIS)/Overseas EIS (OEIS). Since that document was completed, there have been improvements made in the modeling of potential impacts from acoustic stressors as well as the collection of new marine mammal data, new acoustic impact modeling methods, and new impact thresholds and criteria, which have been incorporated into the analysis presented in this Supplemental EIS/OEIS. This Supplemental EIS/OEIS, therefore, focuses on a re-analysis of potential impacts on marine mammals from acoustic stressors during training in the Temporary Military Activities Area portion of the 2011 GOA Final EIS/OEIS Study Area. Acoustic stressors analyzed in this Supplemental EIS/OEIS are identical to those analyzed in the 2011 GOA Final EIS/OEIS and include the following:

- Sonar and other active acoustic sources
- Explosives

Proposed Action Summary of Impacts

- The use of sonar and active acoustic sources and explosives is not expected to result in mortality to marine mammals;
- In general, long-term consequences for individuals or populations of marine mammals would not be expected.
- Pursuant to the Marine Mammal Protection Act (MMPA), use of sonar and other active acoustic sources and explosives may result in Level B harassment of certain marine mammals and may result in Level A harassments of Dall's porpoises.
- Pursuant to the Endangered Species Act (ESA), sonar and other active sources may affect and are likely to adversely affect certain ESA-listed marine mammals.
- Pursuant to the ESA, use of explosives may affect and is not likely to adversely affect ESA-listed marine mammals.
- Acoustic stressors will have no effect on marine mammal critical habitats.

3.8.1 INTRODUCTION

This section (3.8, Marine Mammals) of the Supplemental Environmental Impact Statement (EIS)/Overseas EIS (OEIS) provides the analysis of potential impacts to marine mammals that are found in the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA) Study Area (Study Area). The text box above provides a synopsis of the United States (U.S.) Department of Navy's (Navy's) determination of potential impacts from the Proposed Action on marine mammals. Section 3.8.2 (Affected Environment) provides an introduction to the species that occur in the Study Area. The complete analysis and summary of potential impacts of the Proposed Action on marine mammals are found in Sections 3.8.3 (Environmental Consequences), 3.8.4 (Summary of Impacts [Combined Impacts of All Stressors] on Marine Mammals), and 3.8.5 (Summary of Observations During Previous Navy Activities), respectively.

Marine mammals are a diverse group of approximately 130 species. Most live predominantly in the marine habitat, although some species (e.g., seals) spend time in terrestrial habitats or, in some cases, in freshwater environments, such as certain freshwater dolphins (Jefferson 2009, Rice 1998). The exact number of formally recognized marine mammal species changes periodically with new scientific understanding or findings (Rice 1998). Even the higher-level classification of marine mammals is controversial because the understanding of their origins and relationships continues to evolve (for a list of current species, see the formal list, *Marine Mammal Species and Subspecies*, maintained by the Society for Marine Mammalogy [Perrin et al. 2009]). This analysis uses the list of species provided by the National Oceanic and Atmospheric Administration (NOAA)/National Marine Fisheries Service (NMFS) 2015 U.S. Pacific Marine Mammal Stock Assessments (Carretta et al. 2016b) and the 2015 Alaska Marine Mammal Stock Assessments (Muto et al. 2016).

All marine mammals in the United States are protected under the Marine Mammal Protection Act (MMPA), and some species receive additional protection under the Endangered Species Act (ESA). The MMPA defines a marine mammal “stock” as “a group of marine mammals of the same species or smaller taxon in a common spatial arrangement that interbreed when mature.” For management purposes under the MMPA, a stock is considered an isolated population or group of individuals within a whole species that is found in the same area. However, generally due to a lack of sufficient information, management stocks defined by NMFS may include groups of multiple species, such as the six species grouped together as the *Mesoplodon* beaked whales management unit for the Pacific U.S. West Coast region (Carretta et al. 2016b). In other cases, a single species may include multiple stocks recognized for management purposes (e.g., harbor porpoise in Alaska; see Muto et al. 2016).

For summaries of the general biology and ecology of marine mammals beyond the scope of this Supplemental EIS/OEIS, see Berta et al. (2006), Hoelzel (2003), Jefferson et al. (2008), Perrin et al. (2008), Reynolds and Rommel (1999), Rice (1998), and Twiss and Reeves (1999). Additional species profiles and information on the biology, life history, species distribution, and conservation of marine mammals also can be found through the following organizations:

- NMFS Office of Protected Resources (includes species distribution maps)
- Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (known as OBIS-SEAMAP) species profiles
- NOAA Cetacean Density and Distribution Mapping Working Group
- International Whaling Commission
- International Union for Conservation of Nature, Cetacean Specialist Group
- The Marine Mammal Commission
- Society for Marine Mammalogy

Marine mammal survey data in the offshore waters of the Gulf of Alaska are limited, as most survey efforts have been localized and nearshore. Much of what is known about cetacean occurrence has come from whaling records (e.g., Ivashchenko et al. 2012), stranding records, anecdotal sighting reports, and other additional efforts (Davis et al. 2012; Matsuoka et al. 2013). The Navy conducted the first systematic marine mammal survey of waters in the Study Area from 10 to 20 April 2009 (Rone et al. 2009). The survey was conducted using systematic line-transect survey protocol, and both visual and acoustic detection methods were used during the survey (Rone et al. 2009). Eleven marine mammal species were seen and positively identified during the survey, including fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), gray whale (*Eschrichtius robustus*), minke whale (*Balaenoptera acutorostrata*), killer whale (*Orcinus orca*), Pacific white-sided dolphin (*Lagenorhynchus*

obliquidens), Dall's porpoise (*Phocoenoides dalli*), harbor porpoise (*Phocoena phocoena*), Steller sea lion (*Eumetopias jubatus*), harbor seal (*Phoca vitulina*), and sea otter (*Enhydra lutris kenyoni*). In addition, both sperm whales (*Physeter macrocephalus*) and killer whales were detected acoustically (Rone et al. 2009). Sighting data were sufficient to derive line-transect abundance estimates for fin and humpback whales.

The Navy funded a second systematic survey of the Study Area that occurred from 23 June to 18 July 2013 (Rone et al. 2014). The main goal of the second Gulf of Alaska Line-Transect Survey (GOALS II) was to collect data to assess the abundance and spatial distribution of marine mammals from both visual sighting data and passive acoustics using a towed-hydrophone array and sonobuoys. Sighting and acoustic data were collected from four survey strata designed to sample the diverse habitat present in the Study Area, including a continental shelf or "inshore" stratum (22,749 square kilometers [km²]), slope stratum (36,776 km²), pelagic or "offshore" stratum (60,051 km²), and seamount stratum (45,377 km²). During the survey, there were 802 marine mammal sightings (1,998 individuals) of 13 confirmed species. Confirmed species were Baird's (*Berardius bairdii*) and Cuvier's (*Ziphius cavirostris*) beaked whales, blue (*Balaenoptera musculus*), sperm, fin, humpback, gray, killer and minke whales, Dall's and harbor porpoise, and elephant (*Mirounga angustirostris*) and northern fur (*Callorhinus ursinus*) seals. There were an additional 162 sightings (261 individuals) of unidentified cetaceans and pinnipeds (Rone et al. 2014). Sighting data were sufficient to derive updated line-transect abundance estimates for fin and humpback whales, and new Study Area abundance estimates for blue, sperm, and killer whales, as well as Dall's porpoise and northern fur seals (Rone et al. 2014). Acoustic data gathered during the GOALS II survey were also analyzed to develop the first acoustic-based line-transect survey estimates of abundance for Cuvier's beaked whales within the Gulf of Alaska (U.S. Department of the Navy 2015).

In order to obtain additional information on the occurrence and seasonality of cetaceans in the Study Area, in July 2011 the Navy deployed two High-frequency Acoustic Recording Packages (HARPs) on the shelf (200 meters [m]) and slope (900 m) regions in the north-central Gulf of Alaska (Baumann-Pickering et al. 2012b). During the first 7 months of passive acoustic monitoring, at least 10 species were detected (blue whale [*Balaenoptera musculus*], fin whale, gray whale, humpback whale, sperm whale, killer whale, Stejneger's beaked whale [*Mesoplodon stejnegeri*], Baird's beaked whale [*Berardius bairdii*], Cuvier's beaked whale [*Ziphius cavirostris*], and an unidentified porpoise which was likely Dall's porpoise). An additional HARP was deployed in September 2012 at Pratt Seamount to provide more data relevant to characterizing the occurrence and seasonality of cetaceans in the Study Area (Debich et al. 2013, 2014). A total of five HARPs were deployed in the Gulf of Alaska from 2013 to 2014 with results summarized in Debich et al. 2014. Additional monitoring conducted in the GOA TMAA through spring/summer 2015 included the deployment of five HARPs to detect marine mammals and anthropogenic sounds (Rice et al., 2015). A passive acoustic sensor-mounted Kongsberg Seaglider was also deployed along the continental slope within the TMAA¹. Four baleen whale species were recorded by the HARP instruments. These included blue whales, fin whales, gray whales, and humpback whales. There were no North Pacific right whale calls detected. Across all sites, blue whales, fin whales and humpback whales were commonly detected throughout the recordings, with fin whale detections generally more prevalent at the shelf site. Humpback whales were one of the most commonly detected baleen whales throughout the recordings. Blue whale calls were most prevalent during the summer and fall, while humpback detections were highest from December through March. Fin whale 20 Hz calls were

¹ Marine mammal vocalization and echolocation detections from the Seaglider deployment are still undergoing analysis as of the date of publication for this document. The technical report regarding the results from that the Seaglider will be posted to the Navy's monitoring website [<http://www.navymarinespeciesmonitoring.us/>] once it has been completed.

the dominant call type, peaking from September to December, while 40 Hz calls peaked in the summer months. Signals from three known odontocete species were recorded: sperm whales, Cuvier's beaked whales, and Stejneger's beaked whales. Sperm whales were detected at every site, but were most prevalent at the continental slope site, with peak detections from June through late November 2014 and again in April to May 2015. Cuvier's beaked whales were detected in low numbers at the seamount sites. Stejneger's beaked whales were detected at the continental slope site, and the seamount sites, with most detections occurring at the continental slope site. The only anthropogenic sounds detected in the recordings were explosions, which Rice et al. (2015) attributed to fishery-related seal bombs based on the spectral properties of those acoustic events. The impulsive sound from these acoustic events match explosions detected in passive acoustic monitoring data that has been gathered since 2009 from Southern California, the Pacific Northwest, and the Gulf of Alaska (see for example Baumann-Pickering et al. 2013b; Debich et al. 2014, 2015; Kerosky et al 2013). In addition to the spectral properties of the recorded sounds, their correspondence with known fishing seasons or activity and the lack of any corresponding military activity have also contributed to the identification of these impulsive sounds as being the detonations of explosive pest control devices, which as a group are commonly known as "seal bombs" (Baumann-Pickering et al 2013b; NOAA 2015h). Seal bombs are intended to be used by commercial fishermen to deter marine mammals from preying upon their catch or to prevent interaction or entanglement with fishing gear (NOAA 2015h; Klint 2016; U.S. Department of the Navy 2016).

During their review of Rice et al. (2015), personnel from NMFS' Alaska Fisheries Science Center questioned if some of the acoustic detections identified by the acousticians as seal bomb detonations might have been a variation of a North Pacific right whale vocalization type known as a "gunshot" call (see Širović et al. 2014 regarding North Pacific right whale vocalizations). Further explanation for the identification of seal bombs was subsequently provided to the Fisheries Science Center personnel by Scripps. Scripps noted that the explosions recorded in the Gulf of Alaska and reported in Rice et al. (2015) as well as previous year's reports were broadband, impulsive sounds with a distinctive low-frequency rumble. Additionally, Scripps confirmed that from their experience with the detection of seal bombs signals in acoustic data from multiple locations, including those outside of Alaska (see for example Baumann-Pickering et al 2013b; Debich et al. 2014, 2015; Kerosky et al 2013), seal bombs are frequently deployed in a sequence over a period of time. Therefore, Scripps remains confident that spectral properties of the recorded sounds and the overall patterns and distributions of these acoustic events represent the detonation of seal bombs and that the likelihood of these acoustic events being North Pacific right whale calls is extremely low. Future monitoring will include varying numbers of HARPs or other passive acoustic technologies and the goals and research questions intended to be answered will be based on annual adaptive management meetings between the Navy and NMFS with input from the scientific community.

Marine mammal species known to occur in the Study Area and their currently recognized stocks are presented in Table 3.8-1. All these species are managed by NMFS or the U.S. Fish and Wildlife Service (USFWS) in the U.S. Exclusive Economic Zone (EEZ). Relevant information on their status, abundance, and distribution is presented in Section 3.8.2 (Affected Environment).

Table 3.8-1: Marine Mammals with Possible or Confirmed Presence within the Gulf of Alaska Study Area

Common Name	Scientific Name ¹	Stock ²	Stock Abundance ³ (CV)	Occurrence in Region ⁴	ESA/MMPA Status
Order Cetacea					
Suborder Mysticeti (baleen whales)					
Family Balaenidae (right whales)					
North Pacific right whale	<i>Eubalaena japonica</i>	Eastern North Pacific	31 (0.226)	Rare	Endangered/ Depleted
Family Balaenopteridae (rorquals)					
Humpback whale	<i>Megaptera novaeangliae</i>	Central North Pacific	10,103 (0.300)	Likely	Endangered/ Depleted
		California, Washington, and Oregon	1,918 (0.03)	Likely	Endangered/ Depleted
		Western North Pacific	1,107 (0.300)	Likely	Endangered/ Depleted
Blue whale	<i>Balaenoptera musculus</i>	Eastern North Pacific	1,647 (0.07)	Seasonal; highest likelihood July to December	Endangered/ Depleted
		Central North Pacific	81 (1.14)	Seasonal; highest likelihood July to December	Endangered/ Depleted
Fin whale	<i>Balaenoptera physalus</i>	Northeast Pacific	Not available	Likely	Endangered/ Depleted
Sei whale	<i>Balaenoptera borealis</i>	Eastern North Pacific	126 (0.53)	Rare	Endangered/ Depleted
Minke whale	<i>Balaenoptera acutorostrata</i>	Alaska	Not available	Likely	-
Family Eschrichtiidae (gray whale)					
Gray whale	<i>Eschrichtius robustus</i>	Eastern North Pacific	20,990 (0.05)	Likely: Highest numbers during seasonal migrations	-
		Western North Pacific	140 (0.04)	Rare: Individuals migrate through GOA	Endangered/ Depleted
Suborder Odontoceti (toothed whales)					
Family Physeteridae (sperm whale)					
Sperm whale	<i>Physeter macrocephalus</i>	North Pacific	Not available	Likely; More likely in waters > 1,000 m depth, most often > 2,000 m	Endangered/ Depleted
Family Delphinidae (dolphins)					
Killer whale	<i>Orcinus orca</i>	Alaska Resident	2,347 (n/a)	Likely	-
		Eastern North Pacific Offshore	240: includes known offshore killer whales along the U.S. west coast, Canada, and Alaska (0.049)	Infrequent: few sightings	-

Table 3.8-1: Marine Mammals with Possible or Confirmed Presence within the Gulf of Alaska Study Area (continued)

Common Name	Scientific Name ¹	Stock ²	Stock Abundance ³ (CV)	Occurrence in Region ⁴	ESA/MMPA Status
Family Delphinidae (dolphins) (continued)					
Killer whale	<i>Orcinus orca</i>	AT1 Transient	7	Rare; more likely inside Prince William Sound and Kenai Fjords	-
		GOA, Aleutian Island, and Bering Sea Transient	587	Likely	
Pacific white-sided dolphin	<i>Lagenorhynchus obliquidens</i>	North Pacific	26,880; specific to the GOA, not the management stock (n/a)	Likely	-
Family Phocoenidae (porpoises)					
Harbor porpoise	<i>Phocoena</i>	GOA	31,046 (0.214)	Likely in nearshore locations	-
		Southeast Alaska	11,146 (0.242)	Likely in nearshore locations	
Dall's porpoise	<i>Phocoenoides dalli</i>	Alaska	83,400 (0.097); based on survey data from 1987–1991	Likely	-
Family Ziphiidae (beaked whales)					
Cuvier's beaked whale	<i>Ziphius cavirostris</i>	Alaska	Not available	Likely	-
Baird's beaked whale	<i>Berardius bairdii</i>	Alaska	Not available	Likely	-
Stejneger's beaked whale	<i>Mesoplodon stejnegeri</i>	Alaska	Not available	Likely	-
Order Carnivora					
Suborder Pinnipedia⁵					
Family Otariidae (fur seals and sea lions)					
Steller sea lion	<i>Eumetopias jubatus</i>	Eastern U.S.	59,968 (minimum estimate) (n/a)	Likely	-
		Western U.S.	49,497 (minimum estimate) (n/a)	Likely	Endangered/ Depleted
California sea lion	<i>Zalophus californianus</i>	U.S.	296,750 (n/a)	Rare	-
Northern fur seal	<i>Callorhinus ursinus</i>	Eastern Pacific	648,534 (n/a)	Likely	Depleted
Family Phocidae (true seals)					
Northern elephant seal	<i>Mirounga angustirostris</i>	California Breeding	179,000 (n/a)	Likely	-
Harbor seal	<i>Phoca vitulina</i>	Aleutian Islands	6,431 (n/a)	Extralimital	-

Table 3.8-1: Marine Mammals with Possible or Confirmed Presence within the Gulf of Alaska Study Area (continued)

Common Name	Scientific Name ¹	Stock ²	Stock Abundance ³ (CV)	Occurrence in Region ⁴	ESA/MMPA Status
Family Phocidae (true seals) (continued)					
Harbor seal	<i>Phoca vitulina</i>	Pribilof Islands	232 (n/a)	Extralimital	-
		Bristol Bay	32,350 (n/a)	Extralimital	-
		N. Kodiak	8,321 (n/a)	Rare (inshore waters)	-
		S. Kodiak	19,199 (n/a)	Rare (inshore waters)	-
		Prince William Sound	29,889 (n/a)	Rare (inshore waters)	-
		Cook Inlet/Shelikof	27,386 (n/a)	Extralimital	-
		Glacier Bay/Icy Strait	7,210 (n/a)	Rare (inshore waters)	-
		Lynn Canal/Stephens	9,478 (n/a)	Extralimital	-
		Sitka/Chatham	14,855 (n/a)	Rare (inshore waters)	-
		Dixon/Cape Decision	18,105 (n/a)	Rare (inshore waters)	-
		Clarence Strait	31,634 (n/a)	Extralimital	-
Ribbon seal	<i>Histiophoca fasciata</i>	Alaska	184,000	Rare	
Family Mustelidae (otters)⁶					
Northern sea otter	<i>Enhydra lutris kenyoni</i>	Southeast Alaska	10,563	Rare	-
		Southcentral Alaska	15,090	Rare	-
		Southwest Alaska	47,676	Rare	Threatened

¹ Taxonomy follows Perrin et al. 2009.² Stock names and abundance estimates from Muto et al. 2016 and Carretta et al. 2016b except where noted.³ The stated coefficient of variation (CV) from the NMFS Stock Assessment Reports is an indicator of uncertainty in the abundance estimate and describes the amount of variation with respect to the population mean. It is expressed as a fraction or sometimes a percentage and can range upward from zero, indicating no uncertainty, to high values. For example, a CV of 0.85 would indicate high uncertainty in the population estimate. When the CV exceeds 1.0, the estimate is very uncertain. The uncertainty associated with movements of animals into or out of an area (due to factors such as availability of prey or changing oceanographic conditions) is much larger than is indicated by the CVs that are given.⁴ EXTRALIMITAL: There may be a small number of sighting or stranding records, but the area is outside the species range of normal occurrence. RARE: The distribution of the species is near enough to the area that the species could occur there, or there are a few confirmed sightings. INFREQUENT: Confirmed, but irregular sightings or acoustic detections. LIKELY: Confirmed and regular sightings or acoustic detections of the species in the area year-round. SEASONAL: Confirmed and regular sightings or acoustic detections of the species in the area on a seasonal basis.⁵ There are no data regarding the CV for some of the pinniped species given that abundance is determined by different methods than those used for cetaceans.⁶ There are no data regarding the CV for sea otter given that abundance is determined by different methods than those used for cetaceans.

Notes: CV = coefficient of variation, ESA = Endangered Species Act, GOA = Gulf of Alaska, m = meter(s), MMPA = Marine Mammal Protection Act, n/a = not available, U.S. = United States

3.8.1.1 Species Unlikely to Be Present in the Study Area

The species carried forward for analysis are those likely to be found in the Study Area based on the most recent data available, and do not include species that may have once inhabited or transited the area but have not been sighted in recent years (e.g., species which were extirpated from factors such as nineteenth and twentieth century commercial exploitation). Several species that may be present in the northeast Pacific Ocean have an extremely low probability of presence in the Study Area. These species are considered extralimital, meaning there may be a small number of sighting or stranding records within the Study Area, but the area of concern is outside the species range of normal occurrence. These species include beluga whale (*Delphinapterus leucas*), false killer whale (*Pseudorca crassidens*), short-finned pilot whale (*Globicephala macrorhynchus*), northern right whale dolphin (*Lissodelphis borealis*), and Risso's dolphin (*Grampus griseus*), and have been excluded from subsequent analysis for the reasons described below.

3.8.1.1.1 Beluga Whale (*Delphinapterus leucas*)

There were 28 reported sightings of beluga whales in the GOA region from 1936 to 2000; however, all of these sightings were in the Cook Inlet or in very nearshore locations outside of the Study Area (Goetz et al. 2012, Laidre et al. 2000). The Cook Inlet stock of beluga whales was listed as endangered under the ESA on 22 October 2008 and was designated as depleted under the MMPA (National Oceanic and Atmospheric Administration 2008a). Rugh et al. (2010) found evidence that the Cook Inlet stock has exhibited range contraction towards the northeast, and that sightings in the southern inlet, closest to the Gulf of Alaska, have decreased. Critical habitat was designated for the Cook Inlet stock effective 11 April 2011 (National Oceanic and Atmospheric Administration 2011a), but the areas designated are far from the Study Area. Based on this information and the regulatory definition of the stock as those beluga whales confined to the waters of Cook Inlet (National Oceanic and Atmospheric Administration 2007, 2008a), this stock of beluga whales is not expected to be present in the Study Area. The Alaska Stock assessment report also notes a small number of beluga whales are regularly observed in Yakutat Bay and that these animals are presently considered part of the Cook Inlet stock (Allen and Angliss 2014). However, Yakutat Bay is at least 140 nautical miles (nm) northeast of the nearest border of the TMAA, so the Yakutat Bay beluga whales are not expected to be in the Study Area. NMFS-identified small and resident population areas for beluga whales do not overlap with the Navy TMAA (see Ferguson et al. 2015b). Due to the paucity of any beluga whale sightings in the Gulf of Alaska (Laidre et al. 2000), the occurrence of this species within the Study Area is considered extralimital (see also Goetz et al. 2012; Rugh et al. 2010).

3.8.1.1.2 False Killer Whale (*Pseudorca crassidens*)

False killer whales are found in tropical and temperate waters, generally between 50 degrees (°) South (S) and 50° North (N) latitude (Baird 1989; Odell and McClune 1999), although they are uncommon north of the U.S.-Mexico border. Based on sighting data collected by Southwest Fisheries Science Center during systematic surveys in the northeast Pacific between 1986 and 2005, there were no sightings of false killer whales north of about 30°N (Hamilton et al. 2009). Norman et al. (2004) observed that most strandings for this species north of California occurred during or within a year of an El Niño event. For the MMPA Stock Assessment Reports, there are five management stocks of false killer whale within the U.S. EEZ around the Pacific islands of Hawaii, Palmyra, and American Samoa (Carretta et al. 2014); there are no management stocks recognized for the U.S. west coast or Alaska waters. The occurrence of false killer whale within the Study Area is therefore considered extralimital.

3.8.1.1.3 Short-Finned Pilot Whale (*Globicephala macrorhynchus*)

The short-finned pilot whale is widely distributed throughout most tropical and warm temperate waters of the world. Along the U.S. west coast, short-finned pilot whales are most abundant south of Point Conception, California (Carretta et al. 2014, Reilly and Shane 1986). There are two records of this species in Alaskan waters. A short-finned pilot whale was taken near Katanak on the Alaska Peninsula in 1937, and a group of five short-finned pilot whales were sighted just southeast of Kodiak Island in May 1977 (U.S. Department of the Navy 2006). Stranding records for this species north of California waters are considered to be beyond the normal range of this species rather than an extension of its range (Norman et al. 2004). For the MMPA Stock Assessment Reports, there are two management stocks of short-finned pilot whale within the Pacific U.S. EEZ, including stocks within: (1) waters off California, Oregon, and Washington; and (2) Hawaiian waters (Carretta et al. 2014). There is no management stock recognized for Alaska waters. The occurrence of short-finned pilot whale within the Study Area is therefore considered extralimital.

3.8.1.1.4 Northern Right Whale Dolphin (*Lissodelphis borealis*)

The northern right whale dolphin occurs in cool-temperate to subarctic waters of the North Pacific Ocean, from the west coast of North America to Japan and Russia. This oceanic species is distributed from approximately 30°N to 50°N, 145° West (W) to 118° East (E) and generally not as far north as the Bering Sea (Jefferson et al. 2008). There are two sighting records of northern right whale dolphins in the Gulf of Alaska, but these are considered extremely rare (National Oceanic and Atmospheric Administration 2012b, U.S. Department of the Navy 2006). For the MMPA Stock Assessment Reports, there is a single management stock of northern right whale dolphin that includes animals found within the U.S. EEZ of California, Oregon, and Washington (Carretta et al. 2014); there is no management stock recognized for Alaska waters. The occurrence of northern right whale dolphin within the Study Area is therefore considered extralimital.

3.8.1.1.5 Risso's Dolphin (*Grampus griseus*)

Risso's dolphins are distributed worldwide in tropical to warm-temperate waters, roughly between 60°N and 60°S, where surface water temperature is usually greater than 50° Fahrenheit (F) (10° Celsius [C]); (Kruse et al. 1999). In the eastern North Pacific, Risso's dolphins extend north into Canadian waters (Baird and Stacey 1991, Reimchen 1980). They are most often found along the continental slope (Green et al. 1992, Kruse et al. 1999), and Baumgartner (1997) hypothesized that this distribution strongly correlates with cephalopod distribution. There are a few records of this species near the Study Area. Risso's dolphins have been sighted near Chirikof Island (southwest of Kodiak Island) and offshore in the Gulf of Alaska, just south of the Study Area boundary (Braham 1983, Consiglieri et al. 1980). For the MMPA SARs, there are two management stocks of Risso's dolphin within the Pacific U.S. EEZ, including stocks within: (1) waters off California, Oregon, and Washington; and (2) Hawaiian waters (Carretta et al. 2014). There is no management stock recognized for Alaska waters. Further, NOAA's Cetacean Density and Distribution Mapping Working Group considers the occurrence of Risso's dolphin in the Gulf of Alaska as "unknown" (National Oceanic and Atmospheric Administration 2012c). The occurrence of Risso's dolphin within the Study Area is therefore considered extralimital.

3.8.2 AFFECTED ENVIRONMENT

Four main types of marine mammals are generally recognized: cetaceans (whales, dolphins, and porpoises), pinnipeds (seals, sea lions, and walruses [walruses do not occur in the Study Area]), sirenians (manatees, dugongs, and sea cows [none of which occur in the Study Area]), and marine carnivores (sea otters and polar bears [polar bears do not occur in the Study Area]) (Rice 1998).

Detailed reviews of the different groups of cetaceans can be found in Perrin et al. (2008). The order Cetacea is divided into two suborders. The toothed whales, (suborder Odontoceti; e.g., sperm whale, killer whale, dolphins, porpoises, beaked whales) range in size from slightly longer than 3 feet (ft.) (1 m) to more than 60 ft. (18 m) and have teeth, which they use to capture and consume individual prey. The baleen whales (suborder Mysticeti; e.g., minke [*Balaenoptera acutorostrata*], humpback, gray, fin, and blue whales) are universally large (more than 15 ft. [4.6 m] as adults). They are called baleen whales because, instead of teeth, they have a fibrous structure made of keratin that is suspended from their upper jaws and is called baleen. Keratin is a type of protein similar to that found in human fingernails. The baleen enables the whales to filter and trap food from the water for feeding. They are batch feeders that use baleen instead of teeth to engulf, suck, or skim large numbers of small prey from the water or ocean floor sediments (Heithaus and Dill 2008). The different feeding strategies of mysticetes and odontocetes affect their distribution and occurrence patterns.

Cetaceans inhabit virtually every marine environment in the Study Area, from coastal waters to open ocean environments. Their distribution is influenced by a number of factors, but primary among these are patterns of major ocean currents, bottom relief, and sea surface temperature, which, in turn, affect prey productivity. The continuous movement of water from the ocean bottom to the surface creates a nutrient-rich, highly productive environment for marine mammal prey (Bakun 1996). For most cetaceans, prey distribution, abundance, and quality largely determine where they occur at any specific time (Heithaus and Dill 2008). Most of the large cetaceans are migratory (e.g., Barlow et al. 2011), but many small cetaceans do not migrate in the strictest sense. Instead, they undergo seasonal shifts in distribution induced by changes in their environment (Forney and Barlow 1998).

Pinnipeds in the Study Area are also divided into two groups: phocids (true seals) and otariids (fur seals and sea lions). Phocids lack pinna (ear flaps), their fore flippers are short and have hair, and their hind flippers are oriented toward the back of their bodies and cannot be rotated forward for locomotory purposes. Otariids have external pinna, long hairless or partially haired fore flippers, and hind flippers that can be rotated beneath their bodies. On average, pinnipeds spend approximately 80 percent of their life at sea (Mellish 2014). Pinnipeds spend their time on land at haulout sites used for resting and molting, and at rookeries used for breeding and nursing young. Haulout sites are typically used outside of the breeding season, and/or by non-breeding individuals, whereas a rookery is typically reserved for breeding and pupping. Many pinniped species have well-known seasonal cycles, distributions, and established haulout sites and rookeries that support large colonies of individuals.

The northern sea otter (*Enhydra lutris kenyoni*) is a carnivorous coastal marine mammal species in the family Mustelidae. Sea otters require shallow waters as habitat for reproducing, resting, and foraging. Sea otters rarely come ashore and spend most of their lives in the ocean near shore where they regularly feed and rest.

3.8.2.1 Group Size

Many species of marine mammals, particularly odontocetes, are highly social animals that spend much of their lives living in groups or schools ranging from several to several thousand individuals. Similarly, aggregations of baleen whales may form during particular breeding or foraging seasons. The behavior of aggregating into groups is important for the purposes of mitigation and monitoring in that it can increase the probability of marine mammals being detected. In addition, group size is an important consideration when conducting acoustic exposure analyses. A comprehensive and systematic review of available published and unpublished literature, including journals, books, technical reports, cruise reports, raw cruise data, theses, and dissertations was conducted to summarize relevant information on

marine mammal group sizes. The results of this review were compiled into a Technical Report that includes tables of group size information by species along with relevant citations (Watwood and Buonantony 2012).

3.8.2.2 Diving

Some species of marine mammals have developed specialized adaptations to allow them to make deep dives lasting over an hour, primarily for the purpose of foraging on deep-water prey such as squid. Other species spend the majority of their lives close to the surface, and make relatively shallow dives for shorter durations. The diving behavior of a particular species or individual has implications for the ability to detect them for mitigation and monitoring. In addition, their relative distribution through the water column is an important consideration when conducting acoustic exposure analyses. Information and data on marine mammal diving behavior were compiled and summarized in a Technical Report that provides detailed summaries of time at depth for each species (Watwood and Buonantony 2012).

3.8.2.3 Vocalization and Hearing of Marine Mammals

All marine mammals that have been studied can produce sounds and use sounds to forage, orient and navigate, monitor their environment, detect and respond to predators, and socially interact with others. Measurements of marine mammal sound production and hearing capabilities provide some basis for assessing whether exposure to a particular sound source may affect a marine mammal behaviorally or physiologically. Marine mammal hearing abilities are quantified using live animals and the techniques of behavioral audiometry or electrophysiology (see Au 1993, Nachtigall et al. 2007, Schusterman 1981, Wartzok and Ketten 1999). Behavioral audiograms, which are plots of animals' exhibited hearing threshold versus frequency, are obtained from captive, trained live animals using standard testing procedures with appropriate controls, and are considered to be a more accurate representation of a subject's hearing abilities. Behavioral audiograms of marine mammals are difficult to obtain because many species are too large, too rare, and too difficult to acquire and maintain for experiments in captivity.

Consequently, our understanding of a species' hearing ability may be based on the behavioral audiogram of a single individual or a small group of animals. In addition, captive animals may be exposed to local ambient sounds and other environmental factors that may impact their hearing abilities, whether positively or negatively, and may not accurately reflect the hearing abilities of free-swimming animals (Houser et al. 2010b). For animals not available in captive or stranded settings (including large whales and rare species), estimates of hearing capabilities are made based on morphology and neuroanatomy structures, vocal characteristics, and extrapolations from related species.

In comparison, electrophysiological audiometry measures small electrical voltages produced by neural activity when the auditory system is stimulated by sound. The technique is relatively fast, does not require a conscious response, and is routinely used to assess the hearing of newborn humans. For both methods of evaluating hearing ability, hearing response in relation to frequency is a generalized U-shaped curve or audiogram showing the frequency range of best sensitivity (lowest hearing threshold) and frequencies above and below with higher threshold values.

Direct measurement of hearing sensitivity exists for approximately 25 of the nearly 130 species of marine mammals (Table 3.8-2). This section provides a summary of sound production and hearing capabilities for marine mammal species in the Study Area. For purposes of the analyses in this document, marine mammals are arranged into the following functional hearing groups based on their

generalized hearing sensitivities (note that these categories are not the same as the sonar source categories described in Chapter 2, Description of Proposed Action and Alternatives): high-frequency cetaceans, mid-frequency cetaceans, low-frequency cetaceans (mysticetes), phocid pinnipeds (true seals), otariid pinnipeds (sea lions and fur seals), and Mustelidae (sea otters). For a discussion of all marine mammal functional hearing groups and their derivation see Finneran and Jenkins (2012).

Table 3.8-2: Hearing and Vocalization Ranges for All Marine Mammal Functional Hearing Groups and Species Potentially Occurring within the Study Area

Functional Hearing Group	Species Which May be Present in the Study Area	Sound Production ¹		Functional Hearing Ability Frequency Range ¹
		Frequency Range	Source Level (dB re 1 μ Pa at 1 m)	
High-Frequency Cetaceans	Harbor Porpoise, Dall's Porpoise	100 Hz–200 kHz	120–205	200 Hz–180 kHz
Mid-Frequency Cetaceans	Sperm Whale, Beaked Whales (<i>Berardius</i> , <i>Mesoplodon</i> , and <i>Ziphius</i> species), Killer Whale, Pacific White-sided Dolphin	100 Hz–> 100 kHz	118–236	150 Hz–160 kHz
Low-Frequency Cetaceans	Blue Whale, Gray Whale, Fin Whale, Humpback Whale, Minke Whale, Sei Whale, North Pacific Right Whale	10 Hz–20 kHz	129–195	7 Hz–22 kHz
Phocidae	Northern Elephant Seals, Harbor Seals, Ribbon Seals	100 Hz–12 kHz	103–180	In-water: 75 Hz–75 kHz In-air: 75 Hz–30 kHz
Otariidae	Steller Sea Lion, California Sea Lion, Northern Fur Seal	30 Hz–10 kHz	120–196	In-water: 50 Hz–50 kHz In-air: 50 Hz–75 kHz
Mustelidae	Northern Sea Otter	Primarily (in-air) from 4 to 8 kHz; (energy and harmonics present above 10–60 kHz, although behavioral functionality unknown)	In-air: up to 113	In-water: unknown In-air: 125 Hz–35 kHz; peak sensitivity at 16 kHz

¹ Sound production levels and ranges and functional hearing ranges are generalized composites for all members of the functional hearing groups, regardless of their presence in this Study Area.

Sound production data adapted and derived from: Aburto et al. 1997; Ghoul and Reichmuth 2012; Hanggi and Schusterman 1994; Kastelein et al. 2002a, b; Marten 2000; McShane, et al. 1995; Møhl et al. 2003; Philips et al. 2003; Richardson et al. 1995; Schusterman et al. 1972; Villadsgaard et al. 2007; Dunlop et al. 2013a.

Hearing data adapted and derived from: Ghoul and Reichmuth 2012, 2013, 2014; Southall et al. 2007.

These frequency ranges and source levels include social sounds for all groups and echolocation sounds for mid- and high-frequency groups. In-air vocalizations were not included for pinniped groups. Vocalization parameters for Mustelidae were measured from in-air vocalizations; no underwater data are available for this group.

Notes: dB re 1 μ Pa at 1 m = decibels referenced to 1 micropascal at 1 meter, Hz = Hertz, kHz = kilohertz

3.8.2.3.1 High-Frequency Cetaceans

Marine mammals within the high-frequency cetacean functional hearing group are all odontocetes (toothed whales; suborder: Odontoceti) and include eight species and subspecies of porpoises (family: Phocoenidae); dwarf and pygmy sperm whales (family: Kogiidae); six species and subspecies of river dolphins; and four species of Cephalorhynchus. Only two members of the high-frequency cetacean

group are known to occur or may rarely occur in the Study Area: Dall's porpoise and harbor porpoise. Functional hearing in high-frequency cetaceans occurs between approximately 200 Hertz (Hz) and 180 kilohertz (kHz) (Southall et al. 2007).

Sounds produced by high-frequency cetaceans range from approximately 100 Hz to 200 kHz with source levels of 120–205 decibels (dB) referenced to (re) 1 micropascal (μPa) at 1 m (Madsen et al. 2005, Richardson et al. 1995, Verboom and Kastelein 2003, Villadsgaard et al. 2007). Porpoises, unlike most other odontocetes, either do not produce whistles or do not whistle often (Awbrey et al. 1979, Bassett et al. 2009, Houck and Jefferson 1999, Thomson and Richardson et al. 1995, Verboom and Kastelein 2003). High-frequency cetaceans also generate specialized clicks used in biosonar (echolocation) at frequencies above 100 kHz that are used to detect, localize, and characterize underwater objects such as prey (Richardson et al. 1995).

From a harbor porpoise audiogram derived using behavioral audiometry methods, detection thresholds were estimated from 250 Hz to 180 kHz, with the range of best hearing from 16 to 140 kHz and maximum sensitivity between 100 and 140 kHz (Kastelein et al. 2002a). While no empirical data on hearing ability for Dall's porpoise are available, data on the morphology of the cochlea allow for estimation of the upper hearing threshold at about 170–200 kHz (Awbrey et al. 1979).

3.8.2.3.2 Mid-Frequency Cetaceans

Marine mammals within the mid-frequency cetacean functional hearing group are all odontocetes, and include the sperm whale (family: Phystereidae), 32 species and subspecies of dolphins (family: Delphinidae), the beluga and narwhal (*Monodon monoceros*) (family: Monodontidae), and 19 species of beaked and bottlenose whales (family: Ziphiidae). The following members of the mid-frequency cetacean group are known to occur or may occur in the Study Area: sperm whale, killer whale, Pacific white-sided dolphin, and beaked whales (Cuvier's beaked whale, Baird's beaked whale, and Stejneger's beaked whale). Functional hearing in mid-frequency cetaceans is conservatively estimated to be between approximately 150 Hz and 160 kHz (Southall et al. 2007).

Hearing studies on cetaceans have focused primarily on odontocete species (Houser and Finneran 2006, Kastelein et al. 2002a, 2014, Nachtigall et al. 2005, Szymanski et al. 1999, Yuen et al. 2005). Hearing sensitivity has been directly measured for a number of mid-frequency cetaceans, including Atlantic white-sided dolphins (*Lagenorhynchus acutus*) (Houser et al. 2010a), common dolphins (*Delphinus* spp.) (Houser et al. 2010a), Atlantic bottlenose dolphins (*Tursiops truncatus truncatus*) (Johnson 1967), Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) (Houser et al. 2010a), Black Sea bottlenose dolphins (*Tursiops truncatus ponticus*) (Popov et al. 2007), striped dolphins (*Stenella coeruleoalba*) (Kastelein et al. 2003), white-beaked dolphins (*Lagenorhynchus albirostris*) (Nachtigall et al. 2008), Risso's dolphins (Nachtigall et al. 2005), belugas (Finneran et al. 2005; White et al. 1978), false killer whales (Yuen et al. 2005), killer whales (Szymanski et al. 1999), Gervais' beaked whales (*Mesoplodon europaeus*) (Finneran and Schlundt 2009), and Blainville's beaked whales (*M. densirostris*) (Pacini et al. 2011). All audiograms exhibit the same general U-shaped curve when plotting sound source level against frequency, with a wide nominal hearing range between approximately 150 Hz and 160 kHz.

In general, odontocetes produce sounds across the widest band of frequencies. Their social vocalizations range from a few hundreds of Hz to tens of kHz (Southall et al. 2007) with source levels in the range of 118–236 dB re 1 micropascal-meter ($\mu\text{Pa}\cdot\text{m}$) (see Richardson et al. 1995). As mentioned earlier, they also generate specialized clicks used in echolocation at frequencies above 100 kHz that are used to

detect, localize, and characterize underwater objects such as prey (Au 1993). Echolocation clicks have source levels that can be as high as 229 dB re 1 μ Pa peak-to-peak (Au et al. 1974).

3.8.2.3.3 Low-Frequency Cetaceans

Marine mammals within the low-frequency functional hearing group are all mysticetes. This group is comprised of 13 species and subspecies of mysticete whales in six genera: *Eubalaena*, *Balaena*, *Caperea*, *Eschrichtius*, *Megaptera*, and *Balaenoptera*. The following members of the low-frequency cetacean group (mysticetes) are present or have a reasonable likelihood of being present in the Study Area: North Pacific right (*Eubalaena japonica*), humpback, blue, fin, sei (*Balaenoptera borealis*), minke, and gray whales. Functional hearing in low-frequency cetaceans is conservatively estimated to be between approximately 7 Hz and 22 kHz (Southall et al. 2007).

Because of large animal size and general unavailability of live specimens, direct measurements of mysticete whale hearing are not available, although there was one effort to measure hearing thresholds in a stranded gray whale (Ridgway and Carder 2001). Because hearing ability has not been directly measured in these species, it is inferred from vocalizations, ear structure, and field observations. Vocalizations are audible somewhere in the frequency range of production, but the exact range cannot be inferred (Southall et al. 2007). Ketten (2014) developed predicted audiograms for blue whales and minke whales indicating the species are most sensitive to frequencies between 1 and 10 kHz, and Ketten and Mountain (2014) produced a predicted humpback whale audiogram using a mathematical model based on the internal structure of the ear. Estimated sensitivity was from 700 Hz to 10 kHz, with maximum relative sensitivity between 2 and 6 kHz. Cranford and Krysl (2015) developed similar predictive modeling for fin whales using computerized tomography ("CT") scans of a fin whale's head to understand its sound reception physiology and thereby enable the development of a synthetic audiogram for this low-frequency cetacean species.

Mysticete cetaceans produce low-frequency sounds that range in the tens of Hz to several kHz that most likely serve social functions such as reproduction, but may serve an orientation function as well (Green et al. 1994). Humpback whales are the notable exception within the mysticetes, with some calls exceeding 10 kHz. These sounds can generally be categorized as low-frequency moans, bursts or pulses, or more complex songs (Edds-Walton 1997). Source levels of most mysticete cetacean sounds range from 129 to 190 dB re 1 μ Pa-m (see Richardson et al. 1995).

3.8.2.3.4 Pinnipeds

Pinnipeds are divided into three functional hearing groups, otariids (sea lions and fur seals), phocid seals (true seals), and odobenids (walrus), with different in-air and in-water hearing ranges. The Study Area contains phocids (true seals) and otariids (fur seals). Species known to occur or that may possibly occur in the Study Area are described in the sections below and include harbor seal (*Phoca vitulina*), northern elephant seal (*Mirounga angustirostris*), California sea lion (*Zalophus californianus*), northern fur seal (*Callorhinus ursinus*), ribbon seal (*Histiophoca fasciata*), and Steller sea lion (*Eumetopias jubatus*). Measurements of hearing sensitivity have been conducted on species representing all of the families of pinnipeds (Phocidae, Otariidae, Odobenidae) (see Kastelein et al. 2002b, 2005a, 2012c; Moore and Schusterman 1987; Schusterman et al. 1972; Terhune 1988; Thomas et al. 1990; Turnbull and Terhune 1990; Wolski et al. 2003).

Pinnipeds produce sounds both in air and water that range in frequency from approximately 100 Hz to several tens of kHz, and it is believed that these sounds only serve social functions (Miller 1991) such as

male-male vocal boundary displays, mother-pup recognition and reproduction. Source levels for pinniped vocalizations range from approximately 95–190 dB re 1 μ Pa (see Richardson et al. 1995).

3.8.2.3.4.1 Phocids

Phocids (true seals) known to occur with varying level of frequency in the Study Area include the harbor seal, northern elephant seal, and ribbon seal. Hearing in phocids has been tested in the following species: gray seals (Ridgway et al. 1975), harbor seals (Kastak and Schusterman 1998, Kastelein et al. 2012c, Reichmuth et al. 2013, Richardson et al. 1995, Southall et al. 2007, Terhune and Turnbull 1995, Wolski et al. 2003), harp seals (Terhune and Ronald 1971, 1972), Hawaiian monk seals (Thomas et al. 1990), northern elephant seal (Kastak and Schusterman 1998, 1999, Reichmuth et al. 2013), and ringed seals (Terhune and Ronald 1975, 1976).

Phocid hearing limits are estimated to be 75 Hz–30 kHz in air and 75 Hz–75 kHz in water (Kastak and Schusterman 1999; Kastelein et al. 2009; Reichmuth 2008; Terhune and Ronald 1971, 1972).

3.8.2.3.4.2 Otariids

Otariids (sea lions and fur seals) known to occur with varying level of frequency in the Study Area include California sea lion, northern fur seal, and Steller sea lion. Hearing in otariid seals is adapted to low-frequency sound and less auditory bandwidth than phocid seals. Hearing in otariid seals has been tested in two species present in the Study Area: California sea lion (Kastak and Schusterman 1998, Moore and Schusterman 1987, Schusterman et al. 1972, Southall et al. 2005, Mulsow et al. 2014) and northern fur seal (Babushina et al. 1991, Moore and Schusterman 1987). The otariids' hearing ranges are 50 Hz–75 kHz in air and 50 Hz–50 kHz in water, based on these studies.

3.8.2.3.5 Mustelidae (Sea Otters)

Until recently, there had been no direct studies of hearing in sea otters, although behavioral response to playbacks was undertaken previously (Davis et al. 1988). Maximum hearing sensitivity for sea otters has been inferred based on the anatomy of the inner ear, which indicates they likely have a maximum hearing sensitivity at 16 kHz (Davis et al. 1988). For purposes of the analysis in this document, it is assumed that northern sea otters in the Study Area have hearing ranges of 125 Hz–35 kHz in air and 50 Hz–50 kHz in water, based on their phylogenetic and anatomical similarities to otariids (Finneran and Jenkins 2012). Ghoul and Reichmuth (2013) confirmed that sea otter's in-air hearing closely resembled that of a sea lion, although underwater hearing sensitivity was found to be significantly reduced in comparison to that of pinnipeds. The finding that sea otters are not especially well adapted for hearing underwater suggests that the function of this sense has been less important in their survival and evolution than it has for pinnipeds (Ghoul and Reichmuth 2013).

3.8.2.4 General Threats

Marine mammal populations can be influenced by various factors and human activities. These factors can affect marine mammal populations directly, by activities such as hunting and whale watching, or indirectly, through reduced prey availability or lowered reproductive success of individuals. Twiss and Reeves (1999) provide a general discussion of marine mammal conservation. As detailed in National Oceanic and Atmospheric Administration (2009), investigations of stranded marine mammals are undertaken out of a concern for animal welfare and ocean stewardship. Marine mammals have also been recognized as sentinels of ecosystem health and may therefore provide valuable links to human health (National Research Council 1991). Investigations into the cause of death for stranded animals can also provide indications of the general threats to marine mammals in a given location.

Marine mammals are influenced by natural phenomena, such as storms and other extreme weather patterns. Generally, not much is known about how large storms and other weather patterns affect marine mammals, other than that mass strandings (when two or more marine mammals become beached or stuck in shallow water) sometimes coincide with hurricanes, typhoons, and other tropical storms (Marsh 1989, Rosel and Watts 2008). The global climate is changing and is having impacts on some populations of marine mammals (Salvadeo et al. 2010, Simmonds and Elliott 2009). Climate change can affect marine mammal species directly through habitat loss (especially for species that depend on ice or terrestrial areas) and indirectly via impacts on prey, changing prey distributions and locations, and changes in water temperature. Changes in prey can impact marine mammal foraging success, which in turn affects reproduction success and survival. Climate change also may influence marine mammals through effects on human behavior, such as increased shipping and oil and gas extraction, resulting from sea ice loss (Alter et al. 2010).

Mass die-offs of some marine mammal species have been linked to toxic algal blooms; that is, they consume prey that have consumed toxic plankton, such as die-offs of California sea lions and northern fur seals because of poisoning caused by the diatom *Pseudo-nitzschia* spp. (Doucette et al. 2006, Fire et al. 2008, Lefebvre et al. 2010, Thomas et al. 2010, Torres de la Riva et al. 2009). A comprehensive study by Lefebvre et al. (2016), which sampled over 900 marine mammals across 13 species, including mysticetes, odontocetes, pinnipeds, and mustelids, found detectable concentrations of domoic acid in all 13 species, and saxitoxin, a toxin absorbed from ingesting dinoflagellates, in 10 of the 13 species. For example, in May 2015 there were reports of at least nine drifting and floating whales and multiple pinniped carcasses discovered in Gulf of Alaska waters between Kodiak Island and Unimak Pass. Eventually there were a total of 30 dead whales (fin, humpback, and gray whales) found in Alaska waters around the islands of the western Gulf of Alaska and the southern shoreline of the Alaska Peninsula. NMFS is still investigating these findings but a possible cause referenced has been a toxic algae blooms (Rosen 2015; National Oceanic and Atmospheric Administration 2015f, 2016). Later that June during Northern Edge 2015, on separate days two different Navy vessels training in the Gulf of Alaska encountered a well-decayed whale carcass. The Navy ships followed standard reporting procedures and the information was provided to NMFS to aid them in their investigation. This could have been the same carcass observed by both ships and given the advanced stage of decomposition, might have been one of the floating whales reported by other entities to NMFS before Northern Edge began. The cause of death for the floating carcasses had no connection with Navy activities given their advanced stage of decomposition indicating the animal(s) had died long before Navy ships arrived in the Gulf of Alaska and the Northern Edge maritime training events began.

Additional threats to marine mammals come from marine parasites that, under normal circumstances, probably do little overall harm, but under certain conditions, can cause serious health problems or even death (Bull et al. 2006, Fauquier et al. 2009, Jepson et al. 2005a). Disease affects some individuals (especially older animals), and occasionally disease epidemics can injure or kill a large percentage of the population (Keck et al. 2010, Paniz-Mondolfi and Sander-Hoffmann 2009). Recently, the first case of morbillivirus in the central Pacific was documented for a stranded juvenile male Longman's beaked whale (*Indopacetus pacificus*) at Hamoa Beach, Hana, Maui (West et al. 2012).

Human impacts on marine mammals have received much attention in recent decades, and include hunting (both commercial and native practices), fisheries interactions (such as gear entanglement or shootings by fishers), bycatch (accidental or incidental catch), indirect effects of fisheries through takes of prey species, ship strikes, noise pollution, chemical pollution, marine debris (ingestion and entanglement), increased ocean acidification, and general habitat deterioration or destruction. For

example, in Alaska between 2007 and 2011, there were 24 Northern fur seals found with entanglements caused by marine debris and fishing gear reported to the stranding network (Allen et al. 2014). See Carretta et al. (2016) for a presentation of recent data on human related injury and mortality to Pacific west coast marine mammal stocks (some of which are present in the Study Area) occurring between 2010 and 2014.

Direct hunting, as in whaling and sealing operations, provided the original impetus for marine mammal management efforts and has driven much of the early research on cetaceans and pinnipeds (Twiss and Reeves 1999, Rocha et al. 2015). Some direct hunting still occurs. For example, in 2 years of hunting (2010 and 2011) on St. Paul Island and St. George Island in the Bering Sea, 878 northern fur seals were harvested for subsistence (Testa 2012); a total of 127 gray whales were “struck” during 2013 Russian Federation subsistence whaling (Ilyashenko and Zharikov 2014). Recently uncovered Union of Soviet Socialist Republic (USSR) catch records indicate extensive illegal whaling activity between 1948 and 1979, with a harvest totaling 195,783 whales in the North Pacific Ocean. Of these, only 169,638 were reported by the USSR to the International Whaling Commission (Ivashchenko et al. 2013). However, fishery bycatch is likely the most impactful problem presently and may account for the deaths of more marine mammals than any other cause (Geijer and Read 2013, Hamer et al. 2010, Northridge 2008, Read 2008). In 1994, the MMPA was amended to formally address bycatch. The amendment requires the development of a take reduction plan when a bycatch exceeds a level considered unsustainable by the marine mammal population. At least in part as a result of the amendment, estimates of bycatch in the Pacific declined by a total of 96 percent from 1994 to 2006 (Geijer and Read 2013). Cetacean bycatch declined by 85 percent from 342 in 1994 to 53 in 2006, and pinniped bycatch declined from 1,332 to 53 over the same time period. Fishery interactions other than bycatch include entanglement from nets, fishing line, and the ropes and lines connected to fishing gear (see, for example, Good et al. 2010; Saez et al. 2013; Williams et al. 2011). The most recent data for documented entanglements from 2012 to 2013 were provided to the Navy by NMFS Alaska Region. In 2012–2013, there were seven reported entanglements to three species (1 fin whale, 2 humpback whales, and 4 Steller sea lions) within the Southcentral and Kodiak regions, which are the areas most immediately adjacent to the GOA TMAA. (Savage 2014).

Ship strikes are an issue of increasing concern for most marine mammals, particularly baleen whale species. In Alaska waters from 1978 to 2006, there were 62 reported vessel collisions with whales (Gabriele et al. 2007). These involved motorized, non-motorized, large and small vessels, engaged in a variety of activities with private small vessel (less than 15 m in length) strikes the most common. The most recent ship strike data for 2012–2013 provided to Navy by NMFS Alaska Region indicated there were five ship strikes to humpback whales by commercial ships or recreational vessels in the Southcentral and Kodiak regions (Savage 2014). Any strike by a Navy vessel is required to be reported via the Navy chain of command to NMFS independent of any stranding or stranding data. Given that personnel on Navy vessels up to and including aircraft carriers have known when a whale has been struck because of a reported “shudder” in the vessel, even when there has been no visual detection prior to the event, the Navy is confident that unlike most minimally manned commercial vessels, U.S. Navy vessels are likely to detect all strikes involving large whales. There has never been a Navy vessel strike to a marine mammal in the Study Area during any previous training activities.

Chemical pollution is also of great concern, although for the most part, its effects on marine mammals are just starting to be understood. In a broad scale investigation, the 5.5-year expedition of the *Odyssey* collected 955 biopsy samples from sperm whales around the world to provide a consistent baseline database of ocean contamination and to measure future effects (Ocean Alliance 2010). Chemical

pollutants found in pesticides and other substances flow into the marine environment from human use on land and are absorbed into the bodies of marine mammals, accumulating in their blubber or internal organs, or are transferred to the young from mother's milk (Fair et al. 2010). Important factors that determine the levels of pesticides, heavy metals, and industrial pollutants that accumulate in marine mammals are gender (i.e., adult males have no way to transfer pesticides whereas females may pass pollutants to their calves through milk), habitat, and diet. Living closer to the source of pollutants and feeding on higher-level organisms increase the potential to accumulate toxins (Moon et al. 2010). The buildup of human-made persistent compounds in marine mammals not only increases their likelihood of contracting diseases or developing tumors but also compromises the function of their reproductive systems (Fair et al. 2010).

Oil and other chemical spills are a specific type of ocean contamination that can have damaging effects on some marine mammal species (Marine Mammal Commission 2011). Although information on effects of oil spills on marine mammals is limited, new information gained from study of the recent Deep Water Horizon oil spill in the Gulf of Mexico has provided insight on assessment of long-term effects (Marine Mammal Commission 2011) as well as continued study of the 1989 Exxon Valdez oil spill in Prince William Sound, Alaska (Bodkin et al. 2012, Matkin et al. 2008). In short, marine mammals can be affected directly by contact or ingestion of the oil, indirectly by activities during the containment and cleanup phases, and through long-term impacts on prey and habitat.

Habitat deterioration and loss is a major factor for almost all coastal and inshore species of marine mammals, especially those that live in rivers or estuaries, and it may include such factors as depleting a habitat's prey base and the complete loss of habitat (Ayres et al. 2012, Kemp 1996, Smith et al. 2009). In some locations, especially where urban or industrial activities or commercial shipping is intense, chronic anthropogenic noise is also being increasingly considered as a potential habitat level stressor. Noise is of particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, avoiding predators, and communicating with other individuals. Chronic noise may cause marine mammals to leave a habitat, impair their ability to communicate, or cause stress (Dunlop et al. 2010; Erbe et al. 2012, Hildebrand 2009, Holt et al. 2008, Rolland et al. 2012, Tyack et al. 2011; Williams et al. 2014a). Noise can cause behavioral disturbances, mask other sounds including their own vocalizations, may result in injury, and, in some cases, result in behaviors that ultimately lead to death (National Research Council of the National Academies 2003, 2005; Nowacek et al. 2007; Southall et al. 2009a; Tyack 2009; Würsig and Richardson 2008).

Anthropogenic noise is generated from a variety of sources, including commercial shipping, oil and gas exploration and production activities, commercial and recreational fishing (including fish-finding sonar, fathometers, and acoustic deterrent and harassment devices), recreational boating and whale-watching activities, offshore power generation, research (including noise from air guns, sonar, and telemetry), and military training and testing activities. Commercial shipping's contribution to ambient noise in the ocean has increased by as much as 12 dB over the last few decades (Hildebrand 2009, McDonald et al. 2008). Navy training activities in the Study Area are not a chronic noise source and are not on par with sources of noise such as those from oil and gas seismic exploration or commercial shipping.

3.8.2.5 Marine Mammal Density Estimates

A quantitative impact analysis requires an estimate of the number of animals that might be affected by anthropogenic activities. A key element of this estimation is knowledge of the abundance and concentration of the species in specific areas where those activities will occur. The most appropriate unit of metric for this type of analysis is animal density, or the number of animals present per unit area.

Marine species density estimation requires a significant amount of effort to both collect and analyze data to produce a reasonable estimate. Unlike surveys for terrestrial wildlife, many marine species spend much of their time submerged, and are not easily observed. In order to collect enough sighting data to make reasonable density estimates, multiple observations are required, often in areas that are not easily accessible (e.g., far offshore). Ideally, marine species sighting data would be collected for the specific area and time period (e.g., season) of interest and density estimates derived accordingly. However, in many places, poor weather conditions and high sea states prohibit the completion of comprehensive visual surveys.

For most cetacean species, abundance is estimated using line-transect surveys or mark-recapture studies (e.g., Barlow 2010, Barlow and Forney 2007, Calambokidis et al. 2008). The result provides one single density estimate value for each species across broad geographic areas, such as waters within the U.S. EEZ off California, Oregon, and Washington. This is the general approach applied in estimating cetacean abundance in the NMFS Stock Assessment Reports. Although the single value provides a good average estimate of abundance (total number of individuals) for a specified area, it does not provide information on the species distribution or concentrations within that area, and it does not estimate density for other timeframes or seasons that were not surveyed. More recently, habitat modeling has been used to estimate cetacean densities (Barlow et al. 2009; Becker et al. 2010, 2012a, b, c; Ferguson et al. 2006a; Forney et al. 2012; Redfern et al. 2006). These models estimate cetacean density as a continuous function of habitat variables (e.g., sea surface temperature, seafloor depth, etc.) and thus allow predictions of cetacean densities on finer spatial scales than traditional line-transect or mark-recapture analyses. Within the geographic area that was modeled, densities can be predicted wherever these habitat variables can be measured or estimated.

Uncertainty in published density estimates is typically large because of the low number of sightings available for their derivation. Uncertainty is typically expressed by the coefficient of variation (CV) of the estimate, which is derived using standard statistical methods and describes the amount of variation with respect to the population mean. It is expressed as a fraction or sometimes a percentage and can range upward from zero, indicating no uncertainty, to high values. For example, a CV of 0.85 would indicate high uncertainty in the population estimate. When the CV exceeds 1.0, the estimate is very uncertain. The uncertainty associated with movements of animals into or out of an area (due to factors such as availability of prey or changing oceanographic conditions) is much larger than is indicated by the CV.

The methods used to estimate pinniped at-sea densities are typically different than those used for cetaceans. This is discussed in more detail in the Pacific Navy Marine Species Density Database Technical Report (U.S. Department of the Navy 2014a). Pinniped abundance is generally estimated via shore counts of animals at known rookeries and haulout sites. Translating these numbers to in-water densities is difficult given the variability in foraging ranges, migration, and haulout behavior between species and within each species, and is driven by factors such as age class, sex class, seasonal variation, etc. Details of the density derivation for each species of pinniped in the Study Area are provided in the U.S. Department of the Navy (2014a). In summary, the methods used to derive pinniped densities involved a series of species-specific data reviews to compile the most accurate and up-to-date information available. The total abundance divided by the area of the region was the resultant density estimate for each species in a given location.

There is no single source of density data for every area, marine mammal species, and season because of the fiscal costs, resources, and effort involved to provide enough survey coverage to sufficiently estimate density. NMFS Southwest Fisheries Science Center conducts standard U.S. West Coast surveys

every 5–6 years and cannot logistically support more frequent studies. The U.S. Navy has funded two previous marine mammal surveys in the TMAA (Rone et al. 2009, 2014) in the summer time-period when Navy training activities are most likely to occur. The density data used to quantitatively estimate impacts to marine mammals from Navy training in the TMAA are based on the best available science and were agreed upon with NMFS as a cooperating agency for the EIS/OEIS. As the federal regulator for the MMPA, the NMFS role included having staff marine biologists review and comment on the analysis and the EIS/OEIS. The review also included coordination with NMFS regional scientists from the Southwest Fisheries Science Center and Alaska Fisheries Science Center on the latest emergent data presented in their Pacific Stock Assessment Reports.

In May 2015, the Marine Mammal Commission also reviewed the Marine Species Density Database Technical Report (U.S. Department of the Navy 2014a) and pointed out some textual errors that the Navy subsequently corrected, but otherwise did not identify any changes in the data used for acoustic effects modeling.

A certain number of sightings are required to generate the quality of data necessary to produce either traditional line-transect density estimates or spatial habitat modeled density values. The at-sea identification of some species of specific MMPA designated stocks is not always possible from available field data, nor would additional data collection likely address the identification issue based on low animal occurrence (e.g., Western North Pacific gray whale), cryptic behaviors (e.g., beaked whales), and appearance similarities between stocks (e.g., Steller sea lions). In the absence of species-specific population survey data for these species, density estimates are derived from different methods and data sources, based on NMFS recommendations. The different methods for each of these species are described in Section 3.8.3.1.6.1 (Marine Species Density Data) and the Pacific Marine Species Density Database Technical Report (U.S. Department of the Navy 2014a). NMFS and Navy have determined that these alternative density estimates are sufficient for determining the impacts of Navy training on these marine mammals under all applicable statutes, and therefore are the best available science.

Therefore, to characterize marine mammal density for areas of concern, including the TMAA Study Area, the Navy compiled data from multiple sources. Each data source may use different methods to estimate density and uncertainty (e.g., variance) associated with the estimates.

The Navy thus developed a protocol to select the best available data sources based on species, area, and time (season). The Navy then used this protocol to identify the best density data from available sources, including habitat-based density models, line-transect analyses, and peer-reviewed published studies. These data were incorporated into a Geographic Information System database that includes seasonal (summer/fall and winter/spring) density values for every marine mammal species present within the Study Area. Detailed information on the Navy's selection protocol, datasets, and specific density values are provided in a Pacific Navy Marine Species Density Database Technical Report (U.S. Department of the Navy 2014a).

Already incorporated into the Navy's and NMFS' analysis of effects to marine mammals has been the consideration of emergent science regarding locations where cetaceans are known to engage in activities at certain times of the year that are important to individual animals as well as populations of marine mammals (see discussion in Van Parijs 2015). In 2011, NOAA convened a working group to map cetacean density and distribution within U.S. waters. The specific objective of the Cetacean Density and Distribution Mapping Working Group (CetMap) was to create comprehensive and easily accessible regional cetacean density and distribution maps that are time- and species-specific. Separately, to

augment this more quantitative density and distribution mapping and provide additional context for marine mammal impact analyses, CetMap also identified (through literature search, current science compilation, and expert elicitation) areas of importance for cetaceans, such as reproductive areas, feeding areas, migratory corridors, and areas in which small or resident populations are concentrated. Areas identified through this process have been termed biologically important areas (Aquatic Mammals 2015, Ferguson et al. 2015a, Van Parijs 2015). It is important to note that the BIAs were not meant to define exclusionary zones, nor were they meant to be locations that serve as sanctuaries from human activity, or areas analogous to marine protected areas (see Ferguson et al. [2015a] regarding the envisioned purpose for the BIA designations). NMFS recognizes BIAs as biologically important for some species activity but is not equivalent to the designation of critical habitat under the Endangered Species Act. The BIAs identified in and around the TMAA do not represent the totality of important habitat throughout the marine mammals' full range. The stated intention is for the BIAs to serve as resource management tools and their currently identified boundaries be considered dynamic and subject to change based on any new information as well as "existing density estimates, range-wide distribution data, information on population trends and life history parameters, known threats to the population, and other relevant information" (Van Parijs 2015).

At the time of the BIA designations, there was a lack of science supporting identification of any additional BIAs at this time for the Pacific Regions (see Aquatic Mammals 2015; Ferguson et al. 2015a, 2015b; Van Parijs 2015). The Navy and NMFS have supported and will continue to support the Cetacean and Sound Mapping project, including providing representation on the Cetacean Density and Distribution Mapping Working Group (CetMap) which informed NMFS' identification of BIAs. The same marine mammal density data present in the Navy's Density Database Technical Report (U.S. Department of the Navy 2014a) and used in the analysis for this Supplemental EIS/OEIS was used in the development of the BIAs. The final products, including the Alaska BIAs from this mapping effort, were completed and published in March 2015 (Aquatic Mammals 2015; Ferguson et al. 2015a, 2015b; Van Parijs 2015). The following sections present information on the status and management, abundance, and distribution of species with possible or confirmed presence within the Study Area (see Table 3.8-1) and if there is a known and designated important feeding area, reproductive area, migratory corridor, or area in which small or resident population is concentrated, which is used by that species in the vicinity of the TMAA.

3.8.2.6 North Pacific Right Whale (*Eubalaena japonica*)

3.8.2.6.1 Status and Management

North Pacific right whales are listed as depleted under the MMPA and endangered under the ESA. Once abundant, the North Pacific right whale is one of the most endangered whale species in the world. This species has been listed as endangered under the ESA since 1973 when it was considered the "northern right whale" (including both the North Atlantic [*Eubalaena glacialis*] and North Pacific right whales). In 2008, NMFS listed the right whales as two separate, endangered species. Previously designated critical habitat within the Gulf of Alaska and the Bering Sea was then re-designated as North Pacific right whale critical habitat (Figure 3.8-1; see National Oceanic and Atmospheric Administration 2008b; National Marine Fisheries Service 2013a). In March 2012, NMFS announced a 5-year review of North Pacific right whale under the ESA (National Marine Fisheries Service 2012a). A recovery plan for this species has been prepared (National Marine Fisheries Service 2013a). Although there is designated critical habitat for this species in the western Gulf of Alaska and an area in the southeastern Bering Sea, there is no designated critical habitat for this species within the Study Area. NMFS currently recognizes two stocks of North Pacific right whale: (1) an Eastern North Pacific stock; and (2) a Western North Pacific stock, thought to

feed primarily in the Sea of Okhotsk (Allen and Angliss 2014). It is assumed that any North Pacific right whale in the Study Area would be from the Eastern North Pacific stock.

3.8.2.6.2 Abundance

The most recent estimated population for the North Pacific right whale is between 28 and 31 individuals, and although this estimate may be reflective of a Bering Sea subpopulation, the total Eastern North Pacific population is unlikely to be much larger (Wade et al. 2011b; see also Marques et al. 2011; National Marine Fisheries Service 2013a). Far to the southwest of the TMAA (from 170° E longitude west to Japan), Matsuoka et al. (2014) documented as many as 55 North Pacific right whale sightings representing 77 animals between 1994 and 2013; many of these were likely the same individuals re-sighted in subsequent years.

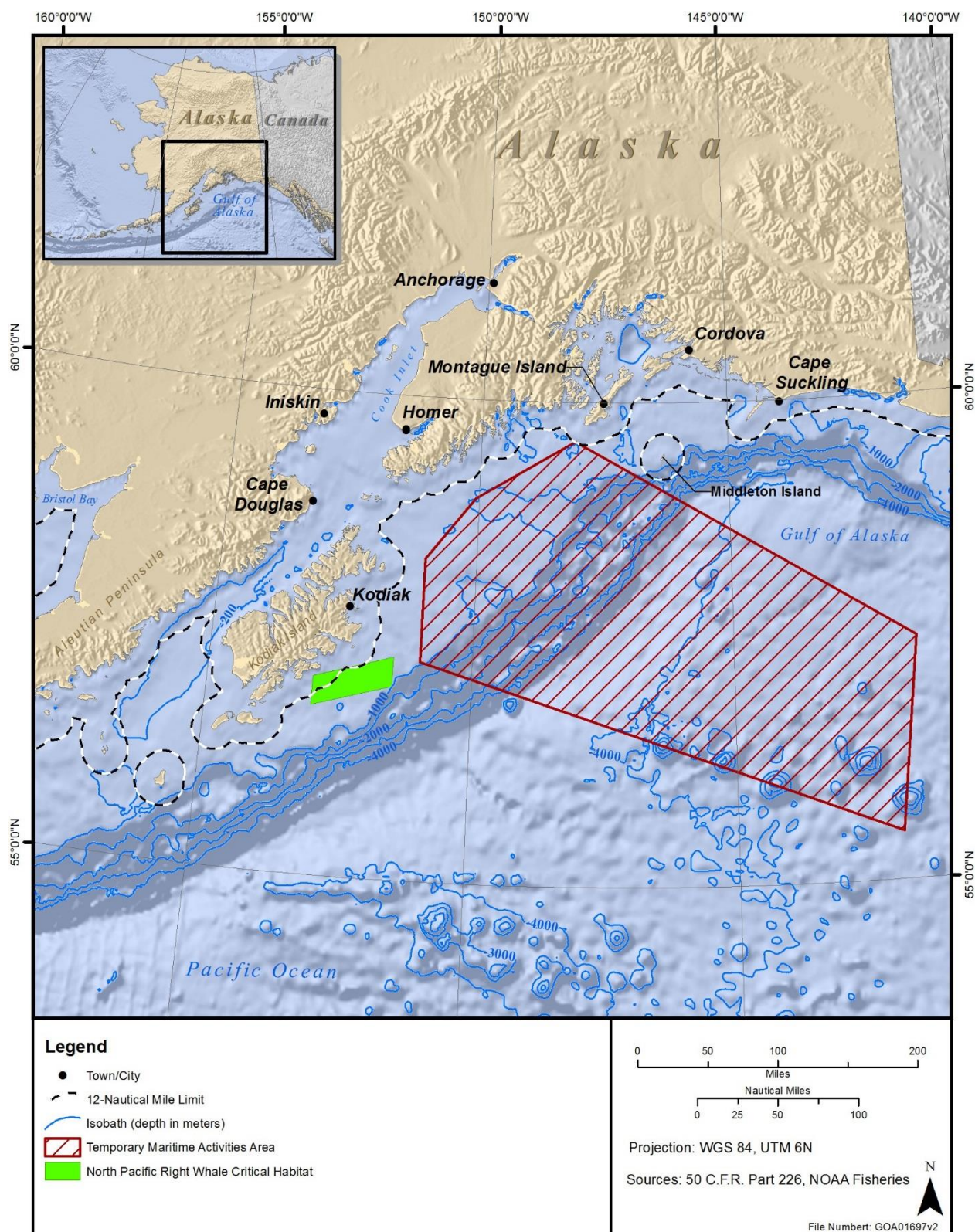


Figure 3.8-1: North Pacific Right Whale Critical Habitat in the Vicinity of the Temporary Maritime Activities Area

3.8.2.6.3 Distribution

North Pacific right whales occur in subpolar to temperate waters. They are generally migratory, with at least a portion of the population moving between summer feeding grounds in temperate or high latitudes and winter calving areas in warmer waters (Clapham et al. 2004, Kraus et al. 1986). The rarity of reports for right whales in more southern coastal areas in winter in either historical or recent times suggests that their breeding grounds may have been offshore (Clapham et al. 2004). Historical whaling records provide virtually the only information on North Pacific right whale distribution. This species historically occurred across the Pacific Ocean north of 35°N, with concentrations in the Gulf of Alaska, eastern Aleutian Islands, south-central Bering Sea, Okhotsk Sea, and the Sea of Japan (Clapham et al. 2004, Shelden et al. 2005, Gregr 2011, Ivashchenko et al. 2012, Omura et al. 1969, Scarff 1986).

Habitat modeling using historic whaling records suggests that the Gulf of Alaska currently provides suitable habitat for North Pacific right whales, although this has not been validated (Gregr 2011). Presently, sightings are extremely rare, occurring primarily in the Okhotsk Sea and the eastern Bering Sea (Brownell et al. 2001, Shelden and Clapham 2006, Shelden et al. 2005, Wade et al. 2006, Zerbini et al. 2010, 2015). Recently, there are far fewer sightings of North Pacific right whales in the Gulf of Alaska than the Bering Sea (Brownell et al. 2001, Wade et al. 2011a, Zerbini et al. 2010). In the summers of 2008 and 2009, satellite transmitters were deployed on four North Pacific right whales on the Bering Sea feeding grounds and the results demonstrated that the movements of these animals were restricted to a relatively small region between 56° and 58° north and 163° and 167° west in the Bering Sea (Zerbini et al. 2010, 2015). From the 1960s through 2002, there were only two documented sightings of North Pacific right whales in the Gulf of Alaska. In March 1979, there was an opportunistic sighting near Yakutat Bay in the eastern Gulf of Alaska (Shelden et al. 2005). A single North Pacific right whale was sighted southeast of Kodiak Island in July 1998 during an aerial survey and, subsequently, two passive acoustic recorders were placed in the northern Gulf of Alaska near Kodiak Island (Waite et al. 2003). Recordings from these instruments, and an additional five placed in the central Gulf of Alaska in 2000–2001, were later analyzed for North Pacific right whale calls. Very few right whale calls were positively identified, and all were detected on the westernmost recorder in the Gulf of Alaska during August and September (Moore et al. 2006).

From 2004 to 2006, there were an additional four sightings of North Pacific right whales in the Gulf of Alaska, all in the Barnabus Trough region on Albatross Bank, southeast of Kodiak Island (Wade et al. 2011a, b). Those sightings tripled the number of North Pacific right whale sightings in the Gulf of Alaska over the last 40 years and suggest that this area represents important habitat for the remaining animals in this population (Wade et al. 2011a). A portion of this area, located to the west/southwest of the Study Area, was designated as critical habitat in 2006 (National Marine Fisheries Service 2013a). The nearest of the 1998 to 2006 sightings upon which this critical habitat was based was located approximately 40 nm from the corner of the TMAA.

Zerbini et al. (2010, 2015) documented fine scale localized small scale movements in the eastern Bering Sea between July and October based on satellite tag tracking of five North Pacific right whales.

During a marine mammal survey in July 2012, a lone North Pacific right whale was seen approximately 40 nm south of the Study Area in deep water, approximately 130 nm east of Kodiak Island (Matsuoka et al. 2013). In July 2013, during the GOALS II survey, three North Pacific right whales were acoustically detected (using sonobuoys) in the Barnabus Trough region on Albatross Bank, well outside the TMAA to the southeast of Kodiak Island (Rone et al. 2014). This is the same area as the 2004–2006 sightings noted above (Wade et al. 2011a, b). North Pacific right whales were not detected on any of the passive

acoustic monitoring devices deployed in the shelf and slope regions of the Study Area between July 2011 and May 2013 (Baumann-Pickering et al. 2012a, b; Debich et al. 2013, 2014). However, on 20 June and then between 27 July 2013 and 5 September 2013, calls were detected on a newly deployed Navy-funded passive acoustic device located at the southeast edge of the GOA TMAA on Quinn Seamount (Debich et al. 2014; Širović et al. 2014). During this time, no right whale calls were detected on four similar devices located at the nearby Pratt Seamount and the nearshore shelf and slope sites, which were also within the GOA TMAA (Debich et al. 2014; Širović et al. 2014). Researchers analyzing the Quinn Seamount detections used sound propagation estimates and received levels at the hydrophone, along with the signal to noise ratio, to determine that the calls were detected from ranges on the order of roughly up to 50 nm to the east from the Quinn Seamount site; the calling animal was not in the vicinity of Quinn Seamount (Debich et al. 2014; Širović et al. 2014). Given the limitations of current passive acoustic detection technology, it is unclear if the Quinn Seamount detections were of an animal within or outside of the TMAA (Debich et al. 2014); however, there were no detections by the device at the Pratt Seamount site, which was located to the east of Quinn Seamount in the TMAA. Passive acoustic monitoring on these same devices from April 2014 to May 2015 had no acoustic detections of right whales at any of the monitoring sites (Rice et al. 2015).

Far to the south of the Study Area in June 2013, a single right whale was sighted in the waters off Haida Gwaii, British Columbia (Hume 2013). Approximately 9 days later and 200 nm to the south, a Navy-funded bottom-mounted passive acoustic monitoring device at Quinault Canyon detected two right whale calls within a 2-hour period (Širović et al. 2014). In October another (different) single right whale was sighted off the Strait of Juan de Fuca (Canada/Washington) and moving south with a group of humpback whales (Pynn 2013; Calambokidis 2013). These observations and detections indicate at least two North Pacific right whales have recently ranged beyond the Bering Sea and Kodiak Island waters in the Gulf of Alaska, if they are in fact part of the small North Pacific population of right whales as described by Wade et al. (2011b).

The NMFS-identified Kodiak Island feeding area for North Pacific right whales encompasses the North Pacific right whale Critical Habitat. The boundary for the feeding area also surrounds all locations where, from 1926 and into the 1960s, Japanese whalers documented having caught or sighted North Pacific right whales in addition to the more recent sightings, acoustic detections, and observed feces as presented in Wade et al. (2011a, b), which indicated North Pacific right whales were present and feeding in the area (Aquatic Mammals 2015; Ferguson et al. 2015b). This area, delineated as a “feeding area,” is applicable from June to September (see Ferguson et al. 2015b) so there is temporal overlap with the proposed Navy training that could occur between April and October in any year in the TMAA. There is, however, minimal spatial overlap between this feeding area and the Navy TMAA (the overlap is only in the southwest corner of the TMAA; see Figure 3.8-2). Additionally and following the end of whaling in the Gulf of Alaska in the 1960s, all recent sightings of North Pacific right whales in the Gulf of Alaska in the designated feeding area (1998–2006; see Wade et al. 2011a, b) occurred no closer than approximately 30 nm from the corner of the TMAA. None of the more recent acoustic data discussed above (Baumann-Pickering et al. 2012a, b; Debich et al. 2013, 2014; Širović et al. 2014) or the recent surveys (see Matsuoka et al. 2013; Rone et al. 2009, 2014) have provided any sightings or acoustic detections of North Pacific right whales in the portion of the designated feeding area that overlaps with the TMAA.

Given their current extremely low population numbers and the general lack of sightings in the Gulf of Alaska, the occurrence of right whales in the TMAA is considered rare. North Pacific right whales have not been visually detected in the TMAA since at least the 1960s.

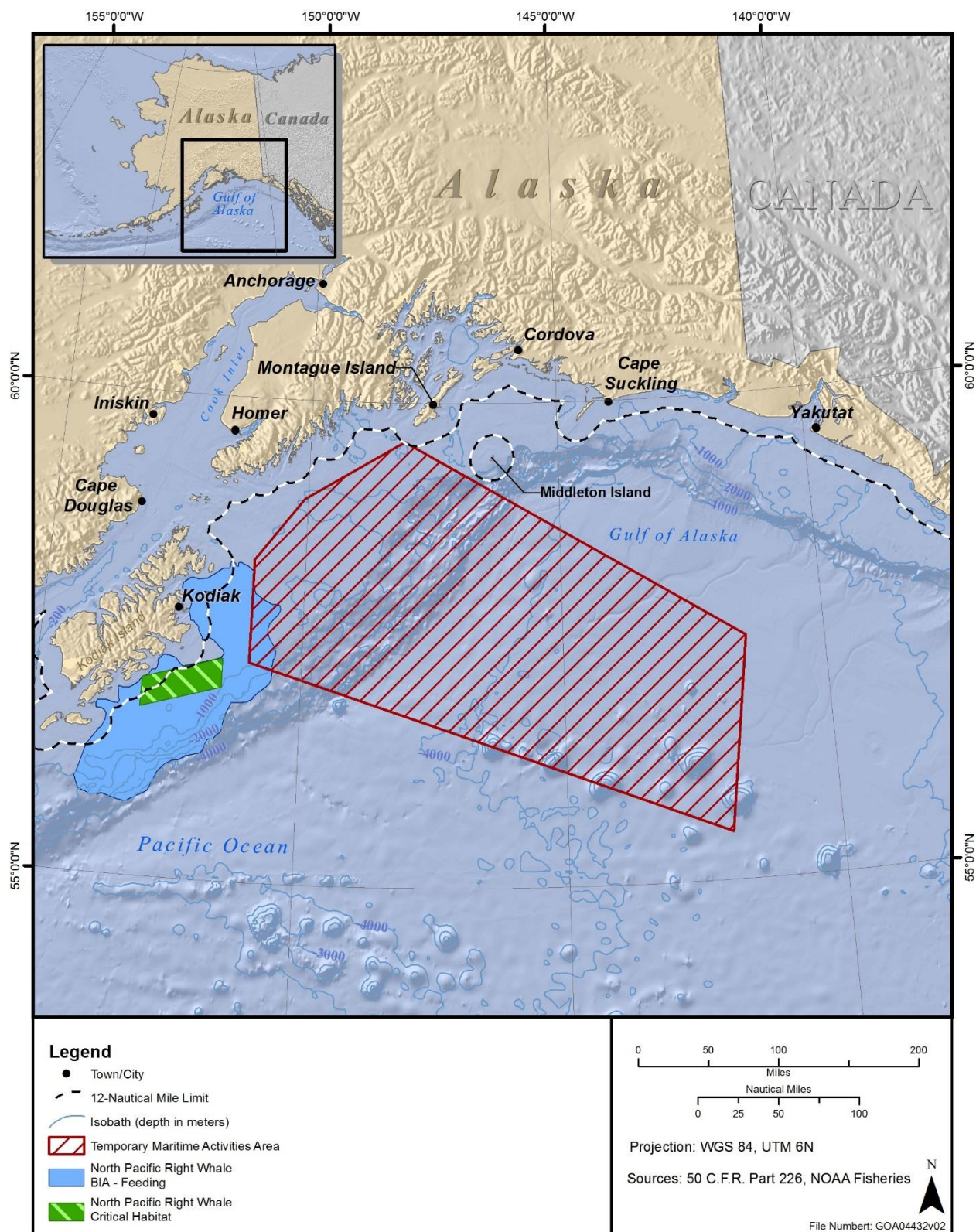


Figure 3.8-2: National Marine Fisheries Service Identified North Pacific Right Whale Feeding Area

The Quinn Seamount passive acoustic detections in summer 2013 (Širović et al. 2014) are the only known potential occurrence records of this species in the TMAA in recent years. Right whale vocalizations were detected on that hydrophone for a brief period on June 22 and July 27, and then for a few hours every couple of days between August 2 and September 5 for a total of 53 hours in 2013. There were no right whale vocalizations detected on the Quinn Seamount hydrophone or any of the other four monitoring hydrophones in the 2014–2015 time period (Rice et al. 2015). This data supports the assessment of right whale presence in the Gulf of Alaska as intermittent and in the TMAA as rare.

3.8.2.7 Humpback Whale (*Megaptera novaeangliae*)

3.8.2.7.1 Status and Management

Humpback whales are listed as depleted under the MMPA and endangered under the ESA, but there is no designated critical habitat for this species in the North Pacific. A comprehensive review of the status of humpback whales has been underway for a number of years as the science has been developed in that regard (see Bettridge et al. 2015). Baker et al. (2013) commented that humpback whales display a complex population structure based on DNA samples taken across 10 humpback whale feeding areas and eight breeding regions within the Pacific (see also Bettridge et al. 2015). Proposed rulemaking for a formal status change was announced April 21, 2015 (National Oceanic and Atmospheric Administration 2015b). In the North Pacific, the proposal is to discard the current stock designations and divide the species into four distinct population segments (DPSs): (1) Western North Pacific, (2) Hawaii, (3) Mexico, and (4) Central America. The proposal is also to remove the endangered status for the species under the ESA, and list the Western North Pacific and the Central America DPSs as “threatened” given it has been determined that these DPSs are likely to become endangered throughout all of their ranges in the foreseeable future (Bettridge et al. 2015; National Oceanic and Atmospheric Administration 2015b). The new Hawaii DPS and the Mexico DPS are not proposed for listing as either threatened or endangered based on their current statuses; those animals will no longer be considered endangered under the ESA. There is no proposal to designate critical habitat for the Western North Pacific DPS or the Central America DPSs because critical habitat “is not currently determinable” (National Oceanic and Atmospheric Administration 2015b). The wintering area for the Western North Pacific DPS is centered off the Ogasawara Islands, the Okinawa Islands, Taiwan, the Philippines, and the Mariana Islands and the wintering area for the Central America DPS are the waters from southern Mexico and south along the coast of Central America (Calambokidis et al. 2008).

These proposed DPSs for the species, if adopted, would not change the overall conclusions regarding likely impacts to humpback whales under the Proposed Action presented in subsequent sections of this Supplemental EIS (SEIS)/OEIS. If the proposed rule designating these DPSs in the North Pacific occurs under the ESA, a parallel revision of MMPA humpback whale population structure in the North Pacific will be considered by NMFS and potentially lead to changes in the currently designated humpback whale stocks considered in this analysis.

A large-scale photo-identification sampling study of humpback whales was conducted from 2004 to 2006 throughout the North Pacific (Barlow et al. 2011, Calambokidis et al. 2008). Known as the SPLASH (Structure of Populations, Levels of Abundance, and Status of Humpbacks) Project, the study was designed to sample all known North Pacific feeding and breeding populations. The SPLASH data demonstrated that humpback whales of the Central American DPS feed almost exclusively offshore of California and Oregon, with the small remaining few individuals who have been identified feeding at the northern Washington–southern British Columbia feeding grounds (Calambokidis et al. 2008). Whales

from the Central American DPS do not come as far north as the GOA TMAA Study Area (Bettridge et al. 2015; Calambokidis et al. 2008).

The SPLASH data showed that humpback whales from the Western North Pacific stock and DPS feed primarily off the Russian coast (Bettridge et al. 2015; Calambokidis et al. 2008, Calambokidis 2010). There is, however, discovery tag data from approximately 50 years ago (summarized and presented in Yamaguchi 2010) and the more recent SPLASH data (Calambokidis et al. 2008) indicating that a few whales from areas assigned to the Western North Pacific DPS have been identified in the Gulf of Alaska near the TMAA, in addition to other feeding areas in the Pacific outside Russian waters and the Bering Sea.

The SPLASH data clearly showed that humpback whales from the Hawaii DPS and the Mexico DPS, which comprise the Central North Pacific stock and the California, Washington, and Oregon stock, are the overwhelming majority of humpback whales found in the northern Gulf of Alaska (see Table 10 in Calambokidis et al. 2008).

Based on the stock assessment for the current Central North Pacific stock, an overall minimum estimate of mortality and serious injury due to fisheries is 14 humpback whales annually, and the mean vessel collision mortality and serious injury rate is 4.3 humpback whales annually (Muto et al. 2016). For the California, Washington, and Oregon stock, the overall minimum estimate of mortality and serious injury due to fisheries is 4.4 humpback whales annually, and the mean vessel collision mortality and serious injury rate is 1.1 humpback whales per year (Carretta et al. 2016a).

There are additional regulations that have been issued governing the approach to humpback whales “within 200 miles of the coast” in Alaska waters (National Marine Fisheries Service 2001a). These regulations were issued to manage the threat caused by whale-watching activities by: (1) prohibiting approach to within 100 yards (yd.) (91 m) of humpback whales, (2) implementation of a “slow safe speed” in proximity to humpbacks, and (3) creating exemptions for some vessels, including military vessels engaged in “official duty” (training). Navy standard practice is for vessels to avoid approaching marine mammals head on and to maneuver to maintain a mitigation zone of 500 yd. (457 m) around observed whales and 200 yd. (183 m) around all other marine mammals (except bow-riding dolphins), providing it is safe to do so.

3.8.2.7.2 Abundance

Overall humpback whale abundance in the North Pacific based on the SPLASH Project was estimated at 21,808 individuals (CV = 0.04), confirming that this population of humpback whales has continued to increase and is now greater than some pre-whaling abundance estimates (Barlow et al. 2011). Data indicate that the North Pacific population has been increasing at a rate of between 5.5 percent and 6.0 percent per year, approximately doubling every 10 years (Calambokidis et al. 2008; see also Bettridge et al. 2015). Campbell et al. (2015) reported no significant changes to the population of humpback whales in Southern California, indicating that the population is at least steady.

The Central North Pacific stock has been estimated at 10,103 (CV = 0.300) individuals based on data from their wintering grounds throughout the main Hawaiian Islands (Muto et al. 2016). In summer, the majority of humpback whales from the Central North Pacific stock are found in the Aleutian Islands, Bering Sea, Gulf of Alaska, and southeast Alaska/northern British Columbia, where relatively high densities of whales occur (Allen and Angliss 2014).

The current best estimate for the Western North Pacific stock is 1,017 (CV = 0.300) individuals, based on data from their Asian wintering grounds (Muto et al. 2016). In summer, animals from this stock are found feeding mainly in waters off Russia, the Aleutian Islands, and the Bering Sea; although to a limited extent they mix with whales from the Central North Pacific stock through the central Gulf of Alaska (Allen and Angliss 2014).

Based on sighting data collected during a Navy-funded line-transect survey of the Study Area in April 2009, there were 219 (CV = 0.57) and 56 (CV = 0.57) humpback whales in the inshore and offshore strata, respectively (Rone et al. 2009). Data collected during line-transect surveys in shelf and nearshore waters from the Kenai Fjords in the Gulf of Alaska to the central Aleutian Islands during July and August 2001, 2002, and 2003 suggest that humpback whale populations in the Gulf of Alaska are increasing (Zerbini et al. 2006). During a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA, sighting data were collected from four survey strata designed to sample the diverse habitat present in the Study Area. Abundance estimates for unidentified large whales were prorated among blue, fin, and humpback whales within each stratum and proportionally incorporated into each species density estimate, resulting in the following abundance estimates for humpback whales: 2,927 (CV = 0.74) inshore stratum, 65 (CV = 0.76) offshore stratum, 53 (CV = 0.64) seamount stratum, and 9 (CV = 1.03) slope stratum (Rone et al. 2014).

3.8.2.7.3 Distribution

Humpback whales are distributed worldwide in all major oceans and most seas. They typically are found during the summer on high-latitude feeding grounds and during the winter in the tropics and subtropics around islands, over shallow banks, and along continental coasts, where calving occurs (Barlow et al. 2011, Calambokidis et al. 2008). The NMFS-identified feeding areas for humpback whales (Figure 3.8-3) are outside the TMAA and do not overlap with the TMAA (see Ferguson et al. 2015b). Most humpback whale sightings are in nearshore and continental shelf waters; however, humpback whales frequently travel through deep water during migrations such as the route to and from the Hawaiian Islands (Barlow et al. 2011, Calambokidis et al. 2001). Migratory transits between the Hawaiian Islands and southeastern Alaska have been documented to take as little as 36–39 days (Calambokidis et al. 2001, Gabriele et al. 1996).

Identifications made between feeding areas and wintering areas indicate that the majority of humpbacks in the GOA winter in Hawaii (about 60 percent of the population), with the remainder wintering in Mexican waters around the Revillagigedo Islands, Baja, and the Mexican mainland (Barlow et al. 2011, Calambokidis et al. 2008). This suggests that whales migrating between breeding areas in Hawaii and feeding areas in northern British Columbia and southeast Alaska must cross paths with whales migrating between breeding areas near Mexico's offshore islands and feeding areas in the Gulf of Alaska (Barlow et al. 2011).

Prior to the SPLASH study, there had been few matches made between humpbacks in the western Pacific and any of the known feeding areas (Calambokidis et al. 2001). Barlow et al. (2011) found that the whales wintering near Japan and the Philippines migrate primarily to Kamchatka and to some extent, the Aleutian Islands, Bering Sea, and Gulf of Alaska. However, approximately 15–17 percent of the whales identified in the western Gulf of Alaska could not be matched to known wintering areas, suggesting the existence of undocumented humpback wintering areas (Calambokidis et al. 2008).

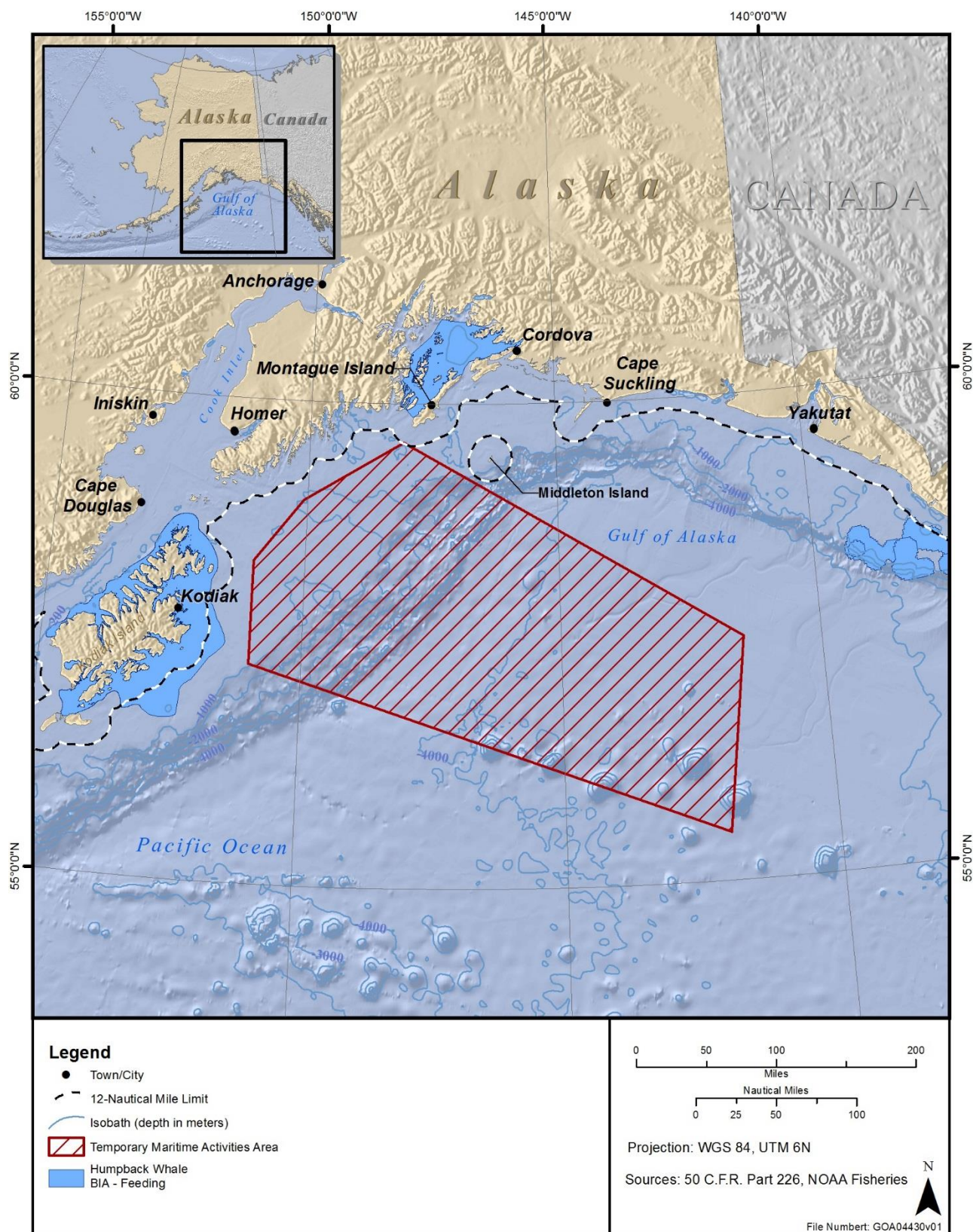


Figure 3.8-3: National Marine Fisheries Service Identified Humpback Whale Feeding Areas Near the TMAA

There were eight on-effort humpback whale sightings during the Navy-funded line-transect survey of the Study Area in April 2009, and only one of these sightings was in the offshore stratum in waters deeper than 2,000 m (Rone et al. 2009). Results from a recent study of humpback whales in the Gulf of Alaska suggest that there may be regional feeding aggregations within the Gulf of Alaska (Witteveen et al. 2011). This study confirmed that humpback whale feeding aggregations exhibit high site fidelity and indicated that, while inshore and offshore aggregations of humpbacks off Kodiak Island and southeastern Alaska represent single feeding aggregations, inshore and offshore whale aggregations off Prince William Sound may be unique (Witteveen et al. 2011).

Humpback whales have been known to occur within the Gulf of Alaska primarily in summer and fall, migrating to southerly breeding grounds in winter and returning to the north in spring (Calambokidis et al. 2008). However, based on recordings from moored hydrophones deployed in six locations in the Gulf of Alaska from October 1999 to May 2002, humpback calls were most commonly detected during the fall and winter (Stafford et al. 2007). More recently, HARPs deployed in the shelf and slope regions of the Study Area confirmed that some humpbacks remain in the area throughout the winter (Baumann-Pickering et al. 2012b). Based on both sighting data and acoustic detections, humpback whales are now known to occur year-round in the Gulf of Alaska (National Oceanic and Atmospheric Administration 2012b, Stafford et al. 2007). Humpback whale occurrence in the Study Area during the summer time period is considered likely.

3.8.2.8 Blue Whale (*Balaenoptera musculus*)

3.8.2.8.1 Status and Management

The blue whale is listed as depleted under the MMPA and as endangered under the ESA, but there is no designated critical habitat for this species. Analyses of acoustic data suggest that blue whales in the North Pacific comprise two distinct stocks based on different call types, an eastern and central population (Stafford 2003, Stafford et al. 2001; Monnahan et al. 2014). Acoustic call types from both populations have been detected in the Gulf of Alaska (Baumann-Pickering et al. 2012b, Stafford 2003, Stafford et al. 2007). For the MMPA Stock Assessment Reports, the Eastern North Pacific stock of blue whales includes animals found in the eastern North Pacific from the northern Gulf of Alaska to the eastern tropical Pacific and the Central (formerly Western) North Pacific stock includes animals found in waters off Hawaii during the winter (Carretta et al. 2016b).

3.8.2.8.2 Abundance

Widespread whaling over the last century is believed to have decreased the blue whale population to approximately 1 percent of its pre-whaling population size (Širović et al. 2004; Branch et al. 2007; Monnahan et al. 2014a; Rocha et al. 2015). The current best available abundance estimate for the Eastern North Pacific stock of blue whales is 1,647 (CV = 0.07) (Carretta et al. 2016b). There was a documented increase in the blue whale population size between 1979/80 and 1991 (Barlow 1994) and between 1991 and 1996 (Barlow 1997), but there had not been evidence to suggest an increase in the population of the Eastern North Pacific stock since then (Barlow and Taylor 2001; Carretta et al. 2014). Based on sighting data collected during a 2010 summer/fall shipboard line-transect survey of the entire Hawaiian Islands EEZ, the central North Pacific stock of blue whales is estimated at 81 animals (CV = 1.14) (Carretta et al. 2016b). This is most likely an underestimate because the majority of blue whales are expected to be at higher latitudes during the summer and fall, when the 2010 survey was conducted (Bradford et al. 2013; Carretta et al. 2016b). Calambokidis et al. (2009a) suggested that when feeding conditions off California are not optimal, blue whales may move to other regions to feed, including waters further north. A comparison of survey data from the 1990s to 2008 indicates that there

has been a northward shift in blue whale distribution within waters off California, Oregon, and Washington (Barlow 2010). Subsequent mark-recapture estimates “indicated a significant upward trend in abundance of blue whales” at a rate of increase just under 3 percent per year for the U.S. west coast blue whale population in the Pacific (Calambokidis et al. 2009b; Calambokidis and Barlow 2013). Consistent with the earlier suggested variability in the distribution patterns, Carretta et al. (2013) report that blue whales from the U.S. west coast have been increasingly found feeding to the north and south of the U.S. west coast during summer and fall. Sighting data collected during a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA provided an abundance estimate for blue whales of 78 (CV = 1.22) based on pooled sightings from all strata and incorporation of prorated estimates for unidentified large whale species (Rone et al. 2014).

Campbell et al. (2015) reported no significant changes to the population of blue whales in Southern California, indicating that the population is at least steady. The information available on the status and trend of blue whale populations precludes any conclusions on the extinction risks facing blue whales as a species, or particular populations of blue whales. The possible exception is the Eastern North Pacific blue whale stock, which may not have been subject to as much commercial whaling as other blue whale populations. Recent literature suggest that this population may be recovering to a stable level since the cessation of commercial whaling in 1971 despite the impacts of ship strikes, interactions with fishing gear, and increased levels of ambient sound in the Pacific Ocean (Monnahan et al. 2014a, 2014b; Campbell et al. 2015; Širović et al. 2015; Carretta et al. 2016b).

3.8.2.8.3 Distribution

Blue whales inhabit all oceans and are distributed from the ice edges to the tropics in both hemispheres (Jefferson et al. 1993). Most blue whale sightings are in nearshore and continental shelf waters; however, blue whales frequently travel through deep oceanic waters during migration (Širović et al. 2004). Most baleen whales spend their summers feeding in productive waters near the higher latitudes and winters in the warmer waters at lower latitudes (Širović et al. 2004). Recently, it has been suggested that the migration patterns of blue whales in the North Pacific change during different oceanographic conditions (Calambokidis et al. 2009a).

Data indicate that whales from the Eastern North Pacific stock winter off Mexico, central America, and south to about 8°S (Stafford et al. 1999), and migrate to summer feeding grounds off the U.S. west coast and to a lesser extent to the Gulf of Alaska (Calambokidis et al. 2009a). Blue whales observed in the spring, summer, and fall off California, Washington, and British Columbia are known to be part of a group that returns to feeding areas off British Columbia and Alaska (Calambokidis and Barlow 2004; Calambokidis et al. 2009). These animals have shown site fidelity, returning to their mother’s feeding grounds on their first migration (Calambokidis and Barlow 2004).

Blue whales from the Central North Pacific stock feed in summer off Kamchatka, the Aleutians, and in the Gulf of Alaska, and migrate to lower latitudes in the winter, including the Western Pacific and to a lesser degree the Central Pacific, including Hawaii (Stafford 2003, Stafford et al. 2001). Based on a photo-identification match of a blue whale observed during the 2013 GOALS II survey in the TMAA, Rone et al. (2014) determined the whale had been previously identified in Mexican waters off Baja California in 2005.

There were no blue whale sightings during an August 1994 line-transect survey south of the Aleutian Islands that covered waters over the continental shelf, the Aleutian Trench, and the northern portion of the abyssal plains of the Gulf of Alaska (Forney and Brownell 1996). A large-scale, inter-disciplinary

monitoring program for the North Pacific Ocean and the southern Bering Sea, conducted seasonally from June 2002 through October 2004, included surveys of marine birds and mammals. The cruises followed a survey track from British Columbia, Canada, to Hokkaido, Japan, crossing the Gulf of Alaska between roughly 51°N and 55°N (Sydeman et al. 2004). On six separate crossings, covering all seasons and including waters of all depths, no blue whales were seen (Sydeman et al. 2004). There also were no blue whale sightings during the Navy-funded survey of the Study Area in April 2009 (Rone et al. 2009). During the 2013 GOALS II survey, there were five on-effort blue whale sightings of seven individuals (Rone et al. 2014).

Despite the lack of sighting data, blue whale calls have been acoustically detected in the Gulf of Alaska from mid-July to mid-December, with peak occurrence from August through November (Moore et al. 2006). Calls from the Eastern North Pacific population are detected from late July to mid-December, and calls from the Western (now Central) North Pacific population are detected from mid-July to mid-December (Stafford et al. 2007). More recently, two Navy-funded HARPs were deployed in the shelf and slope regions of north-central Gulf of Alaska and recordings collected from July 2011 through February 2012 (Baumann-Pickering et al. 2012b). Blue whale calls were detected from both the Eastern North Pacific and Central North Pacific stocks, although calls from the latter were substantially less common. Overall, blue whale calls were detected from the start of HARP deployment in July 2011 through early January 2012, when blue whale calling decreased dramatically (Baumann-Pickering et al. 2012b). The highest number of hours with calls occurred from mid-August until early December, indicating the presence of blue whales in the Study Area from summer through early winter. Blue whale occurrence in the Study Area is considered seasonally likely, primarily from July through December.

3.8.2.9 Fin Whale (*Balaenoptera physalus*)

3.8.2.9.1 Status and Management

The fin whale is listed as depleted under the MMPA and as endangered under the ESA, but there is no designated critical habitat for this species. Fin whale population structure in the Pacific Ocean is not well known. In the North Pacific, NMFS recognizes three fin whale stocks: (1) a Northeast Pacific stock; (2) a California, Oregon, and Washington stock; and (3) a Hawaii stock (Muto et al. 2016; Carretta et al. 2016b). Animals from the Northeast Pacific stock are those that are expected to occur in the Study Area.

3.8.2.9.2 Abundance

In the north Pacific, the total pre-exploitation population size of fin whales is estimated at 42,000–45,000 whales (Ohsumi and Wada 1974). In 1973, fin whale abundance in the entire North Pacific basin was estimated between 13,620 and 18,680 whales (Ohsumi and Wada 1974). Zerbin et al. (2006) have provided evidence of an increasing abundance trend for fin whales in Alaskan waters. Moore and Barlow (2011) reported an increase in fin whale abundance from 1991 to 2008. Currently there are no reliable current or historical population estimates for the Northeast Pacific stock of fin whales (Muto et al. 2016). A previous minimum estimate for the stock was 1,214 (see Muto and Angliss 2015), based on surveys west of the Kenai Peninsula that covered only a portion of the stock's range although that survey is now out of date.

Based on sighting data collected during the Navy-funded line-transect survey of the Study Area in April 2009, there were 594 (CV = 0.29) and 889 (CV = 0.57) fin whales in the inshore and offshore strata, respectively (Rone et al. 2009). Data collected during line-transect surveys in shelf and nearshore waters from the Kenai Fjords in the Gulf of Alaska to the central Aleutian Islands during July and August 2001, 2002, and 2003 suggest that fin whale populations in the Gulf of Alaska are increasing

(Zerbini et al. 2006). During a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA, sighting data were collected from four survey strata designed to sample the diverse habitat present in the Study Area. Abundance estimates for unidentified large whales were prorated among blue, fin, and humpback whales within each stratum and proportionally incorporated into each species density estimate, resulting in the following abundance estimates for fin whales: 1,610 (CV = 0.49) inshore stratum, 1,265 (CV = 0.27) offshore stratum, 207 (CV = 0.39) seamount stratum, and 499 (CV = 0.21) slope stratum (Rone et al. 2014).

3.8.2.9.3 Distribution

The fin whale is found in all the world's oceans (Jefferson et al. 2008) but appears to have a preference for temperate and polar waters (Reeves et al. 2002). Locations of breeding and calving grounds for the fin whale are largely unknown, but they typically migrate seasonally to higher latitudes every year to feed and migrate to lower latitudes to breed (Kjeld et al. 2006, MacLeod et al. 2006b, Mizroch et al. 2009, Campbell et al. 2015). During the summer in the Pacific, fin whales are distributed from the southern Chukchi Sea (69°N) south to 32°N off the California coast (Mizroch et al. 2009). Falcone and Schorr (2014) provide further evidence based on Southern California visual sighting records, photographic ID matches, and satellite tagging from 2006 to 2013 for a Southern California permanent or semi-permanent resident population of fin whales displaying seasonal distribution shifts within the region.

Fin whales have been observed during the summer in the central Bering Sea (Moore et al. 2000). During the winter, fin whales are sparsely distributed from 60°N, south to the northern edge of the tropics, near which it is assumed that they mate and calve (Mizroch et al. 2009). Location data from whales implanted with markers indicate that fin whales show local site fidelity, move consistently within and between summer feeding grounds (including the Gulf of Alaska), and undertake long migrations between the high-latitude summer grounds and the low-latitude winter grounds (Mizroch et al. 2009). The NMFS-identified feeding areas for fin whales adjacent to Kodiak Island do not overlap with the Navy TMAA, where Navy training occurs (see Ferguson et al. 2015b; Figure 3.8-4).

In previous years, fin whales have been acoustically detected in the Gulf of Alaska year-round, with highest call occurrence rates from August through December and lowest call occurrence rates from February through July (Moore et al. 2006, Stafford et al. 2007). More recently, two Navy-funded HARPs were deployed in the shelf and slope regions of north-central Gulf of Alaska and recordings collected from July 2011 through February 2012 (Baumann-Pickering et al. 2012b). Fin whale calls were recorded at both sites during all months, with a peak in calling from late August until the end of December.

There were 20 on-effort fin whale sightings (56 total animals) during the Navy-funded line-transect survey of the Study Area in April 2009; animals were distributed in both the inshore and offshore strata (Rone et al. 2009). During a 2012 survey in summer and early fall, Matsuoka et al. (2013) reported 149 fin whale sightings of 210 individuals. These sightings were made across both shelf and offshore strata within and adjacent to the Gulf of Alaska. During the June–July 2013 GOALS II Navy-funded line-transect survey in and around the TMAA, sighting data were collected from four survey strata designed to sample the diverse habitat present in the Study Area. Abundance estimates for unidentified large whales were prorated among blue, fin, and humpback whales within each stratum and proportionally incorporated into each species density estimate, resulting in the following abundance estimates for fin whales: 1,610 (CV = 0.49) inshore stratum, 1,265 (CV = 0.27) offshore stratum, 207 (CV = 0.39) seamount stratum, and 499 (CV = 0.21) slope stratum (Rone et al. 2014). Fin whale occurrence in the Study Area during the summer time period is considered likely.

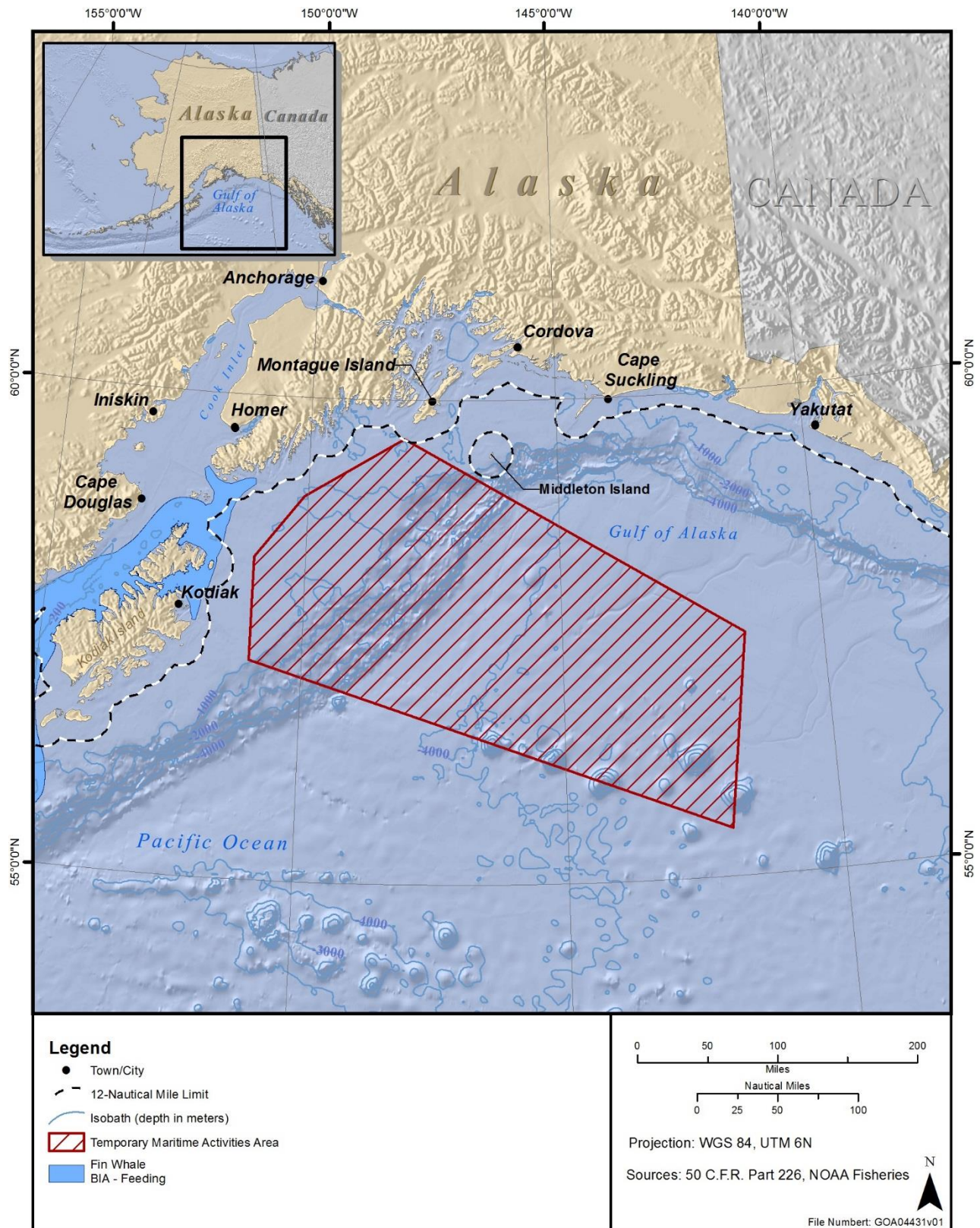


Figure 3.8-4: National Marine Fisheries Service Identified Fin Whale Feeding Area Near the TMAA

3.8.2.10 Sei Whale (*Balaenoptera borealis*)

3.8.2.10.1 Status and Management

The sei whale is listed as depleted under the MMPA and as endangered under the ESA, but there is no designated critical habitat for this species. A recovery plan for the sei whale was completed in 2011 and provides a research strategy for obtaining data required to estimate population abundance and trends, and to identify factors that may be limiting the recovery of this species (National Marine Fisheries Service 2011d). Only a single Eastern North Pacific stock is recognized in the U.S. EEZ of the North Pacific (Carretta et al. 2016b). However, some mark-recapture, catch distribution, and morphological research indicate that multiple stocks exist (Carretta et al. 2016b; Masaki 1976, 1977). The Eastern North Pacific population has been protected since 1976, but is likely still impacted by the effects of continued unauthorized takes from whaling (Carretta et al. 2016b).

3.8.2.10.2 Abundance

Estimates of sei whale abundance in the eastern North Pacific based on survey data are not available. The best current estimate of abundance for the Eastern North Pacific stock of sei whales that occur off California, Oregon, and Washington waters out to 300 nm is 126 animals (CV = 0.53) (Carretta et al. 2016b). There are no abundance data specific to the Gulf of Alaska and no data available on current population trends. Ivashchenko et al. (2013) commented that North Pacific sei whale populations were severely depleted up through 1979 by a combination of high Soviet and Japanese whaling takes.

3.8.2.10.3 Distribution

Sei whales have a worldwide distribution and are found primarily in cold temperate to subpolar latitudes (Horwood 1987). Sei whales spend the summer months feeding in the subpolar higher latitudes and return to the lower latitudes to calve in the winter. Whaling data provide some evidence of differential migration patterns by reproductive class, with females arriving at and departing from feeding areas earlier than males (Horwood 1987, Perry et al. 1999). In the North Pacific, sei whales are thought to occur mainly south of the Aleutian Islands. In the summer they are present across the temperate Pacific from 35°N to 50°N (Horwood 2009, Masaki 1977, Smultea et al. 2010) and in the winter were recently found south of 20°N near the Mariana Islands (Fulling et al. 2011). Sei whales are most often found in deep, oceanic waters of the cool temperate zone. They appear to prefer regions of steep relief, such as the continental shelf break, canyons, or basins between banks and ledges (Best and Lockyer 2002, Grew and Trites 2001, Kenney and Winn 1987, Schilling et al. 1992). Characteristics of preferred breeding grounds are unknown, since they have generally not been identified.

Whaling records from the 1900s indicate there were high densities of sei whales in the northwestern and northeastern portions (i.e., near Portlock Bank) of the Gulf of Alaska during May through August (U.S. Department of the Navy 2006). There were no sei whales sighted during the April 2009 survey of the Study Area (Rone et al. 2009). During a 2012 survey in summer and early fall, Matsuoka et al. (2013) reported 87 sei whale sightings of 1,647 individuals. The majority of these sightings were in the offshore waters in the central to southern Gulf of Alaska and adjacent eastern North Pacific south of the Gulf of Alaska. Hakamada and Matsuoka (2014) provided North Pacific sighting data for sei whales collected during surveys from 2010 to 2012 that included areas within the Gulf of Alaska, including a portion of the Navy's Study Area. There were no sightings of sei whales in the TMAA, and all the sightings were south of 53° N latitude, far south of the Navy's Study Area. During the 2013 GOALS II survey, although sei whales were acoustically detected there were no confirmed visual sightings of sei whale (Rone et al. 2014). Sei whale occurrence in the Study Area during the summer time period is considered rare.

3.8.2.11 Minke Whale (*Balaenoptera acutorostrata*)

3.8.2.11.1 Status and Management

The minke whale is protected under the MMPA and is not listed under the ESA. "Resident" minke whales from California to Washington appear behaviorally distinct from migratory whales farther north, so based on this distinction NMFS recognizes two minke whale stocks: (1) a California, Oregon, and Washington stock; and (2) an Alaska stock (Muto et al. 2016; Carretta et al. 2016b). Animals from the Alaska stock are those that are expected to occur in the Study Area.

3.8.2.11.2 Abundance

Abundance estimates are not available for the Alaska stock of minke whales because only portions of the stock's range have been surveyed (Muto et al. 2016). Data collected during line-transect surveys in shelf and nearshore waters from the Kenai Fjords in the Gulf of Alaska to the central Aleutian Islands during July and August 2001, 2002, and 2003 yielded an abundance estimate of 1,233 (CV = 0.34) for this region (Zerbini et al. 2006); however, this is considered an underestimate because correction factors for animals missed along the trackline were not incorporated.

3.8.2.11.3 Distribution

Minke whales are distributed in polar, temperate, and tropical waters (Jefferson et al. 1993); they are less common in the tropics than in cooler waters. Minke whales generally occupy waters over the continental shelf, including inshore bays, and even occasionally enter estuaries. However, records from whaling catches and research surveys worldwide indicate an open ocean component to the minke whale's habitat. Minke whales are present in the North Pacific from near the equator to the Arctic (Horwood 1990). The summer range extends to the Chukchi Sea (Perrin and Brownell 2002). In the winter, minke whales are found south to within 2° of the equator (Perrin and Brownell 2002). The distribution of minke whale vocalizations (specifically, "boings") suggests that the winter breeding grounds are the offshore tropical waters of the North Pacific Ocean (Rankin and Barlow 2005).

The migration paths of the minke whale include travel between breeding and feeding grounds and have been shown to follow patterns of prey availability (Jefferson et al. 2008). In the northern part of their range, minke whales are believed to be migratory, whereas they appear to establish home ranges in the inland waters of Washington State and along central California (Dorsey 1983, Dorsey et al. 1990), and exhibit site fidelity to these areas between years (Dorsey et al. 1990).

There were a total of 72 on-effort sightings of minke whales during line-transect surveys in shelf and nearshore waters from the Kenai Fjords in the Gulf of Alaska to the central Aleutian Islands during July and August 2001, 2002, and 2003 (Zerbini et al. 2006). Most of the minke whale sightings from these surveys were in the Aleutian Islands in water depths of less than 200 m (Zerbini et al. 2006). There were two on-effort minke whale sightings (three total animals) during the Navy-funded line-transect survey of the Study Area in April 2009; both sightings were in the inshore stratum (Rone et al. 2009). During a 2012 survey in summer and early fall, Matsuoka et al. (2013) reported only two sightings of minke whales. One sighting was on the slope within the eastern Gulf of Alaska and the other offshore in the western Gulf of Alaska. During a recent (June and July 2013) Navy-funded line-transect survey in and around the Study Area, there were three sightings of six minke whales, but only two sightings occurred within the TMAA: one in the slope stratum and one in the seamount stratum (Rone et al. 2014). Minke whales have not been detected on either of the HARPs deployed in the shelf and slope regions of the Study Area, based on recordings collected from July 2011 through February 2012 (Baumann-Pickering

et al. 2012b). Minke whale occurrence in the Study Area during the summer time period is considered likely.

3.8.2.12 Gray Whale (*Eschrichtius robustus*)

3.8.2.12.1 Status and Management

There are currently two formally recognized North Pacific populations of gray whales: the Western North Pacific stock that is critically endangered according to the International Union for Conservation of Nature Red Book, but shows signs of slow recovery, and the Eastern North Pacific stock (also known as the Eastern North Pacific or the California-Chukchi population) has recovered from exploitation (whaling) after 70 years of protection and was removed from listing under the ESA in 1994 (Carretta et al. 2016b, Swartz et al. 2006). Both populations (stocks) could be present in the Study Area (Carretta et al. 2016b, Mate et al. 2012, 2015b). The Western subpopulation, previously known as the Western North Pacific or the Korean-Okhotsk population, has been designated the Western North Pacific stock (Carretta et al. 2013a). All gray whale populations are protected under the MMPA; the Western North Pacific stock is listed as depleted under the MMPA and endangered under the ESA, but there is no designated critical habitat for this species.

A few hundred gray whales that feed along the Pacific coast between southeastern Alaska and Southern California throughout the summer and fall are known as the Pacific Coast Feeding Group (Calambokidis et al. 2002; Carretta et al. 2016b; Weller et al. 2013). The group has been identified as far north as Kodiak Island, Alaska (Gosho et al. 2011), and has generated uncertainty regarding the stock structure of the Eastern North Pacific population (Carretta et al. 2016b; Weller et al. 2013). Photo-identification, telemetry, and genetic studies suggest that the Pacific Coast Feeding Group is demographically distinct from the Eastern North Pacific population (Calambokidis et al. 2010, Frasier et al. 2011, Mate et al. 2010). Currently, however, the Pacific Coast Feeding Group is not treated as a distinct stock in the NMFS Stock Assessment Reports (SARs), but this may change in the future if new information supports such a designation (Carretta et al. 2016b). In 2012–2013, the Navy funded a satellite tracking study of Pacific Coast Feeding Group gray whales (U.S. Department of the Navy 2013d). Tags were attached to 11 gray whales near Crescent City, California in fall 2012. Good track histories were received from 9 of the 11 tags, which confirmed an exclusive near shore (< 15 km) distribution and movement along the California, Oregon, and Washington coasts. The whales did not linger near any submarine canyons or other underwater features, remaining entirely on the continental shelf (Mate 2013a, b; U.S. Department of the Navy 2013e).

Gray whales began to receive protection from commercial whaling by the League of Nations in the 1920s; by the government of Mexico and then later by the International Whaling Commission (IWC) at its inception in 1946. However, hunting of the western population continued for many more years. After changing the status of the recovered species to sustainable harvest, the International Whaling Commission set annual quotas for gray whale harvests from the eastern population for aboriginal subsistence. In 2007 the International Whaling Commission approved a 5-year quota (2008–2012) of 620 whales, with an annual combined maximum of 140 whales for Russian and U.S. (Makah Indian Tribe) aboriginals. Russia and the United States agreed to a shared annual harvest of 120 and 4 whales, respectively; however, all takes during this time period were from Russia (International Whaling Commission 2013). In 2013, a total of 127 gray whales were “struck” in subsistence whaling in the aboriginal harvest by Chukotka indigenous hunters from the Russian Federation (Ilyashenko & Zharikov 2014). Alaskan hunters no longer intentionally pursue gray whales, and the United States has not pursued a gray whale catch limit from the International Whaling Commission for Alaska hunters (Norberg 2013).

3.8.2.12.2 Abundance

Recent abundance estimates for the Eastern North Pacific gray whale population have ranged between 17,000 and 20,000 (Rugh et al. 2008, Swartz et al. 2006). For stock assessment purposes, NMFS currently uses an abundance estimate of 20,990 animals (CV = 0.005; Carretta et al. 2016b). The eastern population has increased, despite the 1999 event in which an unusually large number of gray whales stranded along the coast from Mexico to Alaska (Gulland et al. 2005; Carretta et al. 2016b), when many scientists thought the population had reached “carrying capacity.”

Based on a defined range for the Pacific Coast Feeding Group of between 41°N and 52°N, the latest (2010) abundance estimate is 209 (CV = 0.007) whales (Carretta et al. 2016b).

The Western North Pacific gray whale was once considered extinct but small numbers have been monitored since the mid-1980s (Weller et al. 2002; Mate et al. 2015b). The most recent estimate of this population is 140 individuals ((CV = 0.04; Carretta et al. 2016b).

3.8.2.12.3 Distribution

Eastern North Pacific Gray Whales

The Eastern North Pacific stock of gray whales migrates along the U.S. west coast as they travel between summer arctic feeding grounds and coastal temperate and subtropical winter mating and calving grounds. Winter grounds extend from central California south along Baja California, the Gulf of California, and the mainland coast of Mexico.

Beginning in the fall, whales start the southward migration from the northern summer feeding areas to the winter calving areas, mainly following the coast to Mexico. The trip averages 2 months. The northward migration to the feeding grounds occurs in two phases. The first phase in late January through March consists of newly pregnant females, who go first to maximize feeding time, followed by adult females and males, then juveniles. The second phase, in April through May, consists primarily of mothers and calves that have remained in the breeding area longer, allowing calves to strengthen and rapidly increase in size before the northward migration (Herzing and Mate 1984; Jones and Swartz 2009).

Most of the Eastern North Pacific stock summers in the shallow waters of the northern Bering Sea, Chukchi Sea, and western Beaufort Sea, but as noted above, the Pacific Coast Feeding Group feeds along the Pacific coast throughout the summer and fall (Calambokidis et al. 2002). Gray whales are found along the shore in the northern Gulf of Alaska during migrations between the breeding and feeding grounds. One group consisting of an estimated 25 gray whales was sighted off Kodiak Island (outside the TMAA) during the off-effort portion of the GOALS II survey (Rone et al. 2013). The southbound migration begins in early October, when gray whales move from the Bering Sea through the Unimak Pass and along the coast of the Gulf of Alaska (Braham 1984). The southbound migration continues into the winter season between October and January. Migration of gray whales past Kodiak Island peaks in mid-December (Rugh et al. 2001). During the northbound migration, the peak of migration in the Gulf of Alaska is in mid-April (Braham 1984). As noted above, although most gray whales migrate to the Bering Sea to feed, some Pacific Coast Feeding Group whales do not complete the migration but feed in coastal waters in the Gulf of Alaska (Gosho et al. 2011). The NMFS-identified gray whale feeding area in the region does not overlap with the Navy TMAA, where Navy training occurs (see Ferguson et al. 2015b; See Figure 3.8-5).

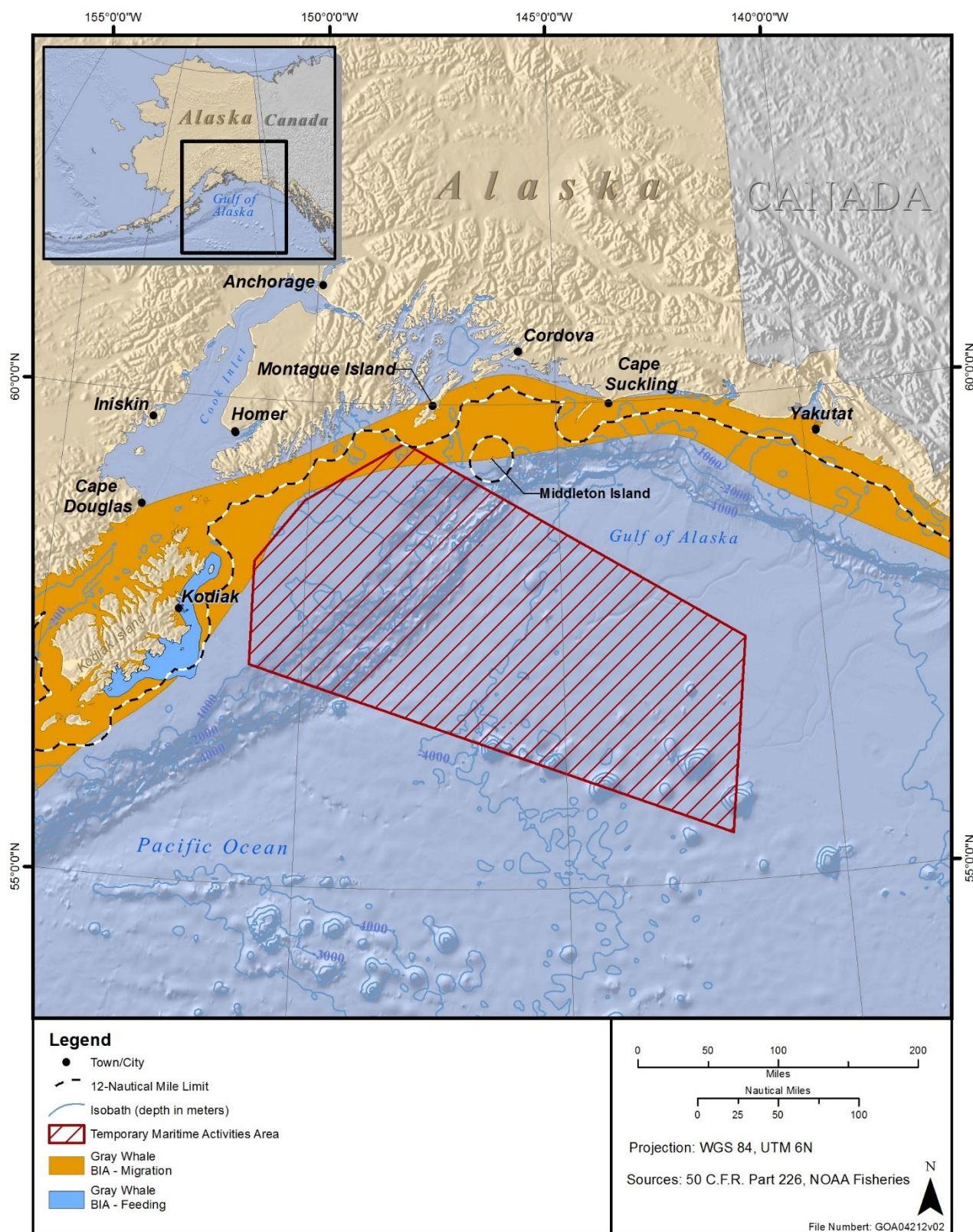


Figure 3.8-5: National Marine Fisheries Service Identified Gray Whale Feeding Areas and Migration Areas Overlapping With or Near the TMAA

Most gray whales follow the coast during migration and stay within approximately 1 mi. (2 kilometers [km]) of the shoreline, except when crossing major bays, straits, and inlets from southeastern Alaska to the eastern Bering Sea (Braham 1984). However, gray whales are known to move farther offshore between the entrance to Prince William Sound and Kodiak Island and between Kodiak Island and the southern part of the Alaska Peninsula (Consiglieri et al. 1982). Gray whales use the nearshore areas of the Alaska Peninsula during the spring and fall migrations and are often found within the bays and lagoons, primarily north of the peninsula, during the summer (U.S. Department of the Navy 2006). During the April 2009 survey of the Study Area, one group of two gray whales was sighted while on-effort within the Study Area (Rone et al. 2009). Outside the TMAA, there was one off-effort sighting (25 individuals) southeast of Kodiak Island during the recent (June and July 2013) GOALS II survey of the central Gulf of Alaska (Rone et al. 2014). The NMFS-identified migration area for gray whales, which was bounded by the extent of the continental shelf (as provided in Ferguson et al. 2015b), has only slight overlap with the Navy TMAA's northernmost corner and western edge (see Ferguson et al. 2015b; see orange area shown in Figure 3.8-4). However, this migration area is applicable only between March to May (spring) and November to January (fall) (see Aquatic Mammals 2015). This NMFS-identified gray whale migration area would not be applicable during the timeframe when training has historically occurred (June/July) and is not likely to have temporal overlap with most of the proposed timeframe (April to October; summer) for Navy training in the TMAA.

Gray whale calls were detected during a single hour on a single day, 29 September 2012, at the HARP deployed in the slope region of north-central Gulf of Alaska (Baumann-Pickering et al. 2012b). Since gray whales tend to stay close to shore during their migration, the HARP deployment locations are likely too far offshore to capture more gray whale signals (Baumann-Pickering et al. 2012b). The occurrence of Eastern North Pacific gray whales in the Study Area during the summer time period is considered likely.

Western North Pacific Gray Whales

The migration routes of the Western North Pacific population of gray whale are poorly known (Weller et al. 2002). Previous sighting data suggested that the original population of gray whales in the western Pacific had a limited range extending between the Okhotsk Sea off the coast of Sakhalin Island (Russia) and the South China Sea (Weller et al. 2002). However, recent long-term studies of radio-tracked whales indicate that the coastal waters of eastern Russia, the Korean Peninsula, and Japan are part of the migratory route (Weller et al. 2012). There is also photographic evidence of a match between a whale found off Sakhalin Island and the Pacific coast of Japan, more than 932 mi. (1,500 km) south of the Sakhalin feeding area (Weller et al. 2008). Mate et al. (2012, 2015b) used long-term satellite-monitoring tags to document the movements of three Western North Pacific gray whales from Russian waters to the eastern North Pacific. One tag quit midway across the Gulf of Alaska and a second quit off the central Oregon coast. The third was tracked to within 60 km of the southern tip of Baja, Mexico and back to Sakhalin Island, visiting all of the known breeding areas of the eastern stock and consistent with the NMFS-identified gray whale migration area (see Ferguson et al. 2015b). Only one of the three tracks presented in Mate et al. (2015b) would have crossed the boundary where the Navy's TMAA is during the summer. All three of these animals subsequently migrated to regions occupied by Eastern North Pacific gray whales (Mate et al. 2015b). Further, photo-catalog comparisons of Eastern and Western North Pacific gray whale populations suggest that there is more exchange between the western and eastern populations than previously thought, since "Sakhalin" whales were sighted off Santa Barbara, California; British Columbia, Canada; and Baja California, Mexico (Weller et al. 2008, 2013; Mate et al. 2015b). In the summer, when Navy training would occur, Western North Pacific gray whales are expected to be in their summer feeding grounds, which extend from Russian waters to the South China Sea. The

occurrence of Western North Pacific gray whales in the Study Area during the summer time period is considered rare.

3.8.2.13 Sperm Whale (*Physeter macrocephalus*)

3.8.2.13.1 Status and Management

The sperm whale is listed as depleted under the MMPA and has been listed as endangered since 1970 under the precursor to the ESA, but there is no designated critical habitat for this species in the North Pacific. Sperm whales are managed as three stocks in the Pacific: (1) the Alaska/North Pacific stock; (2) the California, Oregon, and Washington stock; and (3) the Hawaii stock (Allen and Angliss 2014; Carretta et al. 2014). Animals from the Alaska/North Pacific stock are those that are expected to occur in the Study Area.

3.8.2.13.2 Abundance

Currently there is no reliable abundance estimate for the Alaska/North Pacific stock of sperm whales and the number of animals occurring within Alaska waters is unknown (Allen and Angliss 2014). The number of sperm whales within the eastern temperate North Pacific was estimated at 26,300 (CV = 0.81) from visual surveys and 32,100 (CV = 0.36) from acoustic detections (Barlow and Taylor 2005). During a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA, sighting data were collected from four survey strata designed to sample the diverse habitat present in the Study Area. During the survey there were 19 on-effort sightings of sperm whales and 241 acoustic detections from the towed hydrophone array, 174 of which were localized. Based on the localized acoustic detections, the following abundance estimates were derived for sperm whales: 78 (CV = 0.36) offshore stratum, 16 (CV = 0.55) seamount stratum, and 121 (CV = 0.18) slope stratum (Rone et al. 2014). There were no sperm whale sightings or acoustic detections within the inshore stratum, and 18 of the 19 sperm whale sightings occurred within the slope stratum (Rone et al. 2014).

3.8.2.13.3 Distribution

In the North Pacific, sperm whales appear to be nomadic, showing widespread movements between areas of concentration, and this suggests there are no divisions that would represent separate stocks (Mizroch and Rice 2013). Male sperm whales are found from tropical to polar waters in all oceans of the world, between approximately 70°N and 70°S (Rice 1998). The female distribution is more limited and corresponds approximately to the 40° parallels but extends to 50° in the North Pacific (Whitehead 2003). Sperm whales are somewhat migratory. General shifts occur during summer months for feeding and breeding, while in some tropical areas, sperm whales appear to be largely resident (Whitehead 2003, Whitehead et al. 2008). Pods of females with calves remain on breeding grounds throughout the year, between 40°N and 45°N (Rice 1989, Whitehead 2003), while males migrate between low-latitude breeding areas and higher-latitude feeding grounds (Pierce et al. 2007). In the northern hemisphere, “bachelor” groups (males typically 15–21 years old and bulls [males] not taking part in reproduction) generally leave warm waters at the beginning of summer and migrate to feeding grounds that may extend as far north as the perimeter of the arctic zone. In fall and winter, most return south, although some may remain in the colder northern waters during most of the year (Pierce et al. 2007). Sperm whales show a strong preference for deep waters (Rice 1989, Whitehead 2003). Off the U.S. west coast, their distribution is typically associated with waters over the continental shelf break, over the continental slope, and into deeper waters (Becker et al. 2012b, Forney et al. 2012). This was also the case in the 2013 GOALS II survey during which 18 of 19 sperm whale sightings occurred within the slope stratum (Rone et al. 2014).

Summer surveys between 2001 and 2010 in the coastal waters around the central and western Aleutian Islands have found sperm whales to be the most frequently sighted large cetacean (Allen and Angliss 2014). Acoustic surveys have detected the presence of sperm whales year-round in the Gulf of Alaska, although about twice as many are present in summer as in winter (Mellinger et al. 2004a, Moore et al. 2006). Sperm whale echolocation clicks were detected by two HARPs deployed in the shelf and slope region of north-central Gulf of Alaska in July 2011; however, there were much higher detection rates at the deeper site (Baumann-Pickering et al. 2012b). In contrast to the findings of Mellinger et al. (2004a), Baumann-Pickering et al. (2012b) found high numbers of sperm whale detections in November and December, with a drop off to low numbers of detections throughout January and February. During the April 2009 survey of the Study Area, there were no sperm whale sightings, but they were acoustically detected on 28 different occasions (Rone et al. 2009). During a 2012 survey in summer and early fall, Matsuoka et al. (2013) reported 50 sightings of 57 individual sperm whales. All sightings were of large male sperm whales and distributed on the shelf and offshore waters of the Gulf of Alaska and adjacent areas of the eastern North Pacific. As noted above, during the 2013 GOALS II survey there were 19 sightings of sperm whales totaling 22 individuals and sperm whales were acoustically detected from the towed hydrophone array on 241 occasions (Rone et al. 2014). Sperm whale occurrence in the Study Area during the summer time period is considered likely.

3.8.2.14 Killer Whale (*Orcinus orca*)

A single species of killer whale is currently recognized, but strong and increasing evidence indicates the possibility of several different species of killer whales worldwide, many of which are called “ecotypes” (Ford 2008, Morin et al. 2010, Pilot et al. 2009). The different geographic forms of killer whale are distinguished by distinct social and foraging behaviors and other ecological traits (Morin et al. 2010). In the North Pacific, these recognizable geographic forms are variously known as “residents,” “transients,” and “offshore” ecotypes (Hoelzel et al. 2007).

3.8.2.14.1 Status and Management

The killer whale is protected under the MMPA, and the overall species is not listed on the ESA. The Eastern North Pacific Southern Resident population is listed as depleted under the MMPA and as endangered under the ESA, but is not expected to be present in the Study Area. The AT1 Transient stock of killer whales is also designated as depleted under the MMPA but is not listed under the ESA; this stock’s current abundance estimate is seven animals (Allen and Angliss 2014), and extinction appears likely for this population (Matkin et al. 2012). Eight killer whale stocks are recognized within the Pacific U.S. EEZ, including (1) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock (Prince William Sound through the Aleutian Islands and Bering Sea); (2) the AT1 Transient stock (Alaska from Prince William Sound through the Kenai Fjords); (3) the Alaska resident stock (southeastern Alaska to the Aleutian Islands and Bering Sea); (4) the Northern Resident stock (Washington state through part of southeastern Alaska); (5) the West Coast Transient stock (California through southeastern Alaska); (6) the Eastern North Pacific Offshore stock (California to Alaska); (7) the Southern Resident stock (mainly within the inland waters of Washington State and southern British Columbia, but also in coastal waters from Southeast Alaska through California); and (8) the Hawaii stock (Allen and Angliss 2014, Carretta et al. 2014). Killer whales most likely to occur in the Study Area based on dominant distribution patterns include the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock and the Alaska Resident stock; while whales from the AT1 Transient stock and the Eastern North Pacific Offshore stock could also occur in the Study Area, occurrence is considered rare and infrequent, respectively.

3.8.2.14.2 Abundance

The current best available abundance estimates for the four killer whale stocks that occur or rarely occur in the Study Area are as follows: Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock = 587 animals; the AT1 Transient stock = 7 animals; Alaska Resident stock = 2,347 animals (Allen and Angliss 2014); and the Eastern North Pacific Offshore stock = 211 animals (Carretta et al. 2014). The estimate for the Eastern North Pacific Offshore stock reflects the number of offshore killer whales that occur along the U.S. west coast, Canada, and Alaska; since this is a trans-boundary stock, an abundance estimate specific to Alaska waters is not available (Carretta et al. 2014).

Line-transect surveys conducted in coastal waters of the Gulf of Alaska and Aleutian Islands in July and August 2001, 2002, and 2003 yielded a total of 41 on-effort sightings of killer whales (Zerbini et al. 2007). Sighting data from these surveys were used to derive abundance estimates for the different killer whale ecotypes. The abundance estimate for resident killer whales was 991 (CV = 0.52) and for transients was 200 (CV = 0.48). There were insufficient data (a total of two sightings) to estimate abundance for the offshore ecotype (Zerbini et al. 2007). These estimates were based on ecotype and were not necessarily directly applicable to the different stocks occurring in the Study Area, since ecotype estimates could include members from different stocks (e.g., as noted above, at least four different stocks of transient killer whales may occur in the Study Area during the summer time period). During a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA, sighting data were collected from four survey strata designed to sample the diverse habitat present in the Study Area, and resulted in the following abundance estimates for killer whales: 117 (CV = 0.60) inshore stratum, 107 (CV = 0.77) seamount stratum, and 726 (CV = 1.93) slope stratum (Rone et al. 2014).

3.8.2.14.3 Distribution

Killer whales are found in all marine habitats from the coastal zone (including most bays and inshore channels) to deep oceanic basins and from equatorial regions to the polar pack ice zones of both hemispheres. Although killer whales are also found in tropical waters and the open ocean, they are most numerous in coastal waters and at higher latitudes (Dahlheim and Heyning 1999, Forney and Wade 2006). Killer whales are known to inhabit both the western and eastern temperate Pacific and likely have a continuous distribution across the North Pacific (Steiger et al. 2008). In most areas of their range, killer whales do not show movement patterns that would be classified as traditional migrations. However, there are often seasonal shifts in density, both onshore/offshore and north/south.

Sightings of killer whales are widely distributed, mostly occurring in waters over the continental shelf, but also quite frequently in offshore waters. Based on sightings, strandings, and acoustic detections, all three killer whale ecotypes (residents, transients, and offshore) are known to occur in the Gulf of Alaska (Barbieri et al. 2013, Dahlheim et al. 2008, Forney and Wade 2006, Zerbini et al. 2007). Individuals belonging to the Alaska Resident stock and the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock are the killer whales most likely to occur in the Study Area (Allen and Angliss 2014). The range of the Alaska Resident stock extends across the Gulf of Alaska from Southeast Alaska to the Aleutian Islands, and into the Bering Sea. In 2011 and 2012, Andrews and Matkin (2014) deployed satellite tags on 6 Alaska Resident killer whales and found mean travel distances exceeded 80 km per day, with movements offshore as far as 160 km and as far as 570 km from the tagging site. This correlates with the findings of Fearnbach et al. (2013), who took a 10-year dataset of 3,058 whale photoidentifications from 331 encounters in Alaska waters demonstrating a median distance between repeated encounters of approximately 197 km with a maximum of 1,443 km. The Gulf of Alaska, Aleutian Islands, and Bering Sea

Transient stock has a range that includes all of the U.S. EEZ in Alaska, although sightings in Southeast Alaska are uncommon (Allen and Angliss 2014).

AT1 transients are seen primarily in Prince William Sound and in the Kenai Fjords region, and given their limited numbers and more limited distribution, are less likely to occur in the Study Area (Matkin et al. 2012). Eastern North Pacific Offshore killer whales are most commonly sighted off the coasts of California and Oregon, and less frequently in Southeast Alaska (Carretta et al. 2014), but have been identified in the western Gulf of Alaska near Kodiak Island (Dahlheim et al. 2008, Zerbini et al. 2007). Based on sightings of killer whales along the U.S. west coast and Alaska from 1976 to 2006, only 59 sightings of offshore killer whales have been documented, and of these, 40 have occurred off California (Dahlheim et al. 2008).

During the April 2009 survey of the Study Area, six groups of killer whales totaling 119 animals were sighted, and there were an additional 16 acoustic detections (Rone et al. 2009). During a 2012 survey in summer and early fall, Matsuoka et al. (2013) reported only 17 sightings of 99 killer whales although ecotype was unknown. Sightings were made on the near shore shelf, within the TMAA, and in the very southern part of the Gulf of Alaska south through the eastern North Pacific. Killer whales were detected at both HARPs deployed in the shelf and slope region of north-central Gulf of Alaska (Baumann-Pickering et al. 2012b). Based on the analysis of recordings from July 2011 through early January 2012, peak presence was during mid-July and mid-August, with sporadic detections during the rest of the recording period. Initial evaluation indicates that the burst pulses and whistles most likely were generated from the resident ecotype, but further investigation is required for confirmation (Baumann-Pickering et al. 2012b). Killer whale occurrence in the Study Area during the summer time period is considered likely.

3.8.2.14.4 Pacific White-Sided Dolphin (*Lagenorhynchus obliquidens*)

3.8.2.14.5 Status and Management

The Pacific white-sided dolphin is protected under the MMPA and is not listed under the ESA. NMFS divides Pacific white-sided dolphin management stocks within the U.S. Pacific EEZ into two discrete areas: (1) the Alaska/North Pacific stock; and (2) the California, Oregon, and Washington stock (Allen and Angliss 2014, Carretta et al. 2014). Morphological studies and genetic analyses suggest the existence of several populations of Pacific white-sided dolphins throughout their range (Hayano et al. 2004, Lux et al. 1997). Four populations have been suggested: (1) in the offshore waters of Baja California, (2) in the offshore waters of California to Oregon, (3) offshore of British Columbia and Alaska, and (4) in the offshore waters west of 160°W (Hayano et al. 2004). However, the population boundaries are dynamic, and there is no reliable way to distinguish animals in the field. Thus, populations occurring in the U.S. Pacific EEZ are managed by NMFS as the two stocks noted above. Animals from the Alaska/North Pacific stock are those that are expected to occur in the Study Area.

3.8.2.14.6 Abundance

There is currently no reliable population estimate for the Alaska/North Pacific stock of Pacific white-sided dolphins (Allen and Angliss 2014). However, based on sighting data collected from surveys north of 45°N from 1987 to 1990, an abundance estimate specific to the Gulf of Alaska is 26,880 animals (Allen and Angliss 2014). There were no Pacific white-sided dolphin sightings during a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA (Rone et al. 2014).

3.8.2.14.7 Distribution

The Pacific white-sided dolphin is found in cold temperate waters across the northern rim of the Pacific Ocean (Jefferson et al. 2008, Reeves et al. 2002). It is typically found in deep waters along the continental margins and outer shelf and slope waters. It is also known to inhabit inshore regions of southeast Alaska, British Columbia, and Washington, and occurs seasonally off Southern California (Brownell et al. 1999, Forney and Barlow 1998).

Pacific white-sided dolphins occur regularly year-round throughout the Gulf of Alaska, with peak abundance between July and August (U.S. Department of the Navy 2006). Cetacean surveys near Kenai Peninsula, within Prince William Sound and around Kodiak Island in summer 2003, reported sighting two large groups (an average group size of 56) just off Kenai Peninsula (Waite 2003). During the April 2009 survey of the Study Area, Pacific white-sided dolphins were sighted only once (a group of 60 individuals), although the location of the sighting was outside the Study Area and inside the shelf break to the southeast of Kodiak Island (Rone et al. 2009). Pacific white-sided dolphin clicks were not detected during passive acoustic monitoring from two HARPs deployed in the shelf and slope region of north-central Gulf of Alaska from July 2011 to January 2012 (Baumann-Pickering et al. 2012b). There were no Pacific white-sided dolphin sightings during a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA (Rone et al. 2014). Pacific white-sided dolphin occurrence in the Study Area during the summer time period is considered likely.

3.8.2.15 Harbor Porpoise (*Phocoena phocoena*)

3.8.2.15.1 Status and Management

The harbor porpoise is protected under the MMPA and is not listed under the ESA. Based on genetic differences and discontinuities identified from aerial surveys for populations off California, Oregon, and Washington, and based on somewhat arbitrary boundaries for Alaska populations, nine separate stocks are recognized within U.S. Pacific EEZ waters, six off the U.S. west coast (Carretta et al. 2014) and three off Alaska: (1) a Bering Sea stock, occurring throughout the Aleutian Islands and waters north of Unimak Pass; (2) a Gulf of Alaska stock, occurring from Cape Suckling to Unimak Pass; and (3) a Southeast Alaska stock, occurring from the northern border of British Columbia to Cape Suckling (Allen and Angliss 2014). Harbor porpoise from both the Gulf of Alaska and Southeast Alaska stocks may occur in the Study Area. For the Gulf of Alaska stock, the estimated minimum annual mortality rate incidental to U. S. commercial fisheries is 71.4 harbor porpoises (Allen and Angliss 2014).

3.8.2.15.2 Abundance

The most recent abundance estimates for harbor porpoise stocks that may occur in the Study Area are as follows: Gulf of Alaska stock = 31,046 individuals (CV = 0.21) and Southeast Alaska stock = 11,146 individuals (CV = 0.24; Allen and Angliss 2014). These estimates were derived from aerial survey data collected in summer 1997 in Southeast Alaska and 1998 in the Gulf of Alaska and include correction factors for both perception and availability bias (Hobbs and Waite 2010).

3.8.2.15.3 Distribution

Harbor porpoise are generally found in cool temperate to subarctic waters over the continental shelf in both the North Atlantic and North Pacific (Read 1999). In the eastern North Pacific, harbor porpoise are found in nearshore coastal (generally within a mile or two of shore) and inland waters from Alaska south to Point Conception, California, which is considered the southern extent of this species' normal range (Carretta et al. 2009, Dohl et al. 1983, Hamilton et al. 2009, Hobbs and Waite 2010).

In Alaskan waters, harbor porpoises inhabit nearshore areas and are common in bays, estuaries, and tidal channels. Harbor porpoises are often found in coastal waters in the Gulf of Alaska and occur most frequently in waters less than 328 ft. (100 m) deep (Hobbs and Waite 2010). The majority of the Study Area is offshore and beyond the normal habitat range for harbor porpoise. During the April 2009 marine mammal survey, there was only one harbor porpoise sighting within the Study Area and in one of the shallowest regions (Rone et al. 2009). There were an additional 29 sightings made in-transit to the Study Area, and these were in shallow waters south of Kodiak Island and the Alaska Peninsula. During the recent (June and July 2013) survey of the Study Area, there were a total of eight harbor porpoise sightings in the inshore stratum and on the shelf in the slope stratum (Rone et al. 2014). Harbor porpoise occurrence in the nearshore areas of the Study Area during the summer time period is considered likely.

3.8.2.16 Dall's Porpoise (*Phocoenoides dalli*)

3.8.2.16.1 Status and Management

Dall's porpoise is protected under the MMPA and is not listed under the ESA. Dall's porpoise is managed by NMFS within U.S. Pacific EEZ waters as two stocks: (1) an Alaska stock; and (2) a California, Oregon, and Washington stock (Allen and Angliss 2014, Carretta et al. 2014). Dall's porpoise from the Alaska stock occur in the Study Area.

3.8.2.16.2 Abundance

Dall's porpoises are very abundant, probably one of the most abundant small cetaceans in the cooler waters of the North Pacific Ocean. However, population structure within North American waters has not been well studied. The estimate for the Alaska stock of Dall's porpoise reported in the 2011 Stock Assessment Report was 83,400 animals (CV = 0.97), corrected for vessel attraction behavior (Allen and Angliss 2012). This estimate is now considered unreliable since it is based on survey data that are more than 21 years old (Allen and Angliss 2014). During a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA, sighting data were collected from four survey strata designed to sample the diverse habitat present in the Study Area, and resulted in the following abundance estimates for Dall's porpoise: 4,873 (CV = 0.50) inshore stratum, 1,658 (CV = 0.52) offshore stratum, 486 (CV = 0.41) seamount stratum, and 4,907 (CV = 0.36) slope stratum (Rone et al. 2014).

3.8.2.16.3 Distribution

Dall's porpoise is one of the most common odontocete species in North Pacific waters (Calambokidis and Barlow 2004, Ferrero and Walker 1999, Jefferson 1991, Williams and Thomas 2007, Zagzebski et al. 2006). Dall's porpoise is found from northern Baja California, Mexico, north to the northern Bering Sea and south to southern Japan (Jefferson et al. 1993). However, the species is only common between 32°N and 62°N in the eastern North Pacific (Houck and Jefferson 1999, Morejohn 1979). Dall's porpoise are found in outer continental shelf, slope, and oceanic waters, typically in temperatures less than 63°F (17°C) (Becker et al. 2012b, Forney et al. 2012, Houck and Jefferson 1999, Jefferson et al. 2008, Reeves et al. 2002).

Fiscus et al. (1976a) suggested that Dall's porpoise was probably the most common cetacean from the northeast Gulf of Alaska to Kodiak Island. During an August 1994 line-transect survey south of the Aleutian Islands, there were 151 sightings of Dall's porpoise, comprising 59 percent of all cetacean sightings (Forney and Brownell 1996). The region covered by this survey abuts the Study Area, extending between Kodiak Island to the west and covering waters over the continental shelf, the Aleutian Trench,

and the northern portion of the abyssal plains of the Gulf of Alaska. Dall's porpoise sightings were widespread across this survey region, occurring in all water depths (Forney and Brownell 1996).

A large-scale, inter-disciplinary monitoring program for the North Pacific Ocean and the southern Bering Sea, conducted seasonally from June 2002 through October 2004, included surveys of marine birds and mammals. The cruises followed a survey track from British Columbia, Canada to Hokkaido, Japan, crossing the Gulf of Alaska between roughly 51°N and 55°N (Sydeman et al. 2004). On six separate crossings, covering all seasons, Dall's porpoise was the most frequently sighted marine mammal, accounting for 48 to 76 percent of the sightings on each cruise, and occurring in waters of all depths (Sydeman et al. 2004).

During the April 2009 survey in the Study Area, 10 groups of Dall's porpoise were sighted, totaling 59 individuals in both inshore and offshore strata (Rone et al. 2009). During a 2012 survey in summer and early fall (Matsuoka et al. 2013), Dall's porpoise was the most commonly seen dolphin/porpoise species with 132 sightings of 636 individual. Sightings occurred throughout their survey area and included shelf and offshore water within and adjacent to the Gulf of Alaska. During the 2013 GOALS II survey, there were 320 on-effort sightings of Dall's porpoise totaling 859 individuals (Rone et al. 2014). Unidentified porpoise echolocation clicks, likely Dall's porpoise, were detected at the HARP deployed in the shelf region of north-central Gulf of Alaska (Baumann-Pickering et al. 2012b). The clicks were detected in low numbers from the start of deployment in mid-July 2011 through August 2011. There was a gap in detections until October 2011, when clicks were detected in high numbers, with decreased detections in early November 2011 followed by another gap through early February 2012 (Baumann-Pickering et al. 2012b). Seasonal movements of Dall's porpoise in the Gulf of Alaska are largely unknown. Dall's porpoise occurrence in the Study Area during the summer time period is considered likely.

3.8.2.17 Cuvier's Beaked Whale (*Ziphius cavirostris*)

3.8.2.17.1 Status and Management

Cuvier's beaked whale is protected under the MMPA and is not listed under the ESA. Cuvier's beaked whale is managed by NMFS within U.S. Pacific EEZ waters as three stocks: (1) an Alaska stock; (2) a California, Oregon, and Washington stock; and (3) a Hawaii stock (Allen and Angliss 2014, Carretta et al. 2014). Cuvier's beaked whales in the Study Area are assumed to be from the Alaska stock.

3.8.2.17.2 Abundance

There is currently no reliable abundance estimate for the Alaska stock of Cuvier's beaked whale (Allen and Angliss 2014). Acoustic data collected during the GOALS II survey were used to develop an acoustic-based abundance estimate for Cuvier's beaked whales and resulted in the following abundance estimates: 0 in the inshore stratum, 122 (CV = 0.48) offshore stratum, 138 (CV = 0.30) seamount stratum, and 31 (CV = 0.74) slope stratum (U.S. Department of the Navy 2015). Results from this Navy-funded study represent the first acoustic-based line-transect survey estimates of abundance for Cuvier's beaked whales within the Gulf of Alaska.

3.8.2.17.3 Distribution

Cuvier's beaked whales have an extensive range that includes all oceans, from the tropics to the polar waters of both hemispheres (Barlow and Gisner 2006, Ferguson et al. 2006b, Jefferson et al. 2008, Pitman et al. 1988). A single population likely exists in offshore waters of the eastern North Pacific, ranging from Alaska south to Mexico, and there are no apparent seasonal changes in distribution

(Carretta et al. 2014, Mead 1989, Pitman et al. 1988). Little is known about potential migration. Repeated sightings of the same individuals have been reported off San Clemente Island in Southern California, which indicates some level of site fidelity (Falcone et al. 2009).

Worldwide, beaked whales normally inhabit continental slope and deep oceanic waters. Cuvier's beaked whales are generally sighted in waters with a bottom depth greater than 656 ft. (200 m) and are frequently recorded in waters with bottom depths greater than 3,280 ft. (1,000 m) (Falcone et al. 2009, Jefferson et al. 2008). In the North Pacific, Cuvier's beaked whales range from Canadian waters north to the northern Gulf of Alaska, the Aleutian Islands, and the Commander Islands off Russia (Rice 1998). Rice and Wolman (1982) observed a group of six Cuvier's beaked whales in deep waters of approximately 17,716 ft. (5,400 m) southeast of Kodiak Island. During surveys off the Aleutian Islands in August 1994, Forney and Brownell (1996) made one sighting of Cuvier's beaked whale in waters with a bottom depth of 13,123–16,404 ft. (4,000–5,000 m). Waite (2003) reported one sighting of a group of four Cuvier's beaked whales at the shelf break within the Study Area.

There were no beaked whales detected acoustically or visually during the April 2009 survey of the Study Area (Rone et al. 2009). Cuvier's beaked whales were detected only three times during passive acoustic monitoring from the HARP deployed in the slope region of north-central Gulf of Alaska from July 2011 to February 2012 (Baumann-Pickering et al. 2012b). Acoustic detections were made in October 2011 and January and February 2012. All detections were made at the passive acoustic recording site deployed in the slope region, consistent with this species apparent preference for deep waters (Baumann-Pickering et al. 2012b). During the recent (June and July 2013) survey of the Study Area, one individual Cuvier's beaked whale was identified in the offshore stratum, although there were five additional unidentified sightings of beaked whales (Rone et al. 2014). There were 47 acoustic encounters of Cuvier's beaked whales during the 2013 survey and the Navy-funded analysis of that acoustic data has provided the first acoustic-based line-transect density estimate for Cuvier's beaked whales within the Gulf of Alaska (U.S. Department of the Navy 2015). Based on the acoustic detections, the estimated density was 0.0021 animals/km² for the TMAA (U.S. Department of the Navy 2015). Based on sighting data from Waite (2003) and as presented in U.S. Department of the Navy (2014a), the density estimate used for modeling of acoustic effects to Cuvier's beaked whales in the TMAA was 0.0022 animals/km² (U.S. Department of the Navy 2014a). Cuvier's beaked whale occurrence in the Study Area during the summer time period is considered likely.

3.8.2.18 Baird's Beaked Whale (*Berardius bairdii*)

3.8.2.18.1 Status and Management

Baird's beaked whale is protected under the MMPA and is not listed under the ESA. Baird's beaked whale is managed within Pacific U.S. EEZ waters as two stocks: (1) an Alaska stock; and (2) a California, Oregon, and Washington stock (Allen and Angliss 2014; Carretta et al. 2014). Baird's beaked whales in the Study Area are assumed to be from the Alaska stock.

3.8.2.18.2 Abundance

There is currently no reliable abundance estimate for the Alaska stock of Baird's beaked whale (Allen and Angliss 2014).

3.8.2.18.3 Distribution

Baird's beaked whale occurs mainly in deep waters over the continental slope, near oceanic seamounts, and areas with submarine escarpments, although they may be seen close to shore where deep water

approaches the coast (Jefferson et al. 2008, Kasuya 2009). This species is generally found throughout the colder waters of the North Pacific, ranging from off Baja California, Mexico, to the Aleutian Islands of Alaska (Jefferson et al. 2008, MacLeod and D'Amico 2006). In the North Pacific, the range of Baird's beaked whale extends from Cape Navarin (62°N) and the central Sea of Okhotsk (57°N) to St. Matthew Island, the Pribilof Islands in the Bering Sea, and the northern Gulf of Alaska (Allen and Angliss 2014, Kasuya 2009, Rice 1998).

During surveys off the Aleutian Islands in August 1994, Forney and Brownell (1996) made one sighting of Baird's beaked whale, in waters with a bottom depth of 13,123–16,404 ft. (4,000–5,000 m). Waite (2003) reported a group of four Baird's beaked whales at the shelf break to the east of the Study Area. There were no beaked whales detected acoustically or visually during the April 2009 survey of the Study Area (Rone et al. 2009). Baird's beaked whales were detected regularly from September through February during passive acoustic monitoring from the HARP deployed in the slope region of north-central Gulf of Alaska from July 2011 to February 2012 (Baumann-Pickering et al. 2012b). Higher numbers of detections occurred during November 2011–January 2012. Acoustic detections were not made at the passive acoustic recording site deployed in the shelf region, consistent with this species' apparent preference for deep waters (Baumann-Pickering et al. 2012b). During the recent (June and July 2013) survey of the Study Area, there were six on-effort Baird's beaked whale sightings of 49 individuals (Rone et al. 2014). There were 32 acoustic encounters of Baird's beaked whales during the 2013 survey (U.S. Department of the Navy 2015). These acoustic encounters did not provide a sufficient sample size to reliably estimate density and abundance using line-transect distance sampling methods. Baird's beaked whale occurrence in the Study Area during the summer time period is considered likely.

3.8.2.19 Stejneger's Beaked Whale (*Mesoplodon stejnegeri*)

3.8.2.19.1 Status and Management

Stejneger's beaked whale is protected under the MMPA but is not listed under the ESA. In the Study Area, Stejneger's beaked whales are recognized as an Alaska stock (Allen and Angliss 2014; Carretta et al. 2014).

3.8.2.19.2 Abundance

There is currently no reliable abundance estimate for the Alaska stock of Stejneger's beaked whale (Allen and Angliss 2014).

3.8.2.19.3 Distribution

Worldwide, beaked whales normally inhabit continental slope and deep oceanic waters (greater than 656 ft. [200 m]) (Canadas et al. 2002, Ferguson et al. 2006b, MacLeod and Mitchell 2006, Pitman 2008, Waring et al. 2001). They are occasionally reported in waters over the continental shelf (Pitman and Stinchcomb 2002). Stejneger's beaked whale appears to prefer cold temperate and subpolar waters (Loughlin and Perez 1985, MacLeod et al. 2006a). This species has been observed in waters ranging in depth from 2,395 to 5,120 ft. (730 to 1,560 m) on the steep slope of the continental shelf (Loughlin and Perez 1985). The farthest south this species has been recorded in the eastern Pacific is Cardiff, California (33°N), but this is considered an extralimital occurrence (Loughlin and Perez 1985, MacLeod et al. 2006a, Mead 1989).

Stejneger's beaked whales were detected almost continually during passive acoustic monitoring from the HARP deployed in the slope region of north-central Gulf of Alaska from July 2011 to February 2012 (Baumann-Pickering et al. 2012b, 2014). More acoustic detections of Stejneger's beaked whales

occurred in late September and early October 2012, although the current data are not yet sufficient to demonstrate true seasonality (Baumann-Pickering et al. 2014). Acoustic detections were not made at the passive acoustic recording site deployed in the shelf region, consistent with this species apparent preference for deep waters (Baumann-Pickering et al. 2012b). No Stejneger's beaked whales were visually identified during the recent (June and July 2013) survey of the Study Area, although five unidentified beaked whale sightings were reported (Rone et al. 2014). There were 14 acoustic encounters of Stejneger's beaked whales (U.S. Department of the Navy 2015). These acoustic encounters did not provide a sufficient sample size to reliably estimate density and abundance using line-transect distance sampling methods. Stejneger's beaked whale occurrence in the Study Area during the summer time period is considered likely.

3.8.2.20 Steller Sea Lion (*Eumetopias jubatus*)

3.8.2.20.1 Status and Management

In the North Pacific, NMFS has designated two Steller sea lion stocks corresponding to two Distinct Population Segments (DPS) having the same names as the stocks: (1) the Western U.S. stock/DPS, consisting of populations at and west of Cape Suckling, Alaska (144°W); and (2) the Eastern U.S. stock/DPS, consisting of populations east of Cape Suckling, Alaska. Both stocks of Steller sea lions occur within the Study Area (Jemison et al. 2013). There is "strong evidence" that western stock females have permanently emigrated to the East of 144°W as well as evidence of males mixing between the two stocks and making long-distance movements (Jemison et al. 2013; see also Allen and Angliss 2014 regarding unpublished data documenting mixing of these stocks).

The Western U.S. stock/DPS of Steller sea lions is listed as depleted under the MMPA and endangered under the ESA. The Eastern U.S. stock/DPS of Steller sea lions is listed as depleted under the MMPA. In October 2013, NMFS removed the eastern distinct population segment (the Eastern U.S. stock) of Steller sea lion from the List of Endangered and Threatened Wildlife because they had met the recovery criteria (National Oceanic and Atmospheric Administration 2013a). Based on a study of survival rates at four rookeries in the vicinity of the TMAA and one in the Aleutian Islands, Fritz et al. (2014) found that the population of the Western U.S. stock of Steller sea lions that includes the TMAA has rebounded to nearly the same levels estimated for the 1970s, prior to the decline in abundance. Maniscalco et al. (2014) provided similar findings regarding recovery of the Western U.S. stock based on natality rates at the Chiswell Island rookery (located between the TMAA and Kenai Peninsula) and nearby haulouts in Kenai Fjords, demonstrating natality remains high and consistent with a population in recovery.

For Alaskan waters, critical habitat has been defined for Steller sea lions in the Aleutian Islands and Western Alaska. At this time, there has been no change in the designation of critical habitat despite the recent delisting of the Eastern U.S. DPS (National Oceanic and Atmospheric Administration 2013a). There is no Steller sea lion critical habitat present in the Study Area (Figure 3.8-6); as a conservation measure, the TMAA boundary was specifically drawn to exclude any nearby critical habitat and associated terrestrial, air, or aquatic zones.

For the Western U.S. stock, the minimum estimated mortality rate incidental to U. S. commercial fisheries is 29.6 sea lions per year, and the mean annual subsistence harvest is estimated at 199 Steller sea lions per year (Allen and Angliss 2014). For the Eastern U.S. stock, the minimum estimated mortality rate incidental to U. S. and Canadian commercial fisheries is 49 sea lions per year, and the mean annual subsistence harvest is estimated at 12 Steller sea lions per year (Allen and Angliss 2014).

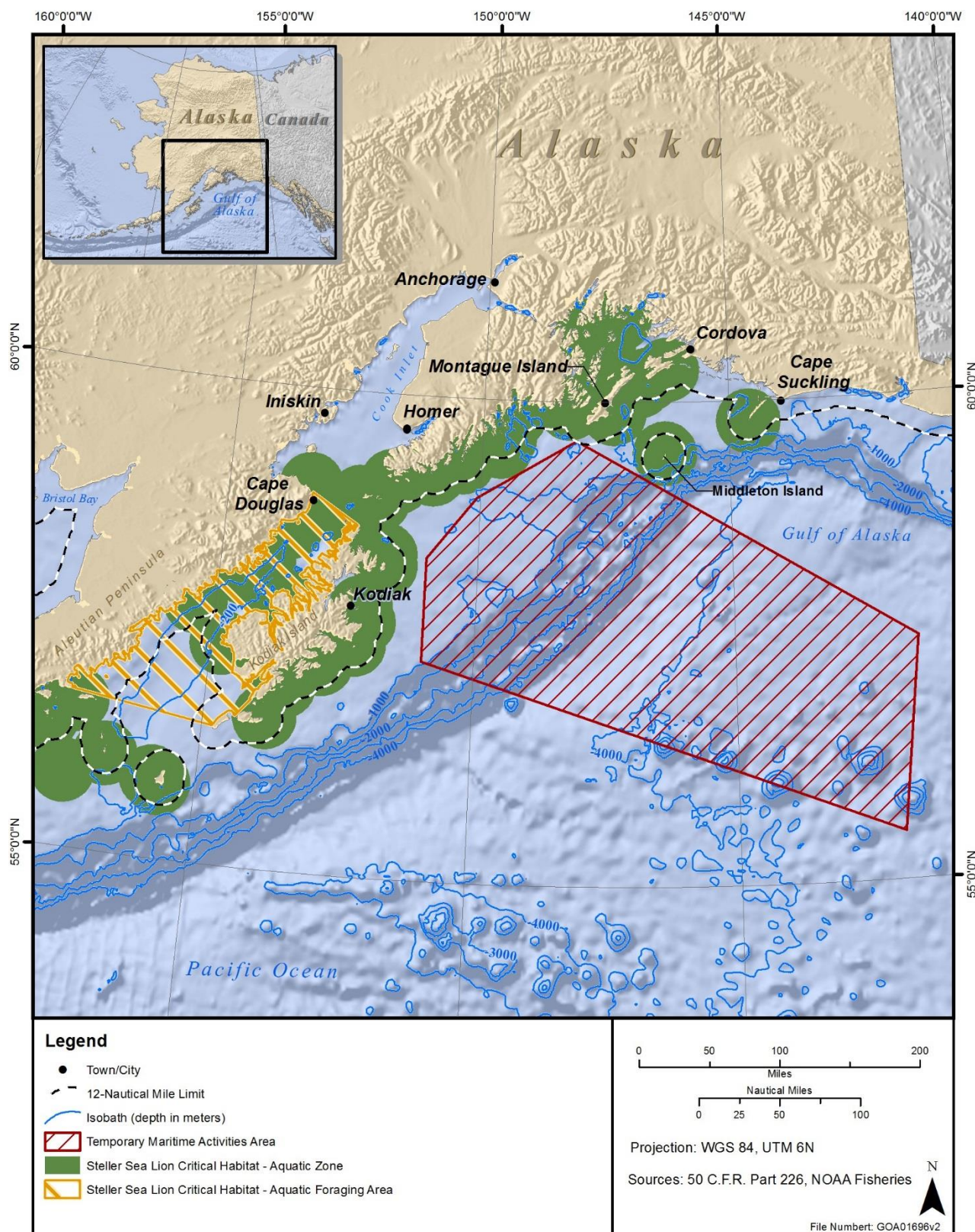


Figure 3.8-6: Steller Sea Lion Western Distinct Population Segment Critical Habitat in the Vicinity of the Temporary Maritime Activities Area

3.8.2.20.2 Abundance

The most recent comprehensive estimate (pups and non-pups) of abundance of the western stock of Steller sea lions in Alaska is based on aerial photographic and land-based surveys conducted in 2013–2014 (Muto et al. 2016). The combination of the survey results yielded a minimum abundance estimate of 49,497 western stock Steller sea lions, an increase from the minimum estimate of 38,988 individuals reported in the 2011 GOA Final EIS/OEIS (as reported in the 2008 Stock Assessment Report; Angliss and Allen 2009).

The most recent minimum population estimate is based on pup counts between 2009 and 2013 providing an abundance for the eastern stock of Steller sea lions of 59,968 individuals (Muto et al. 2016). Counts of Steller sea lion pups from 2005 to 2011 indicate an upward trend in number of pups counted, with 9,950 pups reported in 2005 and 11,547 pups counted in 2011 (DeMaster 2011). The increase has been driven by growth in pup counts in all regions between 1979 and 2010, with the Eastern DPS having increased at a rate of approximately 4.18 percent per year (NOAA 2013a).

3.8.2.20.3 Distribution

Given the wide dispersal of individuals, both the western DPS and eastern DPS may occur in the Study Area (Muto et al. 2016). Steller sea lions do not migrate, but they often disperse widely outside of the breeding season. However, the proposed timeframe for the Navy training activities is the primary breeding season for this species, when territorial males and lactating females have more restricted movements. An area of high occurrence extends from the shore to water depths of 273 fathoms (500 m). In the Gulf of Alaska, foraging habitat is primarily shallow, nearshore, and continental shelf waters 4.3–13 nm offshore with a secondary occurrence inshore of the 3,280 ft. (1,000 m) isobath, and a rare occurrence seaward of the 3,280 ft. (1,000 m) isobath (see Lander et al. 2011 regarding bathymetry influencing the distribution of the species). Six groups of Steller sea lions, which totaled 28 individuals, were sighted during the April 2009 survey of the Study Area, in both the inshore and offshore strata (Rone et al. 2009). No Steller sea lions were identified during the recent (June and July 2013) survey of the Study Area, although there were six sightings of unidentified pinnipeds (Rone et al. 2014). Steller sea lion occurrence in the Study Area during the summer time period is considered likely.

3.8.2.21 California Sea Lion (*Zalophus californianus*)

3.8.2.21.1 Status and Management

The California sea lion is protected under the MMPA and is not listed under the ESA. In the North Pacific, NMFS recognizes a single California sea lion stock, the U.S. stock (Carretta et al. 2016b).

3.8.2.21.2 Abundance

The estimated abundance of the U.S. stock of California sea lions is 296,750 individuals (Carretta et al. 2016b). This number is from counts of animals that were ashore at the four major rookeries in Southern California and at haulout sites north to the Oregon-California border during the 2008 breeding season. Sea lions that were at sea or were hauled out at other locations were not counted. The general trend for this stock is that the population is growing (Carretta et al. 2016b).

Sighting data collected during the Navy-funded line-transect survey of the Study Area in April 2009 did not include any confirmed sightings of California sea lions, although four unidentified pinnipeds were reported (Rone et al. 2009). No California sea lions were identified during the recent (June and July 2013) survey of the Study Area, although there were six sightings of unidentified pinnipeds (Rone et al. 2014).

3.8.2.21.3 Distribution

The primary rookeries for California sea lions are located on the California Channel Islands, far to the south of the Study Area. California sea lions appear to be extending their feeding range farther north, and increasing numbers of sightings are recorded in Alaskan waters (Maniscalco et al. 2004), which are positively correlated with the growth of the California sea lion population.

California sea lions have been sighted throughout Alaska from Forrester Island in southeast Alaska to St. Matthews Bay, Prince William Sound, and St. Paul Island in the Bering Sea. Both male and female California sea lions have been observed as far north as the Pribilof Islands in the Bering Sea (Maniscalco 2002, U.S. Department of the Navy 2006). The few California sea lions recorded in Alaska usually are observed at Steller sea lion rookeries and haulout sites, with most sightings recorded between March and May, although they may be found in the Gulf of Alaska throughout the year (Maniscalco et al. 2004; U.S. Department of the Navy 2006). However, between 1973 and 2003, only 52 sightings of California sea lions were reported (Maniscalco et al. 2004). California sea lion occurrence in the Study Area during the summer time period is considered rare.

3.8.2.22 Northern Fur Seal (*Callorhinus ursinus*)

3.8.2.22.1 Status and Management

NMFS has identified two stocks of northern fur seals based on high natal site fidelity, as well as substantial differences in population dynamics between Pribilof Islands (located in the Bering Sea) and San Miguel Island (Mexico) populations. Animals from the Pribilof Islands (see Lee et al. 2014 for a discussion of trends for this breeding population) are recognized as the Eastern Pacific stock, and those from San Miguel Island are the San Miguel Island stock (Allen and Angliss 2014; Carretta et al. 2014). The Eastern Pacific stock of northern fur seals is listed as depleted under the MMPA and not listed under the ESA. The San Miguel Island stock of northern fur seals is not listed as depleted under the MMPA and not listed under the ESA. Animals from Eastern Pacific stock are the only ones that may occur in the Study Area during the summer time period.

Between 2007 and 2011, there was an annual average of 496 northern fur seals harvested per year in the subsistence harvest, and an estimated minimum annual mortality rate of 4.6 fur seals per year incidental to commercial fisheries (Allen and Angliss 2014).

3.8.2.22.2 Abundance

The Eastern Pacific stock of northern fur seals includes the Pribilof Island breeding group in the Bering Sea. The most recent estimate for the number of fur seals in the Eastern Pacific stock, based on pup counts from 2008 on Sea Lion Rock, from 2008, 2010, and 2012 on St. Paul and St. George Islands, and from 2011 on Bogoslof Island, is 648,534 (Muto et al. 2016). During a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA, sighting data were collected from four survey strata designed to sample the diverse habitat present in the Study Area, and resulted in the following abundance estimates for northern fur seals: 345 (CV = 0.28) inshore stratum, 1,013 (CV = 0.35) offshore stratum, 256 (CV = 0.31) seamount stratum, and 156 (CV = 0.39) slope stratum (Rone et al. 2014).

The most recent (2011) population estimate for the San Miguel Island stock of northern fur seals is 12,368 individuals (Carretta et al. 2016b). It is unlikely that individuals of the San Miguel Island stock of northern fur seals would be present in the Study Area.

3.8.2.22.3 Distribution

Northern fur seals occur from Southern California north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan (Carretta et al. 2014). They are a coldwater species, and when at sea they are usually sighted in foraging areas along the continental shelf and slope and 38–70 nm from land (Kajimura 1984). Benoit-Bird et al. (2013) documented satellite-tracked fur seals in the Bering Sea and compared their movements with ship-based acoustic surveys of their prey. The results showed that fur seal tracks corresponded with juvenile pollock aggregations. The Eastern Pacific stock spends May–November in northern waters and at northern breeding colonies (north of the Gulf of Alaska). There are no rookeries or haulout sites in the vicinity of the Study Area. 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. Adult males from the Eastern Pacific stock generally migrate only as far south as the Gulf of Alaska (Kajimura 1984). Olesiuk (2012) reported that evidence from various sources indicates that juvenile and non-breeding northern fur seal are virtually ubiquitous throughout the Northeastern Pacific Ocean, albeit in densities lower than at the coastal margins. Tagging data indicate the main foraging areas and the main migration route through the Gulf of Alaska are generally located far to the west of the Study Area (Ream et al. 2005; Sterling et al. 2014). Northern fur seals were not sighted during the 2009 survey of the Study Area (Rone et al. 2009) but there were 69 on-effort northern fur seal sightings (74 individuals) during the 2013 GOALS II survey (Rone et al. 2014). Northern fur seal occurrence in the Study Area during the summer time period is considered likely.

3.8.2.23 Northern Elephant Seal (*Mirounga angustirostris*)

3.8.2.23.1 Status and Management

The northern elephant seal is protected under the MMPA and is not listed under the ESA. NMFS recognizes one stock for the northern elephant seal, the California Breeding stock, which is geographically distinct from a population in Baja California.

3.8.2.23.2 Abundance

The California Breeding stock of northern elephant seal has recovered from near extinction in the early 1900s to an estimated 124,000 in 2005 (Carretta et al. 2014). Current census data suggest an increasing population at an average annual rate of 3.8 percent (Lowry et al. 2014), although the population estimate for this stock has not been updated. Lowry et al. (2014) estimate that in 2010 the total population in the U.S. and Mexico was 179,000 elephant seals (Carretta et al. 2016b).

3.8.2.23.3 Distribution

Northern elephant seals are endemic to the North Pacific Ocean, occurring almost exclusively in the eastern and central North Pacific. Adult males and females segregate while foraging and migrating (Stewart and DeLong 1995). Adult females mostly range east to about 173°W, between the latitudes of 40°N and 45°N, remaining far to the west of the Study Area. In contrast, adult males range further north and east into the Gulf of Alaska and along the Aleutian Islands to between 47°N and 58°N (Le Boeuf et al. 2000, Stewart and DeLong 1995, Stewart and Huber 1993).

Northern elephant seal males regularly occur in the Gulf of Alaska year-round. Adults stay offshore during migration, while juveniles and subadults are often seen along the coasts of Oregon, Washington, and British Columbia. Northern elephant seals were not sighted during the 2009 survey of the Study Area (Rone et al. 2009). This result is not wholly unexpected, as the elephant seal pupping/breeding season occurs from December through March on the rookeries in California and Mexico, and the survey was conducted in April. During the recent (June and July 2013) survey of the Study Area, there were

15 on-effort sightings of northern elephant seals (Rone et al. 2014). Northern elephant seal occurrence in the Study Area during the summer time period is considered likely.

3.8.2.24 Harbor Seal (*Phoca vitulina*)

3.8.2.24.1 Status and Management

The harbor seal is protected under the MMPA and is not listed under the ESA. NMFS currently recognizes 12 stocks of harbor seals in Alaskan waters (Aleutian Islands, Pribilof Islands, Bristol Bay, N. Kodiak, S. Kodiak, Prince William Sound, Cook Inlet/Shelikof, Glacier Bay/Icy Strait, Lynn Canal/Stephens, Sitka/Chatham, Dixon/Cape Decision, and Clarence Strait) and three additional stocks associated with the Pacific Northwest (Washington Inland Waters stock, Washington and Oregon Coast stock, and California stock). This represents a significant increase in the number of harbor seal stocks from the three stocks (Bering Sea, Gulf of Alaska, and Southeast Alaska) previously recognized in Alaskan waters. The Northern Kodiak, Southern Kodiak, Prince William Sound, Glacier Bay/Icy Strait, Sitka/Chatham, and Dixon/Cape Decision stocks would be considered rare in the inshore waters of the Study Area, whereas the Aleutian Islands, Pribilof Islands, Bristol Bay, Cook Inlet/Shelikof, Lynn Canal/Stephens, and Clarence Strait stocks would be considered extralimital in the Study Area.

3.8.2.24.2 Abundance

The current statewide abundance estimate for Alaskan harbor seals is 205,090, which is a summation of population estimates from the 12 Alaska stocks from aerial surveys made from 1998 to 2011 (Muto et al. 2016). The most recent estimates for the individual stocks are: Aleutian Islands (6,431), Pribilof Islands (232), Bristol Bay (32,350), N. Kodiak (8,321), S. Kodiak (19,199), Prince William Sound (29,889), Cook Inlet/Shelikof (27,386), Glacier Bay/Icy Strait (7,210), Lynn Canal/Stephens (9,478), Sitka/Chatham (14,855), Dixon/Cape Decision (18,106), and Clarence Strait (31,634) (Muto et al. 2016).

3.8.2.24.3 Distribution

The harbor seal is one of the most widespread of the pinniped species. They are distributed along coastlines in the eastern Baltic Sea, the Atlantic Ocean, and the Pacific Ocean from southern Japan to Monterey, California including the coast and offshore islands of the Gulf of Alaska. Harbor seals are coastal animals that primarily occur within 11 nm from shore. In Alaska, harbor seals range from the Dixon Entrance to Kuskokwim Bay, are widely distributed along the coastal Gulf of Alaska (Allen and Angliss 2014), and are also found at haulout sites on offshore islands. The harbor seal's preferred coastal habitat does not extend into the waters of the Study Area. Studies using satellite tags have documented the movements and home range of harbor seals in the vicinity of the Study Area (Lowry et al. 2001; Small et al. 2005; Womble and Gende 2013). Although these tagging studies have documented harbor seal movement into deep water (beyond the shelf break) in the Gulf of Alaska, such movements are believed to be the exception. During the April 2009 line-transect survey (Rone et al. 2009), there were two encounters with harbor seals in the TMAA. One sighting was along the shelf break west of Kodiak Island, and the other was in the west-central portion of the Study Area, well offshore of the shelf break. No harbor seals were identified during the recent (June and July 2013) survey of the Study Area, although there were six sightings of unidentified pinnipeds (Rone et al. 2014). Harbor seal occurrence in the Study Area during the summer time period is considered rare.

3.8.2.25 Ribbon Seal (*Histiophoca fasciata*)

3.8.2.25.1 Status and Management

NMFS currently recognizes a single stock of ribbon seal in the North Pacific and Bering Sea, the Alaska stock. The Alaska stock of ribbon seal is not designated as depleted under the MMPA and is not listed as

endangered or threatened under the ESA. A petition to list the ribbon seal under the ESA was received by NMFS in late 2007. Following the publication of a finding on that petition (73 Federal Register [FR] 16617), NMFS determined in 2013 that the ribbon seal does not currently warrant listing under the ESA (73 FR 79822; 78 FR 41371). However, the ribbon seal remains designated as a Species of Concern under the ESA, which means that NMFS has some concerns regarding status and threats, but insufficient information is available to indicate a need for listing.

Subsistence harvest data are no longer collected, although the subsistence harvest database previously indicated an annual harvest of 193 ribbon seals per year (Allen and Angliss 2014).

3.8.2.25.2 Abundance

In spring of 2012 and 2013, NOAA and Russian researchers conducted aerial photographic surveys of the entire Bering Sea and the Sea of Okhotsk where ribbon seals are present. Based on the data from the U.S. portion of the Bering Sea, the estimated abundance was approximately 184,000 ribbon seals (Muto et al. 2016).

3.8.2.25.3 Distribution

The distribution of ribbon seals is restricted to the northern North Pacific Ocean and adjoining sub-Arctic and Arctic seas, where they occur most commonly in the Sea of Okhotsk and Bering Sea in the open sea and on pack ice (Boveng et al. 2008). From January to May, adults generally remain with the pack ice of the Bering, Chukchi, and western Beaufort seas, moving with the ice farther south in colder years. Ribbon seals are strongly associated with sea ice during the breeding season (March–June) and are not known to breed on shore. Jones et al. (2011) studied long-term autonomous recordings and found that ribbon seal calls occurred only when there was open water in the fall. Satellite telemetry data presented by Boveng et al. (2008) indicated that outside of the breeding season, ribbon seals disperse widely, from remaining in the Bering Sea to following the seasonal ice to the Bering Strait, Chukchi Sea, or Arctic Basin and south to the Aleutian Islands. In 2007, one adult female ribbon seal was observed and captured onshore in upper Cook Inlet and in autumn 2009 another was observed on the Copper River Delta (Boveng 2010). Additional tagging studies in 2009 (unpublished) showed one of 14 tagged seals spent time in the western Gulf of Alaska and the TMAA or in vicinity of the TMAA (Cameron 2010). Given the small sample size represented by the tagging and these two other observations, use of the Gulf of Alaska by a small fraction of the ribbon seal population may be more common than currently known (Boveng 2010). Ribbon seals were not observed during the April survey of the Study Area (Rone et al. 2009) or the recent June/July 2013 GOALS II survey (Rone et al. 2014). Ribbon seal occurrence in the Study Area during the summer time period is considered rare.

3.8.2.26 Northern Sea Otter (*Enhydra lutris kenyoni*)

3.8.2.26.1 Status and Management

The USFWS recognizes five stocks of sea otters in U.S. waters under MMPA guidelines. These include single stocks each in California (i.e., the southern sea otter [*Enhydra lutris nereis*]) and Washington (i.e., the northern sea otter [*Enhydra lutris kenyoni*]) and three stocks in Alaska that are designated as Southeast, Southcentral, and Southwest stocks. The ranges of these stocks are defined as follows: (1) the Southeast Alaska stock extends from Dixon Entrance to Cape Yakataga; (2) the Southcentral Alaska stock extends from Cape Yakataga to Cook Inlet, including Prince William Sound, the Kenai Peninsula coast, and Kachemak Bay; and (3) the Southwest Alaska stock includes the Alaska Peninsula and Bristol Bay coasts, and the Aleutian, Barren, Kodiak, and Pribilof Islands. All sea otter stocks in Alaska are protected under the MMPA, but only the southwest Alaska stock of the northern sea otter is listed as threatened under the ESA (70 FR 46366–46386). All three of the Alaska stocks of sea otters

could potentially occur in the northern portions of the Study Area. Critical habitat has been designated for the Southwest Alaska population of northern sea otters, and it encompasses approximately 15,000 km² of nearshore habitat, none of which is within the Study Area (Figure 3.8-7).

3.8.2.26.2 Abundance

Aerial surveys of the Alaskan stocks were performed between 2000 and 2005. The population estimate for the Southwest Alaska stock of sea otters derived from these surveys was 47,676 individuals (U.S. Fish and Wildlife Service 2008a). The population estimate for the Southcentral Alaska stock of sea otters derived from these surveys was 15,090 individuals (U.S. Fish and Wildlife Service 2008b). The population estimate for the Southeast Alaska stock of sea otters derived from these surveys was 10,563 individuals (U.S. Fish and Wildlife Service 2008c).

3.8.2.26.3 Distribution

Sea otters occupy nearly all coastal marine habitats, from bays and estuaries to rocky shores exposed to oceanic swells (Riedman and Estes 1990; U.S. Fish and Wildlife Service 2003). Although sea otters prefer rocky shoreline and relatively shallow water (< 131 ft. [40 m] deep) with kelp beds, this is not an essential habitat requirement, and some individuals use soft-sediment areas where kelp is absent (Riedman and Estes 1990; U.S. Fish and Wildlife Service 2003). Sea otters seldom range more than 1.2 mi. (2 km) from shore, although some individuals, particularly juvenile males, travel farther offshore (Ralls et al. 1995, 1996; Riedman and Estes 1990; U.S. Fish and Wildlife Service 2003). Sea otters move seasonally to areas where there is food or where sheltered water offers protection from storms and rough seas (Kenyon 1975; Riedman and Estes 1990). As sea otters seldom range more than 1.2 mi. (2 km) from shore and are not known to migrate, it is not anticipated that they would be present in the Study Area. During the 2009 survey, one northern sea otter was observed; however, this sighting was made in the nearshore waters south of Kodiak Island, approximately 170 km southwest of the Study Area. No sea otters were sighted during the recent (June and July 2013) survey of the Study Area (Rone et al. 2014). Northern sea otter occurrence in the Study Area during the summer time period is considered rare.

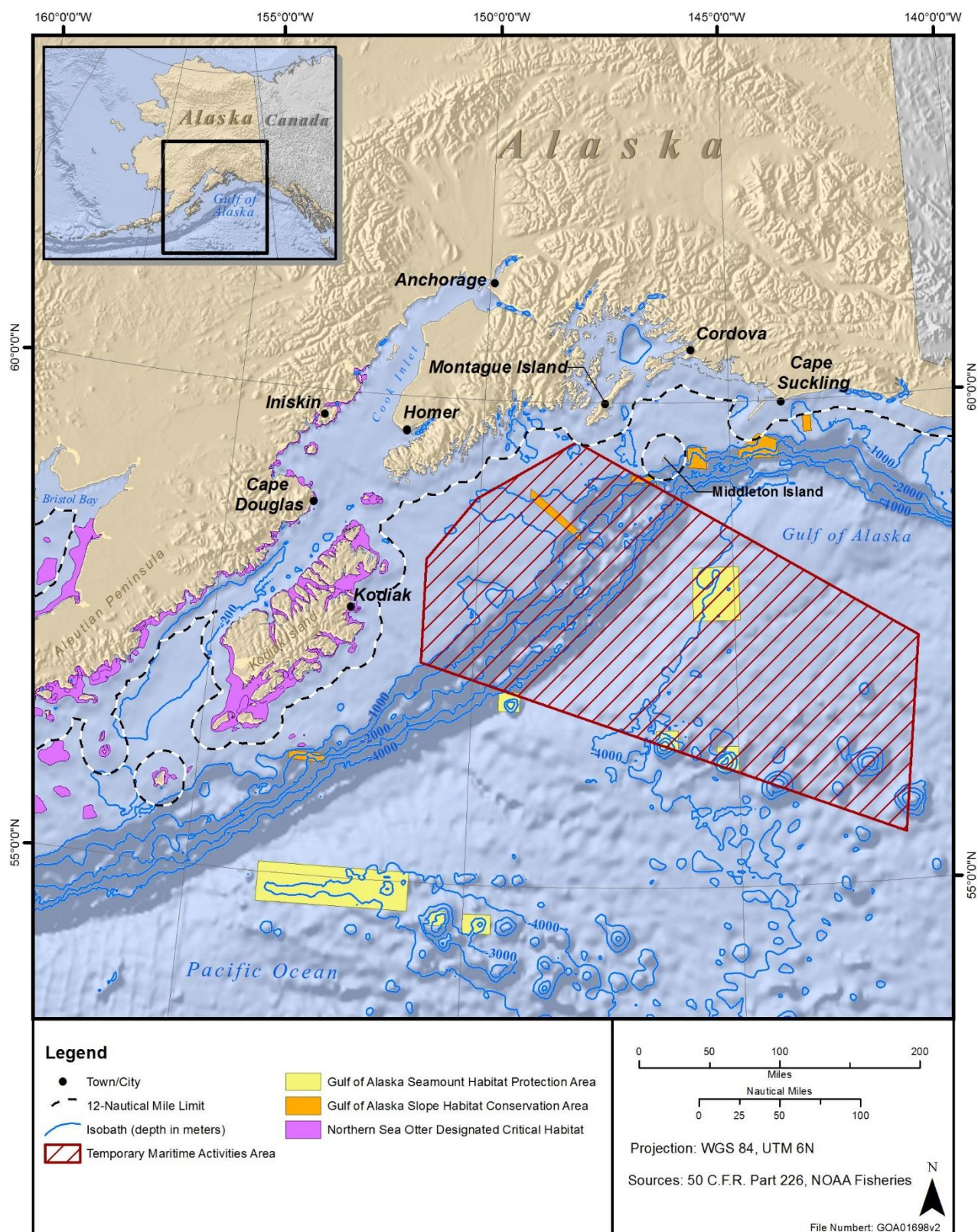


Figure 3.8-7: Southwest Alaska Stock Sea Otter Designated Critical Habitat in the Vicinity of the Temporary Maritime Activities Area

3.8.3 ENVIRONMENTAL CONSEQUENCES

As first noted in Section 1.2 (The Navy's Environmental Compliance and At-Sea Policy), Section 3.8.3 of the Supplemental EIS/OEIS provides the re-analysis of potential impacts on marine mammals in the Study Area from the training activities that were proposed and presented in the 2011 *Gulf of Alaska Navy Training Activities Environmental Impact Statement/Overseas Environmental Impact Statement* (hereafter referred to as the 2011 GOA Final EIS/OEIS). There have been no substantial changes to the activities analyzed as the Proposed Action in the 2011 GOA Final EIS/OEIS. Use of sonar and other active acoustic sources has occurred since the signing of the GOA Navy Training Activities Record of Decision and receipt of the MMPA Authorization and ESA Biological Opinion, all of which were finalized in May 2011. Continuation of training at-sea in the Gulf of Alaska, conducted as a Carrier Strike Group exercise, is required to support the readiness of combat-capable naval forces.

All stressors that may impact marine mammals were analyzed in the 2011 GOA Final EIS/OEIS. As described in Section 3.0.1 (Approach to Analysis), a comprehensive review of literature and scientific publications pertaining to marine mammals and the marine environment since completion of the 2011 GOA Final EIS/OEIS has been undertaken. The literature cited and those publications reviewed and considered in this Supplemental EIS/OEIS have been presented in Section 3.8.8 (References Cited and Considered). In consideration of that material, it has been determined that there have been no substantive changes in the best available science or new information available that would present significantly different conclusions or necessitate any change in the findings presented in the 2011 GOA Final EIS/OEIS (see Section 3.8.7, Environmental Consequences, in the 2011 GOA Final EIS/OEIS) regarding the following stressors:

- Vessel noise, disturbance, and strikes
- Aircraft overflight noise
- Weapons firing noise
- Non-explosive ordnance use (impact noise, ingestion, and strikes)
- Electronic combat (electromagnetic energy stressors)
- Discharges of expended materials (physical disturbance, strikes, entanglement, ingestion, sediments and water quality)

In summary, for stressors other than acoustic stressors including sonar and other active acoustic sources and explosives, there have been no changes to the Region of Influence, existing conditions, species life histories, or any new information available since 2011 that would otherwise substantively change the conclusions presented in the 2011 GOA Final EIS/OEIS.

As a result of the analysis summarized above, the focus of this Supplemental EIS/OEIS and the discussion in this section is the re-analysis of activities involving use of sonar and other active acoustic sources and explosives using the best available science and analytical methodologies that have become available since the 2011 GOA Final EIS/OEIS. Since training activities involving use of sonar and other active acoustic sources and explosives only occur in the TMAA, the re-analysis of acoustic stressor impacts for marine mammals will only address the TMAA portion of the 2011 GOA Final EIS/OEIS Study Area.

Each of these acoustic stressors is analyzed for its potential impacts to marine mammals. The specific analyses of the training activities consider these stressors within the context of the geographic range of the species within the Study Area. Table 3.8-3 presents the stressor categories and components of those stressors that are applicable to marine mammals and are used in the analysis of training activities.

Table 3.8-3: Stressors Applicable to Marine Mammals for Training Activities within the Study Area

Components	Number of Components or Activities		
	No Action Alternative	Alternative 1	Alternative 2
	Training	Training	Training
Acoustic Stressors			
Sonar and other active sources (hours)	0	725	1,450
Sonar and other active sources (items)	0	27.5	55
Explosives	88	152	304

Identical to the alternatives in the 2011 GOA Final EIS/OEIS, the No Action Alternative in this Supplemental EIS/OEIS consists of training activities of the types and levels of intensity as conducted prior to 2011, does not include Anti-Submarine Warfare training activities involving the use of active sonar and other active acoustic sources, but does include the use of explosives as an underwater acoustic stressor. Alternative 1, in addition to accommodating training activities addressed in the No Action Alternative, analyzes an increase in training activities (if needed), as well as the inclusion of Anti-Submarine Warfare training activities involving the use of active sonar and other active acoustic sources. Alternative 1 also proposes training required by force structure changes to be implemented for new weapons systems, instrumentation, and technology as well as new classes of ships, submarines, and new types of aircraft. In addition, specific training instrumentation enhancements would be implemented, to include development and use of the portable undersea tracking range. Alternative 2 would include all elements of Alternative 1 plus one additional Carrier Strike Group exercise and Sinking Exercise during the summer months. Alternative 2 was the Preferred Alternative previously chosen for implementation by the May 2011 GOA Navy Training Activities Record of Decision. Alternative 2 is the preferred alternative for this Supplemental EIS/OEIS.

As presented in Section 1 of this Supplemental EIS/OEIS, the 2011 GOA Final EIS/OEIS used impact thresholds, criteria, an acoustic modeling methodology, and marine mammal density information developed by the Navy, in cooperation with NMFS, which reflected the best available science at the time (National Oceanic and Atmospheric Administration 2011a, b). A subsequent review on behalf of the NMFS by the Center for Independent Experts analyzed the various approaches the Navy used for acoustic effects analyses, such as that in the 2011 GOA Final EIS/OEIS, leading to the refinement of the previous acoustic impact methodology. The result was the development of a standard Navy model for acoustic effects, the Navy Acoustic Effects Model (NAEMO; Marine Species Modeling Team 2015). By using this more comprehensive modeling software, updated marine mammal densities, and revised acoustic criteria², the predicted number of effects were expected to change and have changed from those quantified in the 2011 GOA Final EIS/OEIS. The change represented by the Supplemental EIS/OEIS quantification of impacts pursuant to requirements of the MMPA is only a difference arising as a result of more accurate marine mammal density data, revised acoustic impact criteria, and more comprehensive computer modeling of predicted effects to marine mammals. Assessment of likely long-term consequences to populations of marine mammals are provided by empirical data gathered from areas where Navy routinely trains and tests. Since the 2011 GOA Final EIS/OEIS, substantial Navy-funded marine mammal survey data, monitoring data, and scientific research have been

² The criteria used by the Navy in this analysis parallels the recent National Oceanic and Atmospheric Administration's "Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals," which was proposed in December 2013 and is in review as of June 2014. Details can be found at <http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm>.

completed. This empirical data are beginning to provide insight on the qualitative analysis of the actual (as opposed to model predicted numerical) impact to marine mammals resulting from Navy training and testing based on observations of marine mammals generally in and around Navy Range Complexes. While the model-predicted number of effects have changed, the actual impacts to marine mammals have remained the same since the training activities and the associated stressors have remained unchanged since 2011.

The following subsections of the Supplemental EIS/OEIS presents the potential environmental consequences based on the new modeling methodology and the scientific observations and investigations made over 8 years of monitoring Navy training and testing activities in the Pacific. The majority of this new analysis involves a new quantification of effects from underwater acoustic stressors using new thresholds and criteria for measuring those effects and involves integration of:

- updated marine mammal density data
- new acoustic impact thresholds developed in coordination with NMFS
- new modeling software (Navy Acoustic Exposure Model)
- post-modeling analysis to more fully account for likely marine mammal behaviors based on emergent science and to account for the implementation of standard mitigation measures

The acoustic stressors used during the training may vary in intensity, frequency, duration, and location within the TMAA during the period of the Carrier Strike Group exercise (called the “Northern Edge Exercise” in the 2011 GOA Final EIS/OEIS). The acoustic stressors applicable to the re-analysis in this Supplemental EIS/OEIS include the following non-impulsive and impulsive sources:

- sonar and other active acoustic sources
- explosives (underwater)

In the analysis of acoustic stressors, marine mammal species are grouped together based on similar biology (e.g., hearing) or behaviors (e.g., feeding or expected reaction to stressors) when most appropriate for the discussion. In addition, species are grouped based on their taxonomic relationship and discussed as follows: mysticetes (baleen whales), odontocetes (toothed whales), pinnipeds (seals and sea lions), and mustelids (sea otter). When impacts are expected to be similar to all species or when it is determined there is no impact on any species, the discussion will be general and not species-specific. However, when impacts are not the same to certain species or groups of species, the discussion will be as specific as the best available data allow.

All training activities involving underwater acoustic stressors would occur within the TMAA. Analysis of these activities included all the areas of TMAA in a manner representative of the way training would be conducted so that conclusions presented in the following discussions apply equally to marine mammals in the entire TMAA. Based on acoustic thresholds and criteria developed with NMFS, impacts from sound sources as stressors will be quantified at the species or stock level as is required pursuant to authorization of the proposed actions under the MMPA.

A qualitative analysis of likely impacts is also presented in this Supplemental EIS/OEIS, which has expanded from that presented in the 2011 GOA Final EIS/OEIS due to the increase and availability of monitoring data and scientific research recently conducted in various Navy Range Complexes and the TMAA. As detailed in Section 3.8.5 (Summary of Observations During Previous Navy Activities), this includes over 80 exercise reports (as of December 2013) and monitoring reports submitted to NMFS,

which are available for review at multiple website locations.³

In cases where potential impacts rise to the level that warrants mitigation, mitigation measures designed to minimize the potential impacts are discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring). Some of these mitigations have been refined since the 2011 GOA Final EIS/OEIS based on the new marine mammal impact thresholds and criteria in coordination with NMFS. These mitigation measures have been previously and recently analyzed, reviewed, and subject to public comment (U.S Department of the Navy 2013d) and authorized by NMFS pursuant to the MMPA (National Oceanic and Atmospheric Administration 2013b) for other identical Navy training activities in the Pacific. In addition to the measures presented, additional mitigations or different mitigations or both may subsequently be implemented in future coordination with NMFS resulting from the MMPA authorization and ESA consultation processes.

3.8.3.1 Acoustic Stressors

3.8.3.1.1 Non-Impulsive and Impulsive Sound Sources

Long recognized by the scientific community (Payne and Web 1971), and summarized by the National Academies of Science, human-generated sound could possibly harm marine mammals or significantly interfere with their normal activities (National Research Council 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 (National Research Council 2003, 2005), there are many unknowns in assessing impacts such as the potential interaction of different effects and the significance of responses by marine mammals to sound exposures (Nowacek et al. 2007; Southall et al. 2007, 2009a). Furthermore, many other factors besides just the received level of sound may affect an animal's reaction such as the animal's physical condition, prior experience with the sound, and proximity to the source of the sound (Ellison et al. 2012).

3.8.3.1.2 Analysis Background and Framework

3.8.3.1.2.1 Direct Injury

The potential for direct injury in marine mammals has been inferred from terrestrial mammal experiments and from post-mortem examination of marine mammals believed to have been exposed to underwater explosions (Ketten et al. 1993, Richmond et al. 1973, Yelverton et al. 1973). Additionally, non-injurious effects on marine mammals (e.g., Temporary Threshold Shift [TTS]) are extrapolated to injurious effects (e.g., Permanent Threshold Shift [PTS]) based on data from terrestrial mammals to derive the criteria serving as the potential for injury (Southall et al. 2007). Actual effects on marine mammals may differ from terrestrial animals due to anatomical and physiological adaptations to the marine environment, e.g., some characteristics such as a reinforced trachea and flexible thoracic cavity (Ridgway and Dailey 1972) may or may not decrease the risk of lung injury.

Potential non-auditory direct injury from non-impulsive sound sources, such as sonar, is unlikely due to relatively lower peak pressures and slower rise times than potentially injurious impulsive sources such as explosives. Non-impulsive sources such as sonar also lack the strong shock wave such as that associated with an explosion. Therefore, primary blast injury and barotrauma (i.e., injuries caused by large, rapid pressure changes; discussed below) would not occur due to exposure to non-impulsive

³ These reports are publically available at the Navy website, www.navy.mil/submit_request.asp?topic=main&cid=25388, and from the NMFS Office of Protected Resources website, www.nmfs.noaa.gov/pr/permits/incidental/

sources such as sonar. The theories of sonar induced acoustic resonance and sonar induced bubble formation are discussed below. These phenomena, if they were to occur, would require the co-occurrence of a precise set of circumstances that in the natural environment under real-world conditions are unlikely to occur.

Primary Blast Injury and Barotrauma

The greatest potential for direct, non-auditory tissue effects is primary blast injury and barotrauma after exposure to high amplitude impulsive sources, such as explosions. Primary blast injury refers to those injuries that result from the initial compression of a body exposed to a blast wave. Primary blast injury is usually limited to gas-containing structures (e.g., lung and gut) and the auditory system (Craig and Hearn 1998, Craig Jr. 2001, Phillips and Richmond 1990). Barotrauma refers to injuries caused when large pressure changes occur across tissue interfaces, normally at the boundaries of air-filled tissues such as the lungs. Primary blast injury to the respiratory system, as measured in terrestrial mammals, may consist of pulmonary contusions, pneumothorax, pneumomediastinum, traumatic lung cysts, or interstitial or subcutaneous emphysema (Phillips and Richmond 1990). These injuries may be fatal depending upon the severity of the trauma. Rupture of the lung may introduce air into the vascular system, possibly producing air emboli that can cause a cerebral infarct or heart attack by restricting oxygen delivery to these organs. Though often secondary in life-threatening severity to pulmonary blast trauma, the gastrointestinal tract can also suffer contusions and lacerations from blast exposure, particularly in air-containing regions of the tract. Potential traumas include hematoma, bowel perforation, mesenteric tears, and ruptures of the hollow abdominal viscera. Although hemorrhage of solid organs (e.g., liver, spleen, and kidney) from blast exposure is possible, rupture of these organs is rarely encountered.

The only known occurrence of mortality or injury to a marine mammal due to a U.S. Navy training or testing event involving impulsive sources (use of underwater explosives) occurred in March 2011 in nearshore waters off San Diego, California, at the Silver Strand Training Complex. This area has been used for underwater demolitions training for at least three decades without incident. On this occasion, however, a group of long-beaked common dolphins entered the mitigation zone and approximately 1 minute after detonation, three animals were observed dead at the surface. Navy recovered those animals and transferred them to the local stranding network for necropsy. A fourth animal was discovered 3 days later stranded dead approximately 42 mi. (68 km) to the north of the detonation site. Upon necropsy, all four animals were found to have sustained typical mammalian primary blast injuries (Danil and St. Ledger 2011). See Section 3.8.3.1.2.8 (Stranding) and U.S. Department of the Navy (2013c) for more information on the topic of stranding. There are no underwater demolition training events proposed for the TMAA Study Area.

Auditory Trauma

Relatively little is known about auditory system trauma in marine mammals resulting from a known sound exposure. A single study spatially and temporally correlated the occurrence of auditory system trauma in humpback whales with the detonation of a 5,000-kilogram (kg) (11,023-pound [lb.]) explosive used off Newfoundland during demolition of an offshore oil rig platform (Ketten et al. 1993). The exact magnitude of the exposure in this study cannot be determined, but it is likely the trauma was caused by the shock wave produced by the explosion. There are no known occurrences of direct auditory trauma in marine mammals exposed to tactical sonar or other non-impulsive sound sources (Ketten 2012). The potential for auditory trauma in marine mammals exposed to impulsive sources (e.g., explosions) is inferred from tests of submerged terrestrial mammals exposed to underwater explosions (Ketten et al. 1993, Richmond et al. 1973, Yelverton et al. 1973).

Acoustic Resonance

Acoustic resonance has been proposed as a hypothesis suggesting that acoustically induced vibrations (sound) from sonar or sources with similar operating characteristics could be damaging tissues of marine mammals. In 2002, NMFS convened a panel of government and private scientists to consider the hypothesis of mid-frequency sonar-induced resonance of gas-containing structures (i.e., lungs) (National Oceanic and Atmospheric Administration 2002). They modeled and evaluated the likelihood that Navy mid-frequency sonar caused resonance effects in beaked whales that eventually led to their stranding (U.S. Department of the Navy 2013c). The conclusions of that group were that resonance in air-filled structures was not likely to have caused the Bahamas stranding (National Oceanic and Atmospheric Administration 2002). The frequencies at which resonance was predicted to occur in uncollapsed lungs were below 50 Hz; well below the frequencies utilized by the mid-frequency sonar systems associated with the Bahamas event. Furthermore, air cavity vibrations, even at resonant frequencies, were not considered to be of sufficient amplitude to cause tissue damage, even under the worst-case scenario in which air volumes would be undamped by surrounding tissues and the amplitude of the resonant response would be maximal. These same conclusions would apply to other training and testing activities involving acoustic sources. Therefore, the Navy concludes that acoustic resonance is not likely under realistic conditions during training and testing activities, and this type of impact is not considered further in this analysis.

Bubble Formation (Acoustically Induced)

A suggested cause of injury to marine mammals is rectified diffusion (Crum and Mao 1996), the process of increasing the size of a bubble by exposing it to a sound field (see Section 3.8.3.1.2.8, Stranding, regarding strandings that gave rise to the debate about bubble formation). The process is dependent upon a number of factors including the sound pressure level and duration. Under this hypothesis, one of three things could happen: (1) bubbles grow to the extent that tissue hemorrhage (injury) occurs, (2) bubbles develop to the extent that a complement immune response is triggered or the 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 upon what is known about the specific process involved. Rectified diffusion 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). The dive patterns of some marine mammals (for example, beaked whales) are theoretically predicted to induce greater supersaturation (Houser et al. 2001b). If surface intervals between dives are short, there is insufficient time to clear nitrogen in tissues accumulated due to pressures experienced while diving. Subsequent dives can increase tissue nitrogen accumulation, leading to greater levels of nitrogen saturation at each ascent. 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 (e.g., nausea, disorientation, localized pain, breathing problems).

It is unlikely that the short duration of sonar or explosion sounds 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 microbubbles 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 a problematic size. Recent research with *ex vivo* supersaturated bovine

tissues suggested that for a 37 kHz signal, a sound exposures of approximately 215 dB re 1 μ Pa would be required before microbubbles became destabilized and grew (Crum et al. 2005). Assuming spherical spreading loss and a nominal sonar source level of 235 dB re 1 μ Pa at 1 m, a whale would need to be within 10 yd. (10 m) of the sonar dome to be exposed to such sound levels. Furthermore, tissues in the study were supersaturated by exposing them to pressures of 400–700 kilopascals for periods of hours and then releasing them to ambient pressures. Assuming the equilibration of gases with the tissues occurred when the tissues were exposed to the high pressures, levels of supersaturation in the tissues could have been as high as 400–700 percent. These levels of tissue supersaturation are substantially higher than model predictions for marine mammals (Houser et al. 2001b; Saunders et al. 2008). It is improbable that this mechanism is responsible for stranding events or traumas associated with beaked whale strandings. Both the degree of supersaturation and exposure levels observed to cause microbubble destabilization are unlikely to occur, either alone or in concert.

There is considerable disagreement among scientists as to the likelihood of this phenomenon (Evans and Miller 2003, Piantadosi and Thalmann 2004). Although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Fernández et al. 2005; Jepson et al. 2003), nitrogen bubble formation as the cause of the traumas has not been verified. The presence of bubbles postmortem, particularly after decompression, is not necessarily indicative of bubble pathology (Bernaldo de Quiros et al. 2012, 2013a, 2013b; Danil et al. 2014; Dennison et al. 2011, Moore et al. 2009). Prior experimental work has also demonstrated that post-mortem presence of bubbles following decompression in laboratory animals can occur as a result of invasive investigative procedures (Stock et al. 1980).

3.8.3.1.2.2 Nitrogen Decompression

Although not a direct injury, variations in marine mammal diving behavior or avoidance responses could possibly result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular and tissue bubble formation (Hooker et al. 2012, Jepson et al. 2003, Saunders et al. 2008). The mechanism for bubble formation from nitrogen saturated tissues would be indirect and also different from rectified diffusion, but the effects would be similar. Although hypothetical, the potential process is under debate in the scientific community (Hooker et al. 2012, Saunders et al. 2008). The hypothesis speculates that if exposure to a startling sound elicits a rapid ascent to the surface, tissue gas saturation sufficient for the evolution of nitrogen bubbles might result (Fernández et al. 2005, Hooker et al. 2012, 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.

Previous modeling by Zimmer and Tyack (2007) suggested that even unrealistically rapid rates of ascent from normal dive behaviors are unlikely to result in supersaturation to the extent that bubble formation would be expected in beaked whales. Tyack et al. (2006) suggested that emboli observed in animals exposed to mid-frequency active (MFA) sonar (Fernández et al. 2005, Jepson et al. 2003) could stem instead from a behavioral response that involves repeated dives, shallower than the depth of lung collapse. A bottlenose dolphin was trained to repetitively dive to specific depths to elevate nitrogen saturation to the point that asymptomatic nitrogen bubble formation was predicted to occur. However, inspection of the vascular system of the dolphin via ultrasound did not demonstrate the formation of any nitrogen gas bubbles (Houser et al. 2010a).

More recently, modeling has suggested that the long, deep dives performed regularly by beaked whales over a lifetime could result in the saturation of long-halftime tissues (e.g., fat, bone lipid) to the point that they are supersaturated when the animals are at the surface (Hooker et al. 2009, 2012; Saunders et

al. 2008). Proposed adaptations for prevention of bubble formation under conditions of persistent tissue saturation have been suggested (Fahlman et al. 2006, Hooker et al. 2009), while the condition of supersaturation required for bubble formation has been demonstrated in by-catch animals drowned at depth and brought to the surface (Moore et al. 2009). Since bubble formation is facilitated by compromised blood flow, it has been suggested that rapid stranding may lead to bubble formation in animals with supersaturated, long-half-time tissues because of the stress of stranding and the cardiovascular collapse that can accompany it (Houser et al. 2010a).

A fat embolic syndrome was identified by Fernández et al. (2005) coincident with the identification of bubble emboli in stranded beaked whales. The fat embolic syndrome was the first pathology of this type identified in marine mammals, and was thought to possibly arise from the formation of bubbles in fat bodies, which subsequently resulted in the release of fat emboli into the blood stream. As noted above, it has since been demonstrated that the presence of bubbles postmortem is not necessarily indicative of bubble pathology (Bernaldo de Quiros et al. 2012, 2013a, 2013b; Danil et al. 2014; Dennison et al. 2011; Moore et al. 2009). Dennison et al. (2011) reported on investigations of dolphins stranded in 2009–2010 and, using ultrasound, identified gas bubbles in kidneys of 21 of 22 live-stranded dolphins and in the liver of 2 of 22. The authors postulated that stranded animals are unable to recompress by diving, and thus may retain bubbles that are otherwise re-absorbed in animals that can continue to dive. The researchers concluded that the minor bubble formation observed can be tolerated since the majority of stranded dolphins released did not re-strand (Dennison et al. 2011). Modeling by Kvadsheim et al. (2012) determined that while behavioral and physiological responses to sonar have the potential to result in bubble formation, the actually observed behavioral responses of cetaceans to sonar did not imply any significantly increased risk of over what may otherwise occur normally in individual marine mammals.

As a result of these recent findings and for purposes of this analysis, the potential for acoustically mediated bubble growth and the potential for bubble formation as a result of behavioral altered dive profiles are not addressed further.

3.8.3.1.2.3 Hearing Loss

The most familiar effect of exposure to high intensity sound is hearing loss, meaning an increase in the hearing threshold or loss of hearing sensitivity. The meaning of the term “hearing loss” does not equate to “deafness.” The type of hearing loss discussed in the analysis of marine mammal impacts is called a noise-induced threshold shift, or simply a threshold shift (Miller 1974). If high-intensity sound over-stimulates tissues in the ear, causing a threshold shift, the impacted area of the ear (associated with and limited by the sound’s frequency band) no longer provides the same auditory impulses to the brain as before the exposure (Ketten 2012); the result is a loss in hearing sensitivity. The distinction between PTS and TTS is based on whether there is a complete recovery of a threshold shift or loss of sensitivity following a sound exposure. If the threshold shift eventually returns to zero (i.e., hearing returns to the pre-exposure “normal”), the threshold shift is a TTS.

For TTS, full recovery of the hearing loss (to the pre-exposure threshold) has been determined from studies of marine mammals, and this recovery occurs within minutes to hours for the small amounts of TTS that have been experimentally induced (Finneran et al. 2005, Nachtigall et al. 2004). The time required for recovery is related to the exposure duration, sound exposure level, and the magnitude of the threshold shift, with larger threshold shifts and longer exposure durations requiring longer recovery times (Finneran et al. 2005, Mooney et al. 2009a). In some cases, threshold shifts as large as 50 dB (loss in sensitivity) have been temporary, although recovery sometimes required as much as 30 days (Ketten

2012). If the threshold shift does not return to zero but leaves some finite amount of threshold shift (loss in hearing sensitivity), then that remaining threshold shift is a PTS. Again for clarity, PTS as discussed in this document is not the loss of hearing, but instead is the loss of hearing sensitivity over a particular range of frequencies. Figure 3.8-8 shows one hypothetical threshold shift that completely recovers, a TTS, and one that does not completely recover, leaving some PTS. The actual amount of threshold shift depends on the amplitude, duration, frequency, temporal pattern of the sound exposure, and on the susceptibility of the individual animal.

Both auditory trauma and auditory fatigue may result in hearing loss. Many are familiar with hearing protection devices (i.e., ear plugs) required in many occupational settings where pervasive noise could otherwise cause auditory fatigue and possibly result in hearing loss. The mechanisms responsible for auditory fatigue differ from auditory trauma and would primarily consist of metabolic fatigue and exhaustion of the hair cells and cochlear tissues. Note that the term “auditory fatigue” is often used to mean “temporary threshold shift”; however, in this Supplemental EIS/OEIS a more general meaning is used to differentiate fatigue mechanisms (e.g., metabolic exhaustion and distortion of tissues) from trauma mechanisms (e.g., physical destruction of cochlear tissues occurring at the time of exposure). The actual amount of threshold shift depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure.

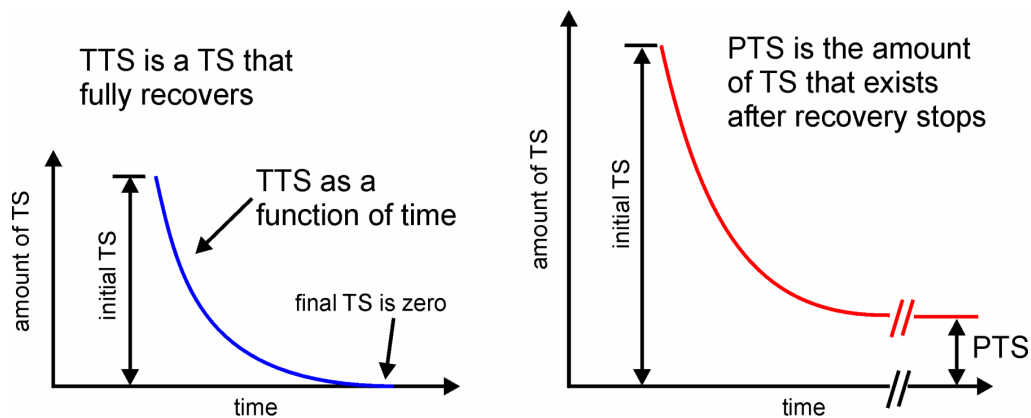


Figure 3.8-8: Two Hypothetical Threshold Shifts, Temporary and Permanent

Hearing loss, or auditory fatigue, in marine mammals has been studied extensively for many years by a number of investigators (Finneran et al. 2000, 2002, 2005, 2007, 2010a, 2010b; Kastak et al. 2007; Lucke 2009; Mooney et al. 2009a; Nachtigall et al. 2003, 2004; Schlundt et al. 2000, Ketten 2012; Kastelein et al. 2012a, 2012b, 2013, 2014a, 2014b 2015; Finneran and Schlundt 2013; Popov et al. 2011, 2013, 2014). The studies of marine mammal auditory fatigue were all designed to determine relationships between TTS and exposure parameters such as level, duration, and frequency. In these studies, hearing thresholds were measured in trained marine mammals before and after exposure to intense sounds. The difference between the pre-exposure and post-exposure thresholds indicated the amount of TTS. Species studied include the bottlenose dolphin, beluga, harbor porpoise, finless porpoise, California sea lion, harbor seal, and Northern elephant seal. 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 (e.g., Schlundt et al. 2000).

The primary findings of the marine mammal TTS studies are:

- The growth and recovery of TTS are analogous to those in terrestrial mammals. This means that, as in terrestrial mammals, threshold shifts primarily depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure.
- The amount of TTS increases with exposure sound pressure level (SPL) and the exposure duration.
- For continuous sounds, exposures of equal energy lead to approximately equal effects (Ward 1997). For intermittent sounds, less hearing loss occurs than from a continuous exposure with the same energy (some recovery will occur during the quiet period between exposures) (Kryter et al. 1965, Ward 1997; Kastelein et al. 2014a, 2015). Sound exposure level is correlated with the amount of TTS and is a good predictor for onset-TTS from single, continuous exposures with similar durations. This agrees with human TTS data presented by Ward et al. (1958, 1959a). However, for longer duration sounds—beyond 16–32 seconds—the relationship between TTS and sound exposure level breaks down and duration becomes a more important contributor to TTS (Finneran et al. 2010a) and Finneran and Schlundt (2010). Ward et al. (1958, 1959) conducted studies using human subjects. Still, for a wide range of exposure durations, sound exposure level correlates reasonably well to TTS growth (Popov et al. 2014).
- The maximum TTS after tonal exposures occurs one-half to one octave above the exposure frequency (Finneran et al. 2007; Schlundt et al. 2000). Temporary threshold shift from tonal exposures can thus extend over a large (greater than one octave) frequency range. Finneran et al. (2007) and Schlundt et al. (2000) conducted studies on marine mammals.
- For bottlenose dolphins, non-impulsive sounds with frequencies above 10 kHz have a greater potential for impact than those at lower frequencies (i.e., hearing is affected at lower sound exposure levels for frequencies above 10 kHz) (Finneran et al. 2010b, Finneran and Schlundt 2013).
- The amount of observed TTS tends to decrease with increasing time following the exposure; however, the relationship is not monotonic. The amount of time required for complete recovery of hearing depends on the magnitude of the initial shift; for relatively small shifts recovery may be complete in a few minutes, while large shifts (e.g., 40 dB) require several days for recovery (see Finneran and Jenkins 2012).
- Temporary threshold shift can accumulate across multiple intermittent exposures, but the resulting TTS will be less than the TTS from a single, continuous exposure with the same sound exposure level (Finneran 2012). This means that predictions based on total, cumulative sound exposure level (such as the predictions made in this analysis) will overestimate the amount of TTS from intermittent exposures.

Although there have been no marine mammal studies designed to measure PTS, the potential for PTS in marine mammals can be estimated based on known similarities between the inner ears of marine and terrestrial mammals. Experiments with marine mammals have revealed their similarities with terrestrial mammals with respect to features such as TTS, age-related hearing loss (called Presbycusis), ototoxic drug-induced hearing loss, masking, and frequency selectivity (Southall et al. 2007; Ketten 2012). Therefore, in the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated by assuming some upper limit of TTS that equates the onset of PTS, then using TTS growth relationships from marine and terrestrial mammals to determine the exposure levels capable of producing this amount of TTS.

Loss of hearing sensitivity resulting from auditory fatigue could effectively reduce the distance over which animals can communicate, detect biologically relevant sounds such as predators, and echolocate (for odontocetes). The costs to marine mammals with TTS, or even some degree of PTS have not been studied; however, it is likely that a relationship between the duration, magnitude, and frequency range of a loss of hearing sensitivity could have consequences to biologically important activities (e.g., intraspecific communication, foraging, and predator detection) that affect survivability and reproduction.

3.8.3.1.2.4 Auditory Masking

Auditory masking occurs when a sound, or noise in general, limits the perception of another sound. As with a loss in hearing sensitivity, auditory masking can effectively limit the distance over which a marine mammal can communicate, detect biologically relevant sounds, and echolocate (odontocetes). Unlike auditory fatigue, which always results in a localized stress response, behavioral changes resulting from auditory masking may or may not be coupled with a stress response. Another important distinction between masking and hearing loss is that masking only occurs in the presence of the sound stimulus, whereas hearing loss can persist after the stimulus is gone.

Critical ratios have been determined for pinnipeds (Southall et al. 2000, 2003) and bottlenose dolphins (Johnson 1967) and detections of signals under varying masking conditions have been determined for active echolocation and passive listening tasks in odontocetes (Au and Pawloski 1989, Erbe 2000, Johnson 1971, Branstetter et al. 2013). These studies provide baseline information from which the probability of masking can be estimated.

Clark et al. (2009) developed a methodology for estimating masking effects on communication signals for low-frequency cetaceans, including calculating the cumulative impact of multiple continuous noise sources. For example, their technique calculates that in Stellwagen Bank National Marine Sanctuary, when two commercial vessels pass through a North Atlantic right whale's optimal communication space (estimated as a sphere of water with a diameter of 20 km), that space is decreased by 84 percent. Subsequent research for the same species and location estimated that an average of 63–67 percent of North Atlantic right whale's communication space has been reduced by an increase in ambient noise levels, and that noise associated with transiting vessels is a major contributor to the increase in ambient noise (Hatch et al. 2012). This methodology relies on empirical data on source levels of calls (which is unknown for many species), and requires many assumptions about ambient noise conditions and simplifications of animal behavior, but it is an important step in determining the impact of anthropogenic noise on animal communication.

Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes to vocal behavior and call structure may result from a need to compensate for an increase in background noise (Hotchkiss and Parks 2013). In cetaceans, vocalization changes have been reported from exposure to anthropogenic sources such as sonar, vessel noise, and seismic surveying (Gordon et al. 2003; Holt et al. 2009, 2010; McDonald et al. 2009; Rolland et al. 2012), as well as changes in the natural acoustic environment (Dunlop et al. 2014).

Dunlop et al. (2010) found that humpbacks changed the proportions of their communication signal types in response to higher natural background noise. As the wind speed and wind-dependent background noise levels rose, the proportion of active surface sounds (e.g., breaching) also increased while the proportion of vocalizations decreased. (Dunlop et al. 2010). In the presence of low frequency active

sonar, humpback whales have been observed to increase the length of their “songs” (Fristrup et al. 2003, Miller et al. 2000), possibly due to the overlap in frequencies between the whale song and the low frequency active sonar (note that low frequency active sonar is not part of the proposed action in this SEIS/OEIS). Holt et al. (2009, 2010) showed that southern resident killer whales in the waters surrounding the San Juan Islands increased their call source level as vessel noise increased. North Atlantic right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise from vessel traffic (Parks et al. 2007; Rolland et al. 2012) as well as increasing the amplitude (intensity) of their calls (Parks 2009; Parks et al. 2010). In contrast, both sperm and pilot whales potentially ceased sound production during the Heard Island feasibility test (Bowles et al. 1994), although it cannot be absolutely determined whether the inability to acoustically detect the animals was due to the cessation of sound production or the displacement of animals from the area.

Differential vocal responding in marine mammals has been documented in the presence of seismic survey sound (note that seismic survey and use of air guns is not part of the proposed action in this SEIS/OEIS). An overall decrease in vocalization during active surveying has been noted in large marine mammal groups (Potter et al. 2007), while detection of blue whale feeding/social calls increased when seismic exploration was underway (Di Iorio and Clark 2010), indicative of a potentially compensatory response to the increased sound level. Melcón et al. (2012) recently documented that blue whales decreased the proportion of time spent producing certain types of calls when simulated mid-frequency sonar was present. Castellote et al. (2012) found that vocalizing fin whales in the Mediterranean left the area where a seismic survey was being conducted and that their displacement persisted beyond the completion of the survey. A seismic survey has very little if any relationship to the Navy activities analyzed in this SEIS/OEIS.

At present it is not known if changes in vocal behavior corresponded to changes in other behaviors. Controlled exposure experiments in 2007 and 2008 in the Bahamas recorded responses of false killer whales, short-finned pilot whales, and melon-headed whales to simulated MFA sonar (De Ruiter et al. 2013b). The responses to exposures between species were variable. After hearing each MFA signal, false killer whales were found to “increase their whistle production rate and made more-MFA-like whistles” (De Ruiter et al. 2013b). In contrast, melon-headed whales had “minor transient silencing” after each MFA signal, while pilot whales had no apparent response.

Evidence suggests that at least some marine mammals have the ability to acoustically identify potential predators. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales, but not others. The seals discriminate between the calls of threatening and non-threatening killer whales (Deecke et al. 2002), a capability that should increase survivorship while reducing the energy required for attending to and responding to all killer whale calls. The occurrence of masking or hearing impairment provides a means by which marine mammals may be prevented from responding to the acoustic cues produced by their predators. Whether or not this is a possibility depends on the duration of the masking/hearing impairment and the likelihood of encountering a predator during the time that predator cues are impeded.

3.8.3.1.2.5 Physiological Stress

Marine mammals may exhibit a behavioral response or combinations of behavioral responses upon exposure to anthropogenic sounds. If a sound is detected by a marine mammal, a stress response (e.g., startle or annoyance) or a cueing response (based on a past stressful experience) can occur. Marine mammals naturally experience stressors within their environment and as part of their life histories.

Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with members of the same species, and interactions with predators all contribute to the stress a marine mammal experiences. In some cases, naturally occurring stressors can have profound impacts on marine mammals; for example, chronic stress, as observed in stranded animals with long-term debilitating conditions (e.g., disease), has been demonstrated to result in an increased size of the adrenal glands and an increase in the number of epinephrine-producing cells (Clark et al. 2006).

Anthropogenic activities have the potential to provide additional stressors above and beyond those that occur naturally. Various efforts have been undertaken to investigate the impact from vessels (both whale-watching and general vessel traffic noise), and demonstrated impacts do occur (Bain 2002; Erbe 2002; Noren et al. 2009; Williams et al. 2006, 2009, 2014a, 2014b; Read et al. 2014; Rolland et al. 2012; Pirotta et al. 2015). This body of research for the most part has investigated impacts associated with the presence of chronic stressors, which differ significantly from the proposed Navy training activities in the TMAA. For example, in an analysis of energy costs to killer whales, Williams et al. (2009) suggested that whale-watching in Canada's Johnstone Strait resulted in lost feeding opportunities due to vessel disturbance, which could carry higher costs than other measures of behavioral change might suggest. Ayres et al. (2012) recently reported on research in the Salish Sea (Washington state) involving the measurement of southern resident killer whale fecal hormones to assess two potential threats to the species recovery: lack of prey (salmon) and impacts to behavior from vessel traffic. Ayres et al. (2012) suggested that the lack of prey overshadowed any population-level physiological impacts on southern resident killer whales from vessel traffic.

Although preliminary because of the small numbers of samples collected, different types of sounds have been shown to produce variable stress responses in marine mammals. Belugas demonstrated no catecholamine (hormones released in situations of stress) response to the playback of oil drilling sounds (Thomas et al. 1990) but showed an increase in catecholamines following exposure to impulsive sounds produced from a seismic water gun (Romano et al. 2004). A bottlenose dolphin exposed to the same seismic water gun signals did not demonstrate a catecholamine response, but did demonstrate an elevation in aldosterone, a hormone that has been suggested as being a significant indicator of stress in odontocetes (St. Aubin and Dierauf 2001, St. Aubin and Geraci 1989). Increases in heart rate were observed in bottlenose dolphins to which conspecific calls were played, although no increase in heart rate was observed when tank noise was played back (Miksis et al. 2001). A beluga's heart rate was observed to increase during exposure to noise, with increase dependent on frequency band of noise and duration of exposure, with a sharp decrease to normal or below normal levels upon cessation of the exposure (Lyamin et al. 2011). It is unknown how chronic exposure to acoustic stressors may affect marine mammals. Opportunistic comparison of levels of stress-related hormone metabolites in North Atlantic right whale feces collected before and after the tragic events of 11 September 2001 showed a decrease in metabolite levels corresponding to lower levels of ambient noise due to reduced ship traffic (Rolland et al. 2012). Collectively, these results suggest a variable response that depends on the characteristics of the received signal and prior experience with the received signal.

Other types of stressors include the presence of vessels, fishery interactions, acts of pursuit and capture, the act of stranding, and pollution. In contrast to the limited amount of work performed on stress responses resulting from sound exposure, a considerably larger body of work exists on stress responses associated with pursuit, capture, handling and stranding. Many cetaceans exhibit an apparent vulnerability in the face of these particular situations when taken to the extreme. One study compared pathological changes in organs/tissues of odontocetes stranded on beaches or captured in nets over a

40-year period (Cowan and Curry 2008). The type of changes observed indicate multisystemic harm caused in part by an overload of catecholamines into the system, as well as a restriction in blood supply capable of causing tissue damage and/or tissue death. This extreme response to a major stressor(s) is thought to be mediated by the overactivation of the animal's normal physiological adaptations to diving or escape. Pursuit, capture and short-term holding of belugas have been observed to result in a decrease in thyroid hormones (St. Aubin and Geraci 1988) and increases in epinephrine (St. Aubin and Dierauf 2001). In dolphins, the trend is more complicated with the duration of the handling time potentially contributing to the magnitude of the stress response (Ortiz and Worthy 2000, St. Aubin 2002, St. Aubin et al. 1996). Male grey seals subjected to capture and short-term restraint showed an increase in cortisol levels accompanied by an increase in testosterone (Lidgard et al. 2008). This result may be indicative of a compensatory response that enables the seal to maintain reproduction capability in spite of stress. Elephant seals demonstrate an acute cortisol response to handling, but do not demonstrate a chronic response; on the contrary, adult females demonstrate a reduction in the adrenocortical response following repetitive chemical immobilization (Engelhard et al. 2002). Similarly, no correlation between cortisol levels and heart/respiration rate changes were seen in harbor porpoises during handling for satellite tagging (Eskesen et al. 2009). Taken together, these studies illustrate the wide variations in the level of response that can occur when faced with these stressors.

Factors to consider when trying to predict a stress or cueing response include the mammal's life history stage and whether they are naïve or experienced with the sound. Prior experience with a stressor may be of particular importance as repeated experience with a stressor may dull the stress response via acclimation (St. Aubin and Dierauf 2001; Bejder et al. 2009).

The sound characteristics that correlate with specific stress responses in marine mammals are poorly understood. Therefore, in practice, a stress response is assumed if a physiological reaction such as a hearing loss or trauma is predicted, or if a behavioral response is predicted.

3.8.3.1.2.6 Behavioral Reactions

The response of a marine mammal to an anthropogenic sound will depend on the frequency, duration, temporal pattern and amplitude of the sound as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). 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). For marine mammals, a review of responses to anthropogenic sound was first conducted by Richardson and others (Richardson et al. 1995). More recent reviews (Ellison et al. 2012; Nowacek 2007; Southall et al. 2007, 2009a) address studies conducted since 1995 and focus on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. Ellison et al. (2012) outlined an approach to assessing the effects of sound on marine mammals that incorporates contextual-based factors. They recommend considering not just the received level of sound, but also the activity the animal is engaged in at the time the sound is received, the nature and novelty of the sound (i.e., if it is a new sound from the animal's perspective), and the distance between the sound source and the animal. They submit that this "exposure context," as described, greatly influences the type of behavioral response exhibited by the animal.

Except for some vocalization changes that may be compensating for auditory masking, all behavioral reactions are assumed to occur due to a preceding stress or cueing response; however, stress responses cannot be predicted directly due to a lack of scientific data (see preceding section on Physiological Stress). Responses can overlap; for example, an increased respiration rate is likely to be coupled to a

flight response. Differential responses between and within species are expected since hearing ranges vary across species and the behavioral ecology of individual species is unlikely to completely overlap.

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

Recent studies with beaked whales have shown them to be particularly sensitive to noise, with animals during three playbacks of sound breaking off foraging dives at levels below 142 dB re 1 μ Pa, although acoustic monitoring during actual sonar exercises revealed some beaked whales continuing to forage at levels up to 157 dB re 1 μ Pa (Tyack et al. 2011). Passive acoustic monitoring of beaked whales, classified as Blainville's beaked whales and Cross Seamount-type beaked whales, at the Pacific Missile Range Facility (PMRF) showed statistically significant differences in dive rates, diel occurrence patterns, and spatial distribution of dives after the initiation of a training event. However, some beaked whale dives continued to occur during mid-frequency active sonar (MFAS) activity, with estimated received levels up to 137 dB re 1 μ Pa while the animals were at depth during their dives (Manzano-Roth et al. 2013).

Behavioral Reactions to Impulsive Sound Sources

Mysticetes

Baleen whales have shown a variety of responses to impulsive sound sources (e.g., explosives and seismic research air guns), including avoidance, reduced surface intervals, altered swimming behavior, and changes in vocalization rates (Castellote et al. 2012, Gordon et al. 2003, Richardson et al. 1995, Southall et al. 2007). While most bowhead whales did not show active avoidance until within 5 mi. (8 km) of seismic vessels (Richardson et al. 1995), some whales avoided vessels by more than 12 mi. (19 km) at received levels as low as 120 dB re 1 μ Pa root mean square (rms). Additionally, Malme et al. (1988) observed clear changes in diving and respiration patterns in bowheads at ranges up to 45 mi. (72 km) from seismic vessels, with received levels as low as 125 dB re 1 μ Pa.

Gray whales migrating along the U.S. west coast showed avoidance responses to seismic vessels by 10 percent of animals at 164 dB re 1 μ Pa, and by 90 percent of animals at 190 dB re 1 μ Pa, with similar results for whales in the Bering Sea (Malme 1986, 1988). In contrast, sound from seismic surveys was not found to impact feeding behavior or exhalation rates while resting or diving in western gray whales off the coast of Russia (Gailey et al. 2007, Yazvenko et al. 2007).

Humpback whales showed avoidance behavior at ranges of 3–5 mi. (5–8 km) from a seismic array during observational studies and controlled exposure experiments in western Australia (McCauley 1998; Todd et al. 1996) found no clear short-term behavioral responses by foraging humpbacks to explosions associated with construction operations in Newfoundland, but did see a trend of increased rates of net entanglement and a shift to a higher incidence of net entanglement closer to the noise source.

Seismic pulses at average received levels of 131 dB re 1 micropascal squared second ($\mu\text{Pa}^2\text{-s}$) caused blue whales to increase call production (Di Iorio and Clark 2010). In contrast, McDonald et al. (1995) tracked a blue whale with seafloor seismometers and reported that it stopped vocalizing and changed its travel direction at a range of 6 mi. (10 km) from the seismic vessel (estimated received level 143 dB re 1 μPa peak-to-peak). Castellote et al. (2012) found that vocalizing fin whales in the Mediterranean moved positions relative to the seafloor seismometer with fewer vocalizations detected, possibly in response to a seismic survey that was being conducted approximately 135 nm (250 km) from the instrument. Approximately two weeks after completion of the seismic survey, the whale vocalizations were again detected on the seafloor seismometer. These studies demonstrate that even low levels of sound received far from the sound source can induce behavioral responses.

Odontocetes

Madsen et al. (2006) and Miller et al. (2009) 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 away from the whales and based on multipath propagation received levels were as high as 162 dB SPL re 1 μPa with energy content greatest between 0.3 and 3.0 kHz (Madsen et al. 2006). The whales showed no horizontal avoidance, although the whale that was approached most closely had an extended resting period and did not resume foraging until the airguns had ceased firing (Miller et al. 2009).

Weir (2008) observed that seismic airgun surveys along the Angolan coast did not significantly reduce the encounter rate of sperm whales during the 10-month survey period. Neither were avoidance behaviors to airgun impulsive sounds observed in sperm whales. Thompson et al. (2013) showed that seismic surveys conducted over a 10-day period in the North Sea did not result in the broad-scale displacement of harbor porpoises away from preferred habitat. The harbor porpoises were observed to leave the area at the onset of survey, but returned within a few hours, implying that they began returning during the seismic survey. The overall response of the porpoises decreased over the 10-day period. However, Atlantic spotted dolphins did show a significant, short-term avoidance response to airgun impulses within approximately 1 km of the source (Weir 2008). The dolphins were observed at greater distances from the vessel when the airgun was in use, and when the airgun was not in use they readily approached the vessel to bow ride.

Captive bottlenose dolphins sometimes vocalized after an exposure to impulsive sound from a seismic watergun (Finneran et al. 2002, Finneran and Schlundt 2010). Subsequent research on captive bottlenose dolphins investigating the effects of multiple impulses found that, at the highest exposure condition, two of the dolphins exhibited behavioral reactions indicating that they were capable of anticipating, and potentially mitigating, the effects of impulsive sounds presented at consistent time intervals (Finneran et al. 2015).

Pinnipeds

A review of behavioral reactions by pinnipeds to impulsive noise can be found in Richardson et al. (1995) and Southall et al. (2007). Blackwell et al. (2004) observed that ringed seals exhibited little or no reaction to pipe-driving noise with mean underwater levels of 157 dB re 1 μPa rms and in air levels of

112 dB re 20 μ Pa, suggesting that the seals had habituated to the noise. In contrast, captive California sea lions avoided sounds from an underwater impulsive source at levels of 165–170 dB re 1 μ Pa (Finneran et al. 2003).

Experimentally, Götz and Janik (2011) tested underwater startle responses to a startling sound (sound with a rapid rise time and a 93 dB sensation level [the level above the animal's threshold at that frequency]) and a non-startling sound (sound with the same level, but with a slower rise time) in wild-captured gray seals. The animals exposed to the startling treatment avoided a known food source, whereas animals exposed to the non-startling treatment did not react or habituated during the exposure period. The results of this study highlight the importance of the characteristics of the acoustic signal in an animal's response of habituation.

Behavioral Reactions to Sonar and Other Active Acoustic Sources

Mysticetes

Specific to U.S. Navy systems using low frequency sound, studies were undertaken in 1997–98 pursuant to the Navy's Low Frequency Sound Scientific Research Program. These studies found only short-term responses to low frequency sound by mysticetes (fin, blue, and humpback) including changes in vocal activity and avoidance of the source vessel (Clark and Fristrup 2001, Croll et al. 2001, Fristrup et al. 2003, Miller et al. 2000, Nowacek et al. 2007). Recent work by Risch et al. (2012) found that humpback whale vocalizations ("songs") were reduced concurrent with pulses from the low frequency Ocean Acoustic Waveguide Remote Sensing source located approximately 200 km away. Baleen whales exposed to moderate low-frequency signals demonstrated no variation in foraging activity (Croll et al. 2001). However, five out of six North Atlantic right whales exposed to an acoustic alarm interrupted their foraging dives, although the alarm signal was long in duration, lasting several minutes, and purposely designed to elicit a reaction from the animals as a prospective means to protect them from ship strikes (Nowacek et al. 2004). Although the animal's received sound pressure level was similar in the latter two studies (133–150 dB SPL), the frequency, duration, and temporal pattern of signal presentation were different. Additionally, the right whales did not respond to playbacks of either right whale social sounds or vessel noise, highlighting the importance of the sound characteristics, species differences, and individual sensitivity in producing a behavioral reaction.

Low-frequency signals of the Acoustic Thermometry of Ocean Climate sound source were not found to affect dive times of humpback whales in Hawaiian waters (Frankel and Clark 2000) or to overtly affect elephant seal dives off California (Costa et al. 2003). However, they did produce subtle effects that varied in direction and degree among the individual seals, again illustrating the equivocal nature of behavioral effects and consequent difficulty in defining and predicting them.

Blue whales exposed to mid-frequency simulated sonar in the Southern California Bight were less likely to produce low frequency calls usually associated with feeding behavior (Melcón et al. 2012). It is not known whether the lower rates of calling actually indicated a reduction in feeding behavior or social contact because the study used data from remotely deployed, passive acoustic monitoring buoys. In contrast, blue whales increased their likelihood of calling when ship noise was present, and decreased their likelihood of calling in the presence of explosive noise, although this result was not statistically significant (Melcón et al. 2012). Additionally, the likelihood of an animal calling decreased with the increased received level of mid-frequency sonar, beginning at a sound pressure level of approximately 110–120 dB re 1 μ Pa (Melcón et al. 2012). In Southall 2011, preliminary results from the 2010–2011 field season of an ongoing behavioral response study in Southern California waters indicated that, in some

cases and at low received levels, tagged blue whales responded to mid-frequency sonar but that those responses were mild and there was a quick return to their baseline activity (Southall et al. 2011).

Further results from the Southern California behavioral response study showed that blue whales also responded to a simulated mid-frequency sound source, with a source level between 160 and 210 dB re 1 μ Pa at 1 m and a received sound level up to 160 dB re 1 μ Pa, by exhibiting generalized avoidance responses and changes to dive behavior during the exposure experiments (Goldbogen et al. 2013). However, reactions were not consistent across individuals based on received sound levels alone, and likely were the result of a complex interaction between sound exposure factors such as proximity to sound source and sound type (mid-frequency sonar simulation vs. pseudo-random noise), environmental conditions, and behavioral state. Surface feeding whales did not show a change in behavior during controlled exposure experiments, but deep feeding and non-feeding whales showed temporary reactions that quickly abated after sound exposure. Whales were sometimes less than a mile from the sound source during the controlled exposure experiments. Blue whales have been documented exhibiting a range of foraging strategies for maximizing feeding dependent on the density of their prey at a given location (Goldbogen et al. 2015), so it may be that a temporary behavioral reaction or avoidance of a location where feeding was occurring is not meaningful to the life history of an animal.

These preliminary findings from Melcón et al. (2012) and Goldbogen et al. (2013) are consistent with the Navy's criteria and thresholds for predicting behavioral effects to mysticetes (including blue whales) from sonar and other active acoustic sources used in the quantitative acoustic effects analysis (Section 3.8.3.1.6, Quantitative Analysis). The behavioral response function predicts a probability of a behavioral reaction for individuals exposed to a received sound pressure level of 120 dB re 1 μ Pa or greater, with an increasing probability of reaction with increased received level as demonstrated in Melcón et al. (2012). Although the long-term implications of disruption in call production to blue whale foraging and other behaviors are currently not well understood, vessel noise is much more pervasive in both time and space compared to the intermittent use of various types of sonar, including fathometers, fish-finders, research sonar, and Navy mid-frequency sonar.

In a behavioral response study conducted in Australian waters, migrating humpback whales passing within 1.2 mi. (2 km) of a moored vessel responded to an artificial tone⁴ by moving away from the stimulus and surfacing more often, presumably to avoid the stimulus (Dunlop et al. 2013b). The response to the tone was consistent and was dependent on received level and distance from the source. When a conspecific social sound (recorded humpback whale vocalization) was played as the stimulus, the response of the whales was inconsistent and depended on the social makeup of the group at the time of the stimulus. In some cases the whales approached the vessel (sound source), and, as with the tone stimulus, changes in diving and surfacing behavior were noted.

Debich et al. (2013, 2014) documented frequent detections of broadband ship noise and other anthropogenic sounds at various underwater passive acoustic monitoring devices within the TMAA area. There were no Navy training activities in the GOA TMAA during 2013 and 2014, so all anthropogenic sounds reported by Debich et al. (2013, 2014) were from non-Navy sources (e.g., commercial shipping,

⁴ The source consisted of an underwater speaker playing a sequence of tones, swept in frequency from 2 to 2.1 kHz over a period of 1.5 seconds, repeated every 8 seconds for 20 minutes. Source levels varied from 148 to 153 dB re 1 μ Pa at 1 m root mean square. This differs from the U.S. Navy's surface ship hull-mounted mid-frequency sonar, in that it was lower in frequency, the sound was repeated approximately five-times more often, and a 20-minute exposure is very unlikely to result from a moving Navy vessel engaged in a training or testing event.

fishing vessels, etc.). Understanding the impacts of vessel noise on blue whale call production is likely more of a concern given its broader implications.

Odontocetes

From 2007 to the present, behavioral response studies were conducted through the collaboration of various research organizations in the Bahamas, Southern California, the Mediterranean, Cape Hatteras, and Norwegian waters. These studies attempted to define and measure responses of cetaceans to controlled exposures of sonar and other sounds to better understand their potential impacts. Through analysis of the behavioral response studies, a preliminary overarching effect of greater sensitivity to all anthropogenic exposures was seen in beaked whales compared to the other odontocetes studied (Southall et al. 2009a). Therefore, beaked whale species have been one of the focal groups in recent studies examining cetacean responses to active sonar transmissions or controlled exposure playback of simulated sonar on various military ranges (Defence Science and Technology Laboratory 2007; Claridge and Durban 2009; McCarthy et al. 2011; Miller et al. 2012; Moretti et al. 2009; Southall et al. 2011, 2012a, 2012b, 2013, 2014; Tyack et al. 2011).

Results from the 2007–2008 study conducted near the Bahamas showed a change in diving behavior of an adult Blainville’s beaked whale to playback of simulated mid-frequency source and predator sounds (Boyd et al. 2008; Southall et al. 2009b; Tyack et al. 2011). Reaction to mid-frequency sounds included premature cessation of clicking and termination of a foraging dive, and a slower ascent rate to the surface. Blainville’s beaked whales located on the range were found to move off-range during sonar use and return only after the sonar transmissions have stopped, sometimes taking several days to do so (Claridge and Durban 2009; Moretti et al. 2009; McCarthy et al. 2011; Tyack et al. 2011).

Preliminary results from the behavioral response studies in Southern California waters have been presented for multiple field seasons (Southall et al. 2011, 2012, 2013, 2014). Stimpert et al. (2014) tagged a Baird’s beaked whale, which was subsequently exposed to simulated mid-frequency sonar. Changes in the animal’s dive behavior and locomotion were observed when received level reached 127 dB re 1 μ Pa. De Ruiter et al. (2013a) presented results from two Cuvier’s beaked whales that were tagged and exposed to simulated mid-frequency active sonar during the 2010 and 2011 field seasons of the southern California behavioral response study. One of the 2011 tagged whales was also incidentally exposed to mid-frequency active sonar from a distant naval exercise. Received levels from the mid-frequency active sonar signals from the controlled and incidental exposures were calculated as 84–144 and 78–106 dB re 1 μ Pa rms, respectively. Both tagged whales showed responses to the controlled exposures, ranging from initial orientation changes to avoidance responses characterized by De Ruiter et al. (2013a) as energetic fluking and swimming away from the source. However, the authors did not detect similar responses to incidental exposure from distant naval sonar exercises at comparable received levels, indicating that context of the exposures (e.g., source proximity, controlled source ramp-up) may have been a significant factor. Results from Schorr et al. (2014) with a larger sample (eight tagged Cuvier’s beaked whales) noted, “the reactive dive durations observed in the experimental exposures do not appear far outside the normal behavioral range of some *Ziphius* in this region.”

During a Submarine Commander Course at Pacific Missile Range Facility in Hawaii involving three surface ships and a submarine using mid-frequency sonar over the span of a multiple-day event, Manzano-Roth et al. (2013) determined that beaked whales (tentatively identified as Blainville’s beaked whales) continued to make foraging dives at estimated distances of 13–52 km from the active mid-frequency sonar. The animals shifted to the southern edge of the instrumented range with differences in the dive vocal period duration, and dive rate. There also was a diel shift after the training event, with more dives

occurring at night than prior to or during the activity. The animals closest to the source were estimated to have been exposed to levels somewhere between 137 and 162 dB re 1 μ Pa (rms).

The concern with beaked whales and an avoidance response is whether that displacement is likely to have long-term consequences for an animal or populations. Research involving three tagged Cuvier's beaked whales in the Southern California (SOCAL) Range Complex reported on by Falcone and Schorr (2012; 2014) has documented movements in excess of hundreds of kilometers by some those animals. Schorr et al. (2014) reported the results for an additional eight tagged Cuvier's beaked whale in the same area. Five of these eight whales made journeys of approximately 250 km from their tag deployment location, and one of these five made an extra-regional excursion over 450 km south to Mexico and back again. Given that some beaked whales may routinely move hundreds of kilometers as part of their normal pattern, temporarily leaving an area to avoid sonar or other anthropogenic activity may have little if any cost to such an animal. Photo identification studies in the SOCAL Range Complex have identified approximately 100 individual Cuvier's beaked whale individuals, with 40 percent having been seen in one or more prior years, with re-sightings up to 7 years apart (Falcone and Schorr 2014). An increasing number of the beaked whales identified in a subsequent survey year, indicate that there may be a small resident population of beaked whales where the Navy routinely conducts training and testing with sonar. The results of this on-going, multi-year study suggest that training and testing activities in this are not driving this population of beaked whale away from that habitat. These results indicate long-term residency by individuals in an intensively used Navy training and testing area, which may also suggest a lack of long-term consequences as a result of exposure to Navy training and testing activities.

Moore and Barlow (2013) noted a decline in the overall beaked whale population in a broad area of the Pacific Ocean within the U.S. EEZ. Moore and Barlow (2013) suggest that one reason for the decline in beaked whales those waters may be as a result of anthropogenic sound, including the use of sonar by the U.S. Navy. The Navy trains and tests in a small fraction of that area off Southern California. Although Moore and Barlow (2013) have noted a decline in the overall beaked whale population along the Pacific coast, in the small fraction of that area where the Navy has been training and testing with sonar and other systems for decades (the Navy's SOCAL Range Complex), higher densities and long-term residency by individual Cuvier's beaked whales suggest that the decline noted elsewhere is not apparent where Navy sonar use is most intense. Navy sonar training and testing is not conducted along a large part of the U.S. west coast from which Moore and Barlow (2013) drew their survey data. In Southern California, based on a series of surveys from 2006 to 2008 and a high number encounter rate, Falcone et al. (2009) suggested the ocean basin west of San Clemente Island may be an important region for Cuvier's beaked whales given the number of animals encountered there. Follow-up research (Falcone and Schorr 2012 2014) in this same location suggests that Cuvier's beaked whales may have population sub units with higher than expected residency, particularly in the Navy's instrumented Southern California Anti-Submarine Warfare Range. Encounters with multiple groups of Cuvier's and Baird's beaked whales indicated not only that they were prevalent on the range where Navy routinely trains and tests, but also that they were potentially present in much higher densities than had been reported for anywhere along the U.S. west coast (Falcone et al. 2009, Falcone and Schorr 2012). This finding is also consistent with concurrent results from passive acoustic monitoring that estimated regional Cuvier's beaked whale densities were higher where Navy trains in the SOCAL training and testing area than indicated by NMFS's broad scale visual surveys for the U.S. west coast (Hildebrand and McDonald 2009).

Moore and Barlow (2013) recognized the inconsistency between their hypothesis and the abundance trends in the region of SOCAL Range Complex stating, "High densities are not obviously consistent with a

hypothesis that declines are due to military sonar, but they do not refute the possibility that declines have occurred in these areas (i.e., that densities were previously even higher).” While it is possible that the high densities of beaked whale currently inhabiting the Navy’s range were even higher before the Navy began training with sonar, there is no data available to test that hypothesis.

For over 3 decades, the ocean west of San Clemente Island has been the location of the Navy's instrumented training range and is one of the most intensively used training and testing areas in the Pacific. Research has documented the presence and long-term residence of Cuvier’s beaked whales for the ocean basin west of San Clemente Island (Falcone et al. 2009, Falcone and Schorr 2012, 2014) and results from passive acoustic monitoring estimated regional Cuvier’s beaked whale densities were higher than indicated by the NMFS’s broad scale visual surveys for the U.S. west coast (Hildebrand and McDonald 2009). Based on these findings of higher beaked whale density where Navy has been training and testing for decades, it is clear that the Navy’s long-term ongoing use of sonar and other active acoustic sources has not precluded beaked whales from also continuing to inhabit those areas. In summary, based on the best available science, the Navy believes that beaked whales that exhibit a behavioral reaction due to sonar and other active acoustic training activities would generally not have long-term consequences for individuals or populations. Neither NMFS nor the Navy anticipates that marine mammal strandings or mortality will result from the operation of sonar or other acoustic sources during Navy exercises within the TMAA. Additionally, through the MMPA process (which allows for adaptive management), NMFS and the Navy will determine the appropriate way to proceed in the event that a causal relationship were to be found between Navy activities and a future stranding involving beaked whale or other marine mammal species.

Controlled exposure experiments in 2007 and 2008 in the Bahamas recorded responses of false killer whales, short-finned pilot whales, and melon-headed whales to simulated MFA sonar (De Ruiter et al. 2013b). The responses to exposures between species were variable and are indicative of variability in species sensitivity. After hearing each MFA signal, false killer whales were found to have “increase[d] their whistle production rate and made more-MFA-like whistles” (De Ruiter et al. 2013b). In contrast, melon-headed whales had “minor transient silencing” after each MFA signal, while pilot whales had no apparent response. Consistent with the findings of other previous research (see Southall et al. 2007 for review), De Ruiter et al. (2013b) found the responses were variable by species and with the context of the sound exposure. In the 2007–2008 Bahamas study, playback sounds of a potential predator—a killer whale—resulted in a similar but more pronounced reaction, which included longer inter-dive intervals and a sustained straight-line departure of more than 20 km from the area. The authors noted, however, that the magnified reaction to the predator sounds could represent a cumulative effect of exposure to the two sound types since killer whale playback began approximately 2 hours after mid-frequency source playback. In contrast, preliminary analyses suggest that none of the pilot whales or false killer whales in the Bahamas showed an avoidance response to controlled exposure playbacks (Southall et al. 2009b).

Miller et al. (2011) reported on behavioral responses of pilot whales, killer whales, and sperm whales off Norway to a Norwegian Navy sonar (Sea Mammals, Sonar, and Safety Project [hereafter referred to as the 3S study]) (see also Miller et al. 2012, Sivle et al. 2012, Kuningas et al. 2013, Antunes et al. 2014, Miller et al. 2014). The sonar outputs included 1–2 kHz up- and down-sweeps and 6–7 kHz upsweeps; source levels were ramped-up from 152 to 158 dB re 1 μ Pa at 1 m to a maximum of 195–214 dB re 1 μ Pa at 1 m. Reactions at different distances and received levels were variable, and types of responses observed included cessation of feeding, avoidance, changes in vocalizations, and changes in dive behavior. Some exposures elicited no observable reactions, and others resulted in brief or minor

reactions, such as minor changes in vocalizations or locomotion. The experimental exposures occurred across different behavioral and environmental contexts, which may have played a role in the type of response observed, at least for killer whales (see Miller et al. 2014).

Many aspects of the experiment differ from typical Navy actions and may have exacerbated observed reactions; for example, animals were directly approached by the source vessel, researchers conducted multiple approaches toward the same animal groups, some exposures were conducted in bathymetrically restricted areas, and, in some cases, researchers “leapfrogged” the groups to move ahead of the animals on their travel path. Many of the observed behavioral responses were of a prolonged duration, as the animals continued moving to avoid the oncoming vessel as it corrected course toward the animals. At the onset of each sonar exposure session, the signal amplitude was ramped-up over several pings while the vessel approached the animals. This rapid increase in received levels of subsequent sonar pings during ramp-up could have been perceived by the animals as a rapidly approaching source. In the Miller et al. (2012) experiment, the vessel towing the sonar also tracked the whales from the close starting location, which probably led to a more intense exposure than would be typical during Navy training and testing activities. In contrast, U.S. Navy vessels avoid approaching marine mammals head-on, and vessels will maneuver to maintain a distance of at least 500 yd. (457 m) from observed animals. Furthermore, Navy mitigation measures would dictate power-down of hull-mounted ASW sonars within 1,000 yd. (914 m) of marine mammals and ultimately shutdown if an animal is within 200 yd. (183 m).

Two of the four exposed killer whale groups were foraging prior to the initial sonar exposure; they ceased to feed and began avoiding the vessel during the first exposure session (Miller et al. 2011, 2012, 2014). Received sound pressure levels corresponding to avoidance reactions or changes in behavioral state varied from approximately 94 dB re 1 μ Pa at 8.9 km to 164 dB re 1 μ Pa at 3,500 yd. (3.2 km) (Miller et al. 2014). One killer whale group that was not foraging was in a shallow part of the fjord and could only be approached to within about 1,750 yd. (1.6 km) by the vessel towing the sonar source. Received sound pressure levels in that case were as high as 166 dB re 1 μ Pa with no observed reactions. This group did not respond to any of the exposures until the final approach, when the group had moved out of the shallow part of the fjord and a young calf became temporarily separated from the rest of the group. Miller et al. (2012) noted that this single observed mother-calf separation was unusual for several reasons, including the fact that the experiment was conducted in an unusually narrow fjord roughly 0.6 mi. (1 km) wide and that the sonar exposure was started unusually close to the pod including the calf. Both of these factors could have contributed to calf separation.

Pilot whale behavioral responses occurred at received sound pressure levels between approximately 152 and 175 dB re 1 μ Pa corresponding to distances of 3,400 yd. (3.1 km) to 98 yd. (90 m), respectively; however, during exposures as high as approximately 172 dB re 1 μ Pa corresponding to a distance of 380 yd. (350 m), no more than minor and brief reactions were observed.

Sperm whales responded at received levels between 116 and 156 dB re 1 μ Pa, corresponding to distances of around 2,000 yd. (1.8 km) to 9,800 yd. (9.0 km), respectively. However, sperm whales exposed to higher levels (up to 166 dB re 1 μ Pa at 980 yd. [0.9 km]) showed no response, or no more than a brief and minor response. These counterintuitive results with respect to received sound pressure level demonstrate some of the issues that must be addressed when interpreting behavioral response data for marine mammals in different contextual conditions.

The 3S study included some control passes of ships with the sonar off to discern the behavioral responses of the animals to vessel presence alone versus active sonar. A single control pass was conducted on killer whales, which was insufficient to rule out vessel presence as a factor in behavioral response. During four control passes on pilot whales, Miller et al. (2011) described similar responses for two of the groups to those observed when the vessels approached with active sonar. In some cases, it is difficult to ascertain if the received sound pressure level alone caused the reactions, or whether the repeated, close passes of the research vessel contributed to the observed behavioral reactions.

As presented in more detail in Section 3.8.3.1.2.8 (Stranding) and U.S. Department of the Navy (2013c), in May 2003, killer whales in Haro Strait, Washington were observed exhibiting what were believed by some observers to be aberrant behaviors while the USS SHOUP was in the vicinity and using MFA sonar. Sound fields modeled for the USS SHOUP sonar transmissions (Fromm 2004a, b; National Marine Fisheries Service 2005b; U.S. Department of the Navy 2004) estimated a mean received sound pressure level of approximately 169 dB re 1 μ Pa at the location of the killer whales during the closest point of approach between the animals and the vessel (estimated sound pressure levels ranged from 150 to 180 dB re 1 μ Pa). For a frame of reference regarding these underwater sound pressure levels, whale watching vessels in the same waters have measured source levels ranged from 145 to 169 dB re 1 μ Pa at 1 m (Erbe 2002) and hydrophone measurements from a location in Admiralty Inlet (Washington) for the Keystone/Port Townsend ferry were used to estimate the ferry's source level of to be 175 to 184 dB re 1 μ Pa at 1 m (Bassett et al. 2010). Attributing the cause of the observed behaviors to any one cause is problematic given there were six nearby whale watch vessels surrounding the pod, and subsequent research has demonstrated that, "Southern Residents modify their behavior by increasing surface activity (breaches, tail slaps, and pectoral fin slaps) and swimming in more erratic paths when vessels are close" (National Oceanic and Atmospheric Administration 2014).

In the Caribbean, research on sperm whales near the Grenadines in 1983 coincided with the U.S. intervention in Grenada where 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 since the source was not visible (Watkins and Schevill 1975; Watkins et al. 1985). The authors did not provide any sound levels associated with these observations, although they did note getting a similar reaction from 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 as had been demonstrated previously on another occasion in which sperm whales in the Caribbean stopped vocalizing when presented with sounds from nearby acoustic pingers (Watkins and Schevill 1975).

Researchers at the Navy's Marine Mammal Program facility in San Diego, California, have conducted a series of controlled experiments on bottlenose dolphins and beluga whales to study TTS (Finneran and Schlundt 2004; Finneran et al. 2001, 2003, 2005; Schlundt et al. 2000). Ancillary to the TTS studies, scientists evaluated whether the marine mammals performed their trained tasks when prompted, during and after exposure 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 (Finneran et al. 2002, Schlundt et al. 2000). Bottlenose dolphins exposed to 1-second intense tones exhibited short-term changes in behavior above received sound levels of 178–193 dB re 1 μ Pa rms, and beluga whales did so at received levels of 180–196 dB re 1 μ Pa and above. In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway et al. 1997, Schlundt et al. 2000). While these studies were generally not designed to test avoidance behavior and animals were commonly reinforced with food, the controlled environment and ability to

measure received levels provide insight on received levels at which animals will behaviorally respond to sound sources.

More recently, a controlled-exposure study was conducted with U.S. Navy bottlenose dolphins at the Navy Marine Mammal Program facility specifically to study behavioral reactions to simulated mid-frequency sonar (Houser et al. 2013a). Animals were trained to swim across a pen, touch a panel, and return to the starting location. During transit, a simulated mid-frequency sonar signal was played. Behavioral reactions were more likely with increasing received level and included increased respiration rates, fluke or pectoral fin slapping, and refusal to participate, among others. From these data, it was determined that bottlenose dolphins were more likely to respond to the initial trials, but habituated to the sound over the course of 10 trials except at the highest received levels. All dolphins responded at the highest received level (185 dB re 1 μ Pa).

These observations are particularly relevant to situations where animals are motivated to remain in an area where they are being exposed to sound. Studies with captive harbor porpoises showed increased respiration rates upon introduction of acoustic alarms, such as those used on fishing nets to help deter marine mammals from becoming caught or entangled (Kastelein et al. 2001, 2006) and emissions for underwater data transmission (Kastelein et al. 2005b). However, exposure of the same acoustic alarm to a striped dolphin under the same conditions did not elicit a response (Kastelein et al. 2006), again highlighting the importance in understanding species differences in the tolerance of underwater noise (Southall et al. 2007, Henderson et al. 2014).

Pinnipeds

Different responses displayed by captive and wild phocid seals to sound judged to be “unpleasant” have been reported; captive seals habituated (did not avoid the sound), and wild seals showed avoidance behavior (Götz and Janik 2010). Captive seals received food (reinforcement) during sound playback, while wild seals were exposed opportunistically. These results indicate that motivational state (e.g., reinforcement via food acquisition) can be a factor in whether or not an animal habituates to novel or unpleasant sounds. Another study found that captive hooded seals reacted to 1–7 kHz sonar signals, in part with displacement to the areas of least sound pressure level, at levels between 160 and 170 dB re 1 μ Pa (Kvadsheim et al. 2010). Low-frequency signals from the Acoustic Thermometry of Ocean Climate sound source were not found to overtly affect elephant seal dives (Costa et al. 2003). However, they did produce subtle effects that varied in direction and degree among the individual seals, again illustrating the equivocal nature of behavioral effects and consequent difficulty in defining and predicting them.

Captive studies with other pinnipeds have shown a reduction in dive times when presented with qualitatively “unpleasant” sounds. These studies indicated that the subjective interpretation of the pleasantness of a sound, minus the more commonly studied factors of received sound level and sounds associated with biological significance, can affect diving behavior (Götz and Janik 2010). A controlled-exposure study similar to the bottlenose dolphin study (Houser et al. 2013a) was conducted with U.S. Navy California sea lions (*Zalophus californianus*) at the Navy Marine Mammal Program facility specifically to study behavioral reactions (Houser et al. 2013b). Animals were trained to swim across a pen, touch a panel, and return to the starting location. During transit, a simulated mid-frequency sonar signal was played. Behavioral reactions included increased respiration rates, prolonged submergence, and refusal to participate, among others. Younger animals were more likely to respond than older animals, while some sea lions did not respond consistently at any sound source level.

Sea Otters

Sea otters depend on visual acuity to forage, and their eyes are able to focus both in air and underwater (Riedman and Estes 1990). Davis et al. (1988) conducted a behavioral response study that included underwater an acoustic harassment devices (10–20 kHz at 190 dB; designed to keep dolphins and pinnipeds from being caught in fishing nets). The authors found that the sea otters often remained undisturbed, quickly became tolerant of the various sounds, and even when chased from a location by presentation of a purposefully harassing sound, they generally moved only a short distance (110–220 yd. [100–200 m]) before resuming normal activity. Recently, Ghoul and Reichmuth (2013) confirmed that sea otter's underwater hearing sensitivity is significantly reduced in comparison to that of a pinniped, which suggested that sea otters are not especially well adapted for hearing underwater and that underwater hearing has been less important to their survival. USFWS has stated that they had no evidence that defense-related activities have had any adverse effects on the well-monitored experimental population of Southern sea otters at San Nicolas Island (California) or in the SOCAL Range Complex (U.S. Fish and Wildlife Service 2011).

Behavioral Reactions to Vessels

Although no re-analysis of impacts associated with vessel noise is necessary in this Supplemental EIS/OEIS, the information is presented here given that the new method of analysis for underwater acoustic stressors incorporates likely avoidance of the areas having intense vessel activity. During the training of a Carrier Strike Group, as proposed in the Study Area, high-intensity vessel activity would occur in the vicinity of sonar and other active acoustic sources.

Navy vessels during the Carrier Strike Group exercise are a small component of overall vessel traffic and vessel noise in the Gulf of Alaska. Figure 3.8-9 and Figure 3.8-10 depict the commercial vessel density provided by the automated identification system data for the area from Alaska to the Pacific Northwest in 2011 and 2014, respectively (it can be reasonably inferred that the vessel traffic patterns depicted are similar year to year). As evident from the graphics, commercial vessel use is highest in the U.S. EEZ, at straits and passages, and along least-distance line routes between ports. Also evident from the figures is that some of those commercial vessel routes pass through the TMAA.

Bassett et al. (2012) recorded vessel traffic over a period of approximately 1 year (short by 11 percent) as large vessels passed within 11 nm of a hydrophone site located at Admiralty Inlet in Puget Sound, Washington. Although not specifically relevant to the Study Area, the research provides insight into noise generated by transiting vessels, including military vessels. During this period there were 1,363 unique Automatic Identification System transmitting vessels recorded. Because Naval vessels are much fewer in number, they are a small component of overall vessel traffic and vessel noise in most areas where they operate. Data presented by Mintz and Filadelfo (2011) shows that Navy vessel-hours constitute approximately 6 percent of large vessel-hours in the U.S. EEZ and small percentages even within Navy concentration areas such as the range complexes (i.e., Virginia Capes, Hawaii Range Complex, Southern California). In addition, Navy combatant vessels have been designed to generate minimal noise and use ship quieting technology to elude detection by enemy passive acoustic devices (Mintz and Filadelfo 2011, Southall et al. 2005). Navy vessels do not purposefully approach or follow marine mammals and are generally not expected to elicit avoidance or alarm behavior.

Sound emitted from large vessels, such as shipping and cruise ships, is the principal source of low-frequency noise in the ocean today, and marine mammals are known to react to or be affected by that noise (Anderward et al. 2013; Erbe et al. 2014; Hatch and Wright 2007; Hildebrand 2005; Richardson et al. 1995; Williams et al. 2014a, 2014b). Acoustic monitoring in the TMAA has indicated

ship noise has detected with some regularity at the recording site mid-shelf off Kenai Peninsula site and relatively infrequently at the site farther offshore near the shelf-break (for the locations of these passive acoustic monitoring buoys, see Baumann-Pickering et al. 2012b).

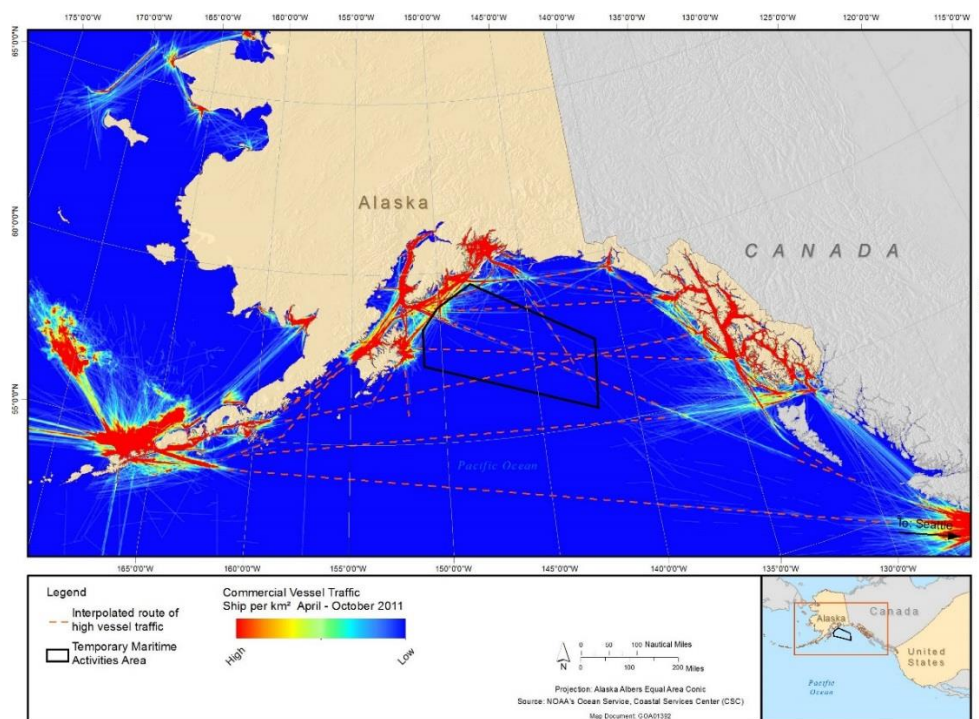


Figure 3.8-9: Commercial Vessel Density In and Around the Study Area in 2011

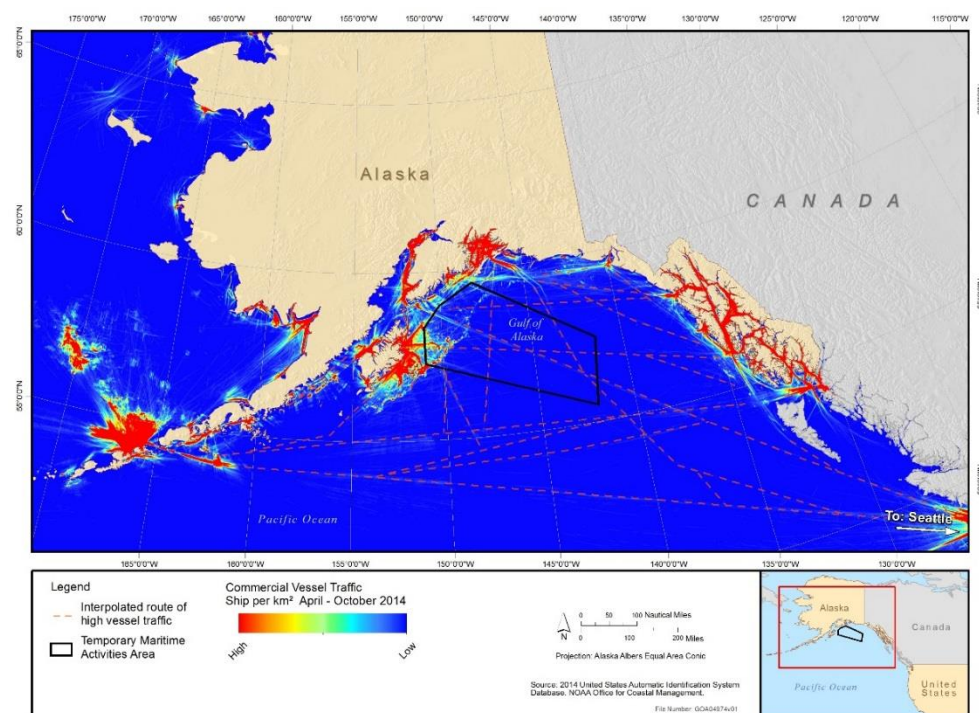


Figure 3.8-10: Commercial Vessel Density In and Around the Study Area in 2014

Limited evidence suggests that beaked whales respond to vessel noise, anthropogenic noise in general, and mid-frequency sonar at similar sound levels (Aguilar de Soto et al. 2006, Tyack 2009, Tyack et al. 2011). In short term studies, researchers have noted changes in resting and surface behavior states of cetaceans to whale-watching vessels (Acevedo 1991, Aguilar de Soto et al. 2006, Arcangeli and Crosti 2009, Au and Green 2000, Christiansen et al. 2010, Erbe 2002, Noren et al. 2009, Stensland and Berggren 2007, Stockin et al. 2008, Williams et al. 2009).

Most studies of this type are opportunistic and have only examined the short-term response to vessel sound and vessel traffic (May-Collado and Quiñones-Lebrón 2014, Lusseau 2006, Magalhães et al. 2002, Noren et al. 2009, Richardson et al. 1995, Watkins 1981); however, recent research has attempted to quantify the effects of whale watching using focused experiments (Pirrotta et al. 2015, Meissner et al. 2015). The long-term and cumulative implications of ship sound on marine mammals is largely unknown (National Marine Fisheries Service 2012a). Clark et al. (2009) provided a discussion on calculating the cumulative impacts of anthropogenic noise on baleen whales and estimated that in one Atlantic setting and with the noise from the passage of two vessels, the optimal communication space for the North Atlantic right whale could be decreased by 84 percent (see also Hatch et al. 2012).

Mysticetes

Fin whales may alter their swimming patterns by increasing speed and heading away from the vessel, as well as by changing their breathing patterns in response to a vessel approach (Jahoda et al. 2003). Vessels that remained 328 ft. (100 m) or farther from fin and humpback whales were largely ignored in one study in an area where whale-watching activities are common (Watkins 1981). Only when vessels approached more closely did the fin whales in this study alter their behavior by increasing time at the surface and exhibiting avoidance behaviors. Other studies have shown when vessels are near, some but not all fin whales change their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions (Au and Green 2000; Castellote et al. 2012; Richter et al. 2003; Williams et al. 2002).

Based on passive acoustic recordings and in the presence of sounds from passing vessels, Melcón et al. (2012) reported that blue whales had an increased likelihood of producing certain types of calls. Castellote et al. (2012) demonstrated that fin whales songs had shortened duration and decreased bandwidth, center frequency, and peak frequency in the presence of high vessel noise levels such as those found in the Strait of Gibraltar. At present, it is not known if these changes in vocal behavior corresponded to changes in other behaviors.

In the Watkins (1981) study, humpback whales did not exhibit any avoidance behavior but did react to vessel presence. In a study of regional vessel traffic Baker et al. (1983) found that when vessels were in the area, the respiration patterns of the humpback whales changed. The whales also exhibited two forms of behavioral avoidance: horizontal avoidance (changing direction or speed) when vessels were between 1.24 and 2.48 mi. (2,000 and 4,000 m) away, and vertical avoidance (increased dive times and change in diving pattern) when vessels were within 1.24 mi. (2,000 m) away (Baker et al. 1983). Similar findings were documented for humpback whales that were approached by whale watch vessels in Hawaii and had responses that including increased speed, changed direction to avoid, and staying submerged for longer periods of time (Au and Green 2000).

Gende et al. (2011) reported on observations of humpback whale in inland waters of Southeast Alaska subjected to frequent cruise ship transits (i.e., in excess of 400 transits in a 4-month season in 2009). The study was focused on determining if close encounter distance was a function of vessel speed. The

reported observations, however, seem in conflict with other reports of avoidance at much greater distance, so it may be that humpback whales in those waters are more tolerant of vessels (given their frequency) or are engaged in behaviors, such as feeding, that they are less willing to abandon. This example again highlights that context is critical for predicting and understanding behavioral reactions as concluded by Southall et al. (2007) and Ellison et al. (2012). Navy vessels avoid approaching large whales head on and maneuver to maintain a mitigation zone of 500 yd. (457 m) around observed large whales.

Sei whales have been observed ignoring the presence of vessels and passing close to the vessel (National Marine Fisheries Service 1998). In the presence of approaching vessels, blue whales perform shallower dives accompanied by more frequent surfacing, but otherwise do not exhibit strong reactions (Calambokidis et al. 2009a). Minke whales in the Antarctic did not show any apparent response to a survey vessel moving at normal cruising speeds (about 12 knots [22 km/hour]) at a distance of 5.5 nm; however, when the vessel drifted or moved at very slow speeds (about 1 knot [1.8 km/hour]), many whales approached it (Leatherwood et al. 1982).

Anderward et al. (2013) investigated minke whale reactions to a temporary increase in vessel traffic off Ireland's coast in association with construction activities. They found the presence of minke whales decreased with the increase in vessel traffic and that low-frequency vessel noise was the likely cause of the displacement. The results, however, suggested "slight degrees of avoidance" to the increase in the number of vessels present instead of an "extreme displacement response" (Anderward et al. 2013). Christensen et al. (2013) observed minke whales on feeding grounds frequented by whale watching vessels and compared behavior (e.g., breathing interval), in the presence and absence of the vessels. The authors observed that the presence of whale watching vessels disturbed the feeding behavior of the minke whales, which they hypothesize could have long-term consequences for the population by reducing the energy needed for fetal development and the survival of calves.

Although not present in the Study Area, North Atlantic right whales tend not to respond to the sounds of oncoming vessels and continue to use habitats in high vessel traffic areas (Nowacek et al. 2004). Studies show that North Atlantic right whales demonstrate little if any reaction to sounds of vessels approaching or the presence of the vessels themselves (Nowacek et al. 2004, Terhune and Verboom 1999). Although this may minimize potential disturbance from passing ships, it does increase the whales' vulnerability to potential ship strike. The regulated vessel approach distance for North Atlantic right whales is 500 yd. (457 m) (National Oceanic and Atmospheric Administration 1997). It is unknown how informative observations from Atlantic right whales may be with regard to the likely behavior of North Pacific right whales.

Using historical records, Watkins (1986) showed that the reactions of four species of mysticetes to vessel traffic and whale-watching activities in Cape Cod had changed over the 25-year period examined (1957–1982). Reactions of minke whales changed from initially more positive reactions, such as coming towards the boat or research equipment to investigate, to more "uninterested" reactions towards the end of the study. Finback [fin] whales, the most numerous species in the area, showed a trend from initially more negative reactions, such as swimming away from the boat with limited surfacing, to more uninterested (ignoring) reactions allowing boats to approach within 98.4 ft. (30 m). Right whales showed little change over the study period, with a roughly equal number of reactions judged to be negative and uninterested; no right whales were noted as having positive reactions to vessels. Humpback whales showed a trend from negative to positive reactions with vessels during the study period. The author concluded that the whales had habituated to the human activities over time (Watkins 1986).

Mysticetes have been shown to both increase and decrease calling behavior in the presence of vessel noise. An increase in feeding call rates and repetition by humpback whales in Alaskan waters is associated with vessel noise (Doyle et al. 2008). Melcón et al. (2012) also recently documented that blue whales increased the proportion of time spent producing certain types of calls when vessels were present. Conversely, decreases in singing activity have been noted near Brazil due to boat traffic (Sousa-Lima and Clark 2008). The Central North Pacific stock of humpback whales is the focus of whale-watching activities in both its feeding grounds (Alaska) and breeding grounds (Hawaii). Regulations addressing minimum approach distances and vessel operating procedures are in place in Hawaii. However, there is still concern that whales may abandon preferred habitats if the disturbance is too high (Allen and Angliss 2010).

Bernasconi et al. (2012) observed the reactions of six individual baleen whales in the presence of a fishing vessel conducting an acoustic survey of pelagic fisheries. The vessel was also equipped with a system for measuring the acoustic target strength of observed whales, which was the main purpose of the experiment. During the target strength measurements, the whales were free to interact with the vessel and were sighted at distances from 50 to 400 m while behavioral observations were made. During the fisheries survey, the vessel attempted to encircle the whale at a distance of approximately 200 m while acoustically surveying for fish. The results showed that breathing intervals of feeding whales did not increase during the fisheries survey, contrary to the anticipated result, and no increase in swimming speed was observed either. The authors did note a change in the swimming direction of the whales during the fisheries survey.

Odontocetes

Sperm whales generally react only to vessels approaching within several hundred meters; however, some individuals may display avoidance behavior, such as quick diving (Magalhães et al. 2002; Wursig et al. 1998). One study showed that after diving, sperm whales showed a reduced timeframe from when they emitted the first click than before vessel interaction (Richter et al. 2006). The smaller whale-watching and research vessels generate more noise in higher frequency bands and are more likely to approach odontocetes directly, and to spend more time near the individual whale. Reactions to Navy vessels are not well documented, but smaller whale-watching and research boats have been shown to cause these species to alter their breathing intervals and echolocation patterns.

Wursig et al. (1998) reported most *Kogia* species and beaked whales react negatively to vessels by quick diving and other avoidance maneuvers. Cox et al. (2006) noted very little information is available on the behavioral impacts of vessels or vessel noise on beaked whales. A single observation of vocal disruption of a foraging dive by a tagged Cuvier's beaked whale, documented when a large noisy vessel was opportunistically present, suggests that vessel noise may disturb foraging beaked whales (Aguilar de Soto et al. 2006). Tyack et al. (2011) noted the result of a controlled exposure to pseudorandom noise suggests that beaked whales would respond to vessel noise and at similar received levels to those noted previously and for mid-frequency sonar.

Most delphinids react neutrally to vessels, although both avoidance and attraction behavior is known to occur (Anderward et al. 2013; Hewitt 1985; Wursig et al. 1998). Avoidance reactions include a decrease in resting behavior or change in travel direction (Bejder et al. 2006). Incidence of attraction includes harbor porpoises approaching a vessel and common, rough-toothed, and bottlenose dolphins bow riding and jumping in the wake of a vessel (Norris and Prescott 1961; Ritter 2002; Shane et al. 1986; Wursig et al. 1998). A study of vessel reactions by dolphin communities in the eastern tropical Pacific found that populations that were often the target of tuna purse-seine fisheries (spotted, spinner and common

dolphins) show evasive behavior when approached; however, populations that live closer to shore (within 100 nm; coastal spotted and bottlenose dolphins) that are not set on by purse-seine fisheries tend to be attracted to vessels (Archer et al. 2010a, b). The presence of vessels has also been shown to interrupt feeding behavior in delphinids (Pirotta et al. 2015, Meissner et al. 2015).

Killer whales, the largest of the delphinids, are targeted by numerous small whale-watching vessels in the Pacific Northwest, and research suggests that whale-watching guideline distances may be insufficient to prevent behavioral disturbances (Noren et al. 2009). These vessels have measured source levels that ranged from 145 to 169 dB re 1 μ Pa at 1 m, and the sound they produce underwater has the potential to result in behavioral disturbance, interfere with communication, and affect the killer whales' hearing (Erbe 2002). Killer whales foraged significantly less and traveled significantly more when boats were within 328 ft. (100 m) of the whales (Kruse 1991; Lusseau et al. 2009; Noren et al. 2009; Trites and Bain 2000; Williams et al. 2002, 2009). These short-term feeding activity disruptions may have important long-term population-level effects (Lusseau et al. 2009, Noren et al. 2009; Williams et al. 2014b). The reaction of the killer whales to whale-watching vessels may be in response to the vessel pursuing them, rather than to the noise of the vessel itself, or to the number of vessels in their proximity. Williams et al. (2014b) reported moderate responses by northern resident killer whales to large ship traffic in Johnstone Strait, Canada. The authors did caveat their work by stating the evaluation of response was highly influenced by a subjective decision about the severity score used to indicate a response.

For inland waters of Washington State, regulations were promulgated in 2011, restricting approach to within 200 yd. (182.9 m) of "whales." The approach regulations do not apply to "government vessels," which includes the U.S. Navy. Although these regulations were specifically developed to protect the endangered southern resident killer whales, the regulation reads "whales" and does not specify if it applies to only killer whales, all cetaceans, or marine mammals with a common name including the word "whale" (National Oceanic and Atmospheric Administration 2011d). Navy standard practice is to avoid approaching marine mammals head on and to maneuver to maintain a mitigation zone of 500 yd. around detected whales, which is therefore more protective than the distance provided by the regulation.

Similar behavioral changes (increases in traveling and other stress-related behaviors) have been documented in Indo-Pacific bottlenose dolphins in Zanzibar (Christiansen et al. 2010, Englund and Berggren 2002, Stensland and Berggren 2007). Short-term displacement of dolphins due to tourist boat presence has been documented (Carrera et al. 2008), while longer term or repetitive/sustained displacement for some dolphin groups due to chronic vessel noise has been noted (Haviland-Howell et al. 2007; Miksis-Olds et al. 2007). Most studies of the behavioral reactions to vessel traffic of bottlenose dolphins have documented at least short-term changes in behavior, activities, or vocalization patterns when vessels are near, although the distinction between vessel noise and vessel movement has not been made clear (Acevedo 1991; Arcangeli and Crosti 2009; Berrow and Holmes 1999; Gregory and Rowden 2001; Janik and Thompson 1996; Lusseau 2004; Mattson et al. 2005; Scarpaci et al. 2000).

Both finless porpoise (Li et al. 2008) and harbor porpoise (Polacheck and Thorpe 1990) routinely avoid and swim away from large motorized vessels. The vaquita, which is taxonomically closely related to the harbor porpoise in the Study Area, appears to avoid large vessels at about 2,995 ft. (913 m) (Jaramillo-Legorreta et al. 1999). The assumption is that the harbor porpoise would respond similarly to large Navy vessels.

Odontocetes have been shown to make short-term changes to vocal parameters such as intensity (Holt et al. 2008) as an immediate response to vessel noise, as well as increase the pitch, frequency modulation, and length of whistling (May-Collado and Wartzok 2008). Likewise, modification of multiple vocalization parameters has been shown in belugas residing in an area known for high levels of commercial traffic. These animals decreased their call rate, increased certain types of calls, and shifted upward in frequency content in the presence of small vessel noise (Lesage et al. 1999). Another study detected a measurable increase in the amplitude of their vocalizations when ships were present (Scheifele et al. 2005). Killer whales are also known to modify their calls during increased noise. For example, the source level of killer whale vocalizations was shown to increase with higher background noise levels associated with vessel traffic (the Lombard effect) (Holt et al. 2008; Hotchkin and Parks 2013). In addition, killer whale calls with a high-frequency component had higher source levels than other calls, which may be related to behavioral state, or may reflect a sustained increase in background noise levels (Holt et al. 2011). On the other hand, long-term modifications to vocalizations may be indicative of a learned response to chronic noise, or of a genetic or physiological shift in the populations. This type of change has been observed from killer whales off the northwestern coast of the United States between 1973 and 2003. This population increased the duration of primary calls once a threshold in observed vessel density (e.g., whale watching) was reached, which has been suggested as a long-term response to increased masking noise produced by the vessels (Foote et al. 2004).

Pinnipeds

Little is known about pinniped reactions to underwater non-impulsive sounds (Southall et al. 2007), including vessel noise. In a review of reports on reactions of pinnipeds to small craft and ships, Richardson et al. (1995) note that information on pinniped reactions is limited and most reports are based on anecdotal observations. Specific case reports in Richardson et al. (1995) vary based on factors such as routine anthropogenic activity, distance from the vessel, engine type, wind direction, and ongoing subsistence hunting. As with reactions to sound reviewed by Southall et al. (2007), pinniped responses to vessels are affected by the context of the situation and by the animal's experience. In summary, pinniped reactions to vessels are variable; reports include a wide entire spectrum of possibilities, from avoidance and alert to cases where animals in the water are attracted and cases on land where there is lack of significant reaction suggesting "habituation" or "tolerance" of vessels (Richardson et al. 1995). Anderward et al. (2013) investigated grey seal reactions to an increase in vessel traffic off Ireland's coast in association with construction activities, and their data suggests the number of vessels had an indeterminate effect on the seals' presence.

A study of reactions of harbor seals hauled out on ice to cruise ship approaches in Disenchantment Bay, Alaska, revealed that animals are more likely to flush and enter the water when cruise ships approach within 1,640 ft. (500 m) and four times more likely when the cruise ship approaches within 328 ft. (100 m) (Jansen et al. 2010). Navy vessels would generally not operate in vicinity of nearshore natural areas that are pinniped haulout or rookery locations.

Sea Otters

Sea otters depend on visual acuity to forage, and their eyes are able to focus both in air and under water (Riedman and Estes 1990). Davis et al. (1988) conducted the one identified study of southern sea otter's reactions to various underwater and in-air acoustic stimuli. The purpose of the study was to identify a means to purposefully move sea otters from a location in the event of an oil spill. Anthropogenic sound sources used in this behavioral response study included truck air horns and an acoustic harassment

device (10–20 kHz at 190 dB⁵; designed to keep dolphins and pinnipeds from being caught in fishing nets). The authors found that the sea otters often remained undisturbed, quickly became tolerant of the various sounds, and even when the desired response occurred (chased from a location) by the presence of a harassing sound, they generally moved only a short distance (110–220 yd. [100–200 m]) before resuming normal activity.

Behavioral Reactions to Aircraft and Missile Overflights

The following paragraphs summarize what is known about the reaction of various marine mammal species to overhead flights of many types of fixed-wing aircraft, helicopters, and missiles. No re-analysis of impacts associated with aircraft and missile overflights is necessary in this Supplemental EIS/OEIS. The information is presented here, given the re-analysis of underwater acoustic stressors, incorporates the potential for marine mammals to avoid areas of high-intensity aircraft activity or hovering helicopters, as would occur during Carrier Strike Group training (see Chapter 2, Table 2.3-1). Thorough reviews of the subject and available information are presented in Richardson et al. (1995), Efroymson et al. (2001), Luksenburg and Parsons (2009), and Holst et al. (2011), including that the transmission of airborne sound into the water is generally limited to a narrow, approximately 26-degree cone described by Snell's law. The most common responses of cetaceans to overflights were short surfacing durations, abrupt dives, and percussive behavior (breaching and tail slapping) (Nowacek et al. 2007). Other behavioral responses such as flushing and fleeing the area of the source of the noise have also been observed (Holst et al. 2011, Mancini et al. 1988). Richardson et al. (1995) noted that marine mammal reactions to aircraft overflight largely consisted of opportunistic and anecdotal observations lacking clear distinction between reactions potentially caused by the noise of the aircraft and the visual cue an aircraft presents. In addition, it was suggested that variations in the responses noted were due to generally other undocumented factors associated with overflight (Richardson et al. 1995). These factors could include aircraft type (single engine, multi-engine, jet turbine), flight path (centered on the animal, off to one side, circling, level and slow), environmental factors such as wind speed, sea state, cloud cover, and locations where native subsistence hunting continues.

Mysticetes

Mysticetes either ignore or occasionally dive in response to aircraft overflights (Koski et al. 1998; Efroymson et al. 2001). Richardson et al. (1995) reported that while data on the reactions of mysticetes is meager and largely anecdotal, there is no evidence that single or occasional aircraft flying above mysticetes causes long-term displacement of these mammals. In general, overflights above 1,000 ft. (305 m) do not cause a reaction, and NOAA has promulgated a regulation for Hawaiian Waters and the Hawaii Humpback Whale National Marine Sanctuary adopting this stand-off distance. For right whales, the stand-off distance for aircraft is 500 yd. (427 m) (National Marine Fisheries Service 2001b).

Bowhead whales in the Beaufort Sea exhibited a transient behavioral response to fixed-wing aircraft and vessels. Reactions were frequently observed at less than 1,000 ft. (305 m) above sea level, infrequently observed at 1,500 ft. (457 m), and not observed at 2,000 ft. (610 m) above sea level (Richardson et al. 1995). Bowhead whales reacted to helicopter overflights by diving, breaching, changing direction or behavior, and altering breathing patterns. Behavioral reactions decreased in frequency as the altitude of the helicopter increased to 492 ft. (150 m) or higher. It should be noted that bowhead whales may have more acute responses to anthropogenic activity than many other marine mammals since these animals are often presented with limited egress due to limited open water between ice floes. Additionally, many

⁵ Note that reference units for this dB level were not provided in the citation. It is assumed that the reference intended it to be 190 dB re 1µ Pa as an underwater sound level.

of these animals may be hunted by Native Alaskans, which could lead to animals developing additional sensitivity to human noise and presence.

Odontocetes

Variable responses to aircraft have been observed in toothed whales, though overall little change in behavior has been observed during flyovers. Some toothed whales dove, slapped the water with their flukes or flippers, or swam away from the direction of the aircraft during overflights; others did not visibly react (Richardson et al. 1995).

During standard marine mammal surveys at an altitude of 750 ft. (229 m), some sperm whales remained on or near the surface the entire time the aircraft was in the vicinity, while others dove immediately or a few minutes after being sighted. Other authors have corroborated the variability in sperm whales' reactions to fixed-wing aircraft or helicopters (Green et al. 1992; Richter et al. 2003, 2006; Smultea et al. 2008a; Wursig et al. 1998). In one study, sperm whales showed no reaction to a helicopter until they encountered the downdrafts from the rotors (Richardson et al. 1995). A group of sperm whales responded to a circling aircraft (altitude of 800–1,100 ft. [244–335 m]) by moving closer together and forming a defensive fan-shaped semicircle, with their heads facing outward. Several individuals in the group turned on their sides, apparently to look up toward the aircraft (Smultea et al. 2008a). Whale-watching aircraft apparently caused sperm whales to turn more sharply but did not affect blow interval, surface time, time to first click, or the frequency of aerial behavior (Richter et al. 2003). Navy aircraft do not fly at low altitude, hover over, or follow whales and so are not expected to evoke this type of response.

Smaller delphinids generally react to overflights either neutrally or with a startle response (Wursig et al. 1998). The same species that show strong avoidance behavior to vessel traffic (*Kogia* species and beaked whales) also react to aircraft (Wursig et al. 1998). Beluga whales reacted to helicopter overflights by diving, breaching, changing direction or behavior, and altering breathing patterns to a greater extent than mysticetes in the same area (Patenaude et al. 2002). These reactions increased in frequency as the altitude of the helicopter dropped below 492 ft. (150 m).

Pinnipeds

Richardson et al. (1995) noted that data on pinniped reactions to aircraft overflight largely consisted of opportunistic and anecdotal observations. Richardson et al.'s (1995) summary of this variable data note that responsiveness generally was dependent on the altitude of the aircraft, the abruptness of the associated aircraft sound, and life cycle stage (e.g., breeding and molting). Hauled out pinnipeds exposed to aircraft sight and/or sound often react by becoming alert and in many cases rushing into the water. Stampedes resulting in mortality to pups (by separation or crushing) have been noted in some cases, although it is rare (Holst et al. 2011 provides an up-to-date review of this subject).

Helicopters are used in studies of several species of seals hauled out and are considered an effective means of observation (Bester et al. 2002, Gjertz and Børset 1992), although they have been known to elicit behavioral reactions such as fleeing (Hoover 1988). In other studies, harbor seals showed no reaction to helicopter overflights (Gjertz and Børset 1992).

Ringed seals near an oil production island in Alaska reacted to approaching Bell 212 helicopters generally by increasing vigilance, although one seal left their basking site for the water after a helicopter approached within approximately 328 ft. (100 m) (Blackwell et al. 2004). Seals in the study near an oil

production platform were thought to be habituated and showed no reactions to industrial noise in water or in air, including impact pipe-driving, during the rest of the observations.

For California sea lions and Steller sea lions at a rocky haulout off Crescent City in northern California, helicopter approach to landing typically caused the most severe response (National Oceanic and Atmospheric Administration 2010a). Responses were also dependent on the species with Steller sea lions being more “skittish” and California sea lions more tolerant. The timing between subsequent approaches affected the number of animals hauled out in between exposures and fewer animals reacted upon subsequent exposures (National Oceanic and Atmospheric Administration 2010a).

Pinnipeds reactions to rocket launches and overflight at San Nicolas Island (California) are studied annually pursuant to the Navy’s Incidental Harassment Authorization covering that testing. For the time period of August 2001–October 2008 (and consistent with other reports), Holst et al. (2011) documented that behavioral reactions differed between species. California sea lions startled and increased vigilance for up to 2 minutes after a rocket overflight, with some individuals moving down the beach or returning to the water. Northern elephant seals showed little reaction to any overflight. Harbor seals had the most pronounced reactions of the three species observed with most animals within approximately 2.5 mi. (4 km) of the rocket trajectory leaving their haulout sites for the water and not returning for several hours. The authors concluded that the effects of the rocket launches were minor with no effects on local populations, evidenced by the increasing populations of pinnipeds on San Nicolas Island (Holst et al. 2011).

Sea Otters

There is no specific information available indicating that overflights of any kind have an impact on sea otters. Fixed-wing aerial surveys are often recommended as a means to monitor populations of sea otter. There has been no evidence that any aircraft or missile overflight has had adverse effects on the translocated colony of sea otters at the Navy’s San Nicolas Island located off the coast of Southern California (U.S. Department of the Navy 2002; U.S. Fish and Wildlife Service 2011).

3.8.3.1.2.7 Repeated Exposures

Repeated exposures of an individual to multiple sound-producing activities over a season, year, or life stage could cause reactions with costs that can accumulate over time to cause long-term consequences for the individual. Conversely, some animals habituate to or become tolerant of repeated exposures over time, learning to ignore a stimulus that in the past has not accompanied any overt threat.

Repeated exposure to acoustic and other anthropogenic stimuli has been studied in several cases, especially as related to vessel traffic and whale watching. Common dolphins in New Zealand responded to dolphin-watching vessels by interrupting foraging and resting bouts, and took longer to resume behaviors in the presence of the vessel (Stockin et al. 2008). The authors speculated that repeated interruptions of the dolphins foraging behaviors could lead to long-term implications for the population. Bejder et al. (2006) studied responses of bottlenose dolphins to vessel approaches and found stronger and longer-lasting reactions in populations of animals that were exposed to lower levels of vessel traffic overall. The authors indicated that lesser reactions in populations of dolphins regularly subjected to high levels of vessel traffic could be a sign of habituation, or it could be that the more sensitive animals in this population previously abandoned the area of higher human activity.

Marine mammals exposed to high levels of human activities may leave the area, habituate to the activity, or tolerate the disturbance and remain in the area. Marine mammals that are more tolerant

may stay in a disturbed area, whereas individuals that are more sensitive may leave for areas with less human disturbance. However, animals that remain in the area throughout the disturbance may be unable to leave the area for a variety of physiological or environmental reasons. Terrestrial examples of this abound as human disturbance and development displace more sensitive species, and tolerant animals move in to exploit the freed resources and fringe habitat. Longer-term displacement can lead to changes in abundance or distribution patterns of the species in the affected region if they do not become acclimated to the presence of the sound (Bejder et al. 2006, Blackwell et al. 2004, Teilmann et al. 2006). Gray whales in Baja California abandoned an historical breeding lagoon in the mid-1960s due to an increase in dredging and commercial shipping operations. Whales did repopulate the lagoon after shipping activities had ceased for several years (Bryant et al. 1984).

Over a shorter time scale, studies on the Atlantic Undersea Test and Evaluation Center (AUTEC) instrumented range in the Bahamas have shown that some Blaineville's beaked whales may be resident during all or part of the year in the area, and that individuals may move off of the range for several days during and following a sonar event. However animals are thought to continue feeding at short distances (a few kilometers) from the range out of the louder sound fields (less than 157 dB re 1 μ Pa) (McCarthy et al. 2011, Tyack et al. 2011). Mysticetes in the northeast tended to adjust to vessel traffic over a number of years, trending towards more neutral responses to passing vessels (Watkins 1986), indicating that some animals may habituate or otherwise learn to cope with high levels of human activity. Nevertheless, the long-term consequences of these habitat utilization changes are unknown, and likely vary depending on the species, geographic areas, and the degree of acoustic or other human disturbance.

Moore and Barlow (2013) have noted a decline in beaked whales in a broad area of the Pacific Ocean area out to 300 nm from the coast and extending from the Canadian-U.S. border to the tip of Baja Mexico. There are scientific caveats and limitations to the data used for that analysis, as well as oceanographic and species assemblage changes not thoroughly addressed in Moore and Barlow (2013) although the authors suggest Navy sonar as one possible explanation for the apparent decline in beaked whale numbers over that broad area. Interestingly, however, in the small portion of the Pacific coast overlapping the Navy's SOCAL Range Complex, long-term residency by individual Cuvier's beaked whales and documented higher densities of beaked whales provide indications that the proposed decline in numbers elsewhere along the Pacific coast is not apparent where the Navy has been intensively training and testing with sonar and other systems for decades. While it is possible that a downward trend in beaked whales over the Pacific Coast may have gone unnoticed at the range complex (due to a lack of survey precision) or that beaked whale densities may have been higher before the Navy began using sonar more than 60 years ago, there is no data to suggest that beaked whale numbers have declined on the range where Navy sonar use has routinely occurred. As Moore and Barlow (2013) point out, it remains clear that the Navy range in Southern California continues to support high densities of beaked whales and that high densities, specifically where the Navy trains and tests with sonar, are not consistent with their hypothesis that the declines noted for the Pacific Coast are due to "military sonar."

Due to sonar training in the TMAA occurring at most twice a year, for a total of 42 days between April and October, and given the dynamic movement of the training event participants, sonar exposures should not be acute or chronic. NMFS agrees that the vast majority of impacts expected from sonar exposure and underwater detonations are behavioral in nature, temporary and comparatively short in duration, relatively infrequent, and not of the type or severity that would be expected to be additive for the small portion of the stocks and species likely to be exposed (National Marine Fisheries Service 2014, 2015).

3.8.3.1.2.8 Stranding

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 and Lounsbury 2005, Geraci et al. 1999). Animals outside of their “normal” habitat are also sometimes considered “stranded” even though they may not have beached themselves. Under the U.S. law, a stranding is an event in the wild that meets any of the following criteria: “(A) 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 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 Section 1421h).

Marine mammals are subjected to a variety of natural and anthropogenic factors, acting alone or in combination, which may cause a marine mammal to strand on land or die at-sea (Geraci and Lounsbury 2005, Geraci et al. 1999). Barbieri et al. (2013) state that “disease is a major mortality factor for many marine mammal species and has been the cause of numerous mortality events worldwide.” Natural factors related to strandings include, for example, the availability of food, predation, disease, parasitism, climatic influences, and aging (Bradshaw et al. 2006, Culik 2002, Geraci and Lounsbury 2005, Geraci et al. 1999, Hoelzel 2003, National Research Council 2006, Perrin and Geraci 2002, Walker et al. 2005). Anthropogenic factors include, for example, pollution (Elfes et al. 2010; Hall et al. 2006a, b; Jepson et al. 2005a; Marine Mammal Commission 2010; Tabuchi et al. 2006), vessel strike (Berman-Kowalewski et al. 2010, de Stephanis and Urquiola 2006, Geraci and Lounsbury 2005, Jensen and Silber 2003, Laist et al. 2001), fisheries interactions (Look 2011, Read et al. 2006), entanglement (Baird and Gorgone 2005, Johnson and Allen 2005, Saez et al. 2013), and noise (Cox et al. 2006, National Research Council 2003, Richardson et al. 1995).

Along the coasts of the continental United States and Alaska between 2001 and 2009, there were on average approximately 1,400 cetacean strandings and 4,300 pinniped strandings (5,700 total) per year (National Marine Fisheries Service 2011a, b, c). Even for the fractions of more thoroughly investigated strandings involving post-stranding data collection and necropsies, the cause (or causes) for the majority of strandings remain undetermined.

For example, because the number of harbor porpoise strandings in the northwest had been increased beginning in 2003 and through 2006, an Unusual Mortality Event in the Pacific Northwest was declared by NMFS (see U.S. Department of the Navy [2013c], Cetacean Stranding Report for more detail on this Unusual Mortality Event). The harbor porpoise stranding numbers continued to increase each year; between 2003 and 2013, with the Northwest Marine Mammal Stranding Network documenting a total of 255 harbor porpoise strandings in Washington’s inland waters over that 10-year period (Barre 2014). It was, however, recently determined, “that this was not an actual mortality event but was likely the result of a combination of factors, including: (1) a growing population of harbor porpoises; (2) expansion of harbor porpoises into previously sparsely populated areas in Washington’s inland waters; and (3) a more well established stranding network that resulted in better reporting and response.” (Huggins et al. 2015).

In 2013, NMFS declared an Unusual Mortality Event due to large numbers of emaciated sea lion pups that had stranded that year in Southern California, which has continued into 2015. NMFS biologists indicated that warmer ocean temperatures have shifted the location of prey species that are no longer

adjacent to the rookeries, which thereby impacted the female sea lions' ability to find food for their pups (National Oceanic and Atmospheric Administration 2015a). As a result, this confluence of natural events causes the pups to leave the rookeries on their own, and many are subsequently found stranded dead or emaciated due to starvation from the naturally occurring events.

In May 2015 and through part of that summer, 11 fin whales, 14 humpback whales, 1 gray whale, and 4 unidentified cetaceans (unidentified because of their state of decomposition) were found around the islands of the western Gulf of Alaska and the southern shoreline of the Alaska Peninsula (National Oceanic and Atmospheric Administration 2015f, 2016). National Oceanic and Atmospheric Administration has declared this an Unusual Mortality Event. Like almost all stranding events, the cause of this stranding event is currently unknown. An investigation by NOAA is underway to try to determine the cause. It was clear from the dates of discovery and/or the carcass conditions that these strandings are not attributable to Navy activities because the Navy initiated its activities three weeks after the strandings were discovered. A comprehensive study by Lefebvre et al. (2016) of stranded animals found in Alaska between 2004 and 2013 found detectable concentrations of domoic acid in all 13 species, and saxitoxin, a toxin absorbed from ingesting dinoflagellates, in 10 of the 13 species. Algal toxins were investigated as a possible contributor to the 2015 large whale unusual mortality event, but the carcasses were too degraded by the time they were found to produce useful test results and in most cases were not sampled.

Several "mass stranding" events—strandings that involve two or more individuals of the same species (excluding a single cow-calf pair)—that have occurred over the past two decades have been associated with naval operations, seismic surveys, and other anthropogenic activities that introduced sound into the marine environment. An in-depth discussion of strandings is presented in the Navy's *Marine Mammal Strandings Associated with U.S. Navy Sonar Activities* (U.S. Department of the Navy 2013c).

Sonar use during exercises involving U.S. Navy (most often in association with other nations' defense forces) has been identified as a contributing cause or factor in five specific stranding events: Greece in 1996; the Bahamas in March 2000; Madeira Island, Portugal in 2000; the Canary Islands in 2002, and Spain in 2006 (Marine Mammal Commission 2006). These five mass stranding events resulted in about 40 known stranding deaths among cetaceans, consisting mostly of beaked whales, with a potential causal link to sonar (International Council for the Exploration of the Sea 2005a, b). The previously discussed U.S. Navy-funded research involving behavioral response studies in Southern California and the Bahamas (see Section 3.8.3.1.2.6, Behavioral Reactions) was motivated by the desire to understand any links between the use of mid-frequency sonar and cetacean behavioral responses, including the potential for strandings.

Exposure to non-impulsive acoustic energy has been considered a potential indirect cause of the death of marine mammals (Cox et al. 2006). One hypothesis is that strandings may result from tissue damage caused by "gas and fat embolic syndrome" (Fernández et al. 2005; Jepson et al. 2003, 2005b). Models of nitrogen saturation in diving marine mammals have been used to suggest that altered dive behavior might result in the accumulation of nitrogen gas such that the potential for nitrogen bubble formation is increased (Houser et al. 2001a, b; Zimmer and Tyack 2007). If so, this mechanism might explain the findings of gas and bubble emboli in stranded beaked whales. It is also possible that stranding is a behavioral response to a sound under certain contextual conditions and that the subsequently observed physiological effects (e.g., overheating, decomposition, or internal hemorrhaging from being on shore) were the result of the stranding rather than direct physical impact from exposure to sonar (Cox et al. 2006).

As International Council for the Exploration of the Sea (2005b) noted, taken in context of marine mammal populations in general, sonar is not a major threat, or significant portion of the overall ocean noise budget. This has also been demonstrated by monitoring in areas where Navy operates (Bassett et al. 2010, Baumann-Pickering et al. 2010, Hildebrand et al. 2011, McDonald et al. 2006, Tyack et al. 2011). Regardless of the direct cause, the Navy considers potential sonar related strandings important and continues to fund research and work with scientists to better understand circumstances that may result in strandings.

On 4 March 2011 at the Silver Strand Training Complex (San Diego, California), three long-beaked common dolphins were found dead immediately after an underwater detonation associated with a Navy training event.⁶ In addition to the three dolphin mortalities at the detonation site, the remains of a fourth dolphin were discovered 3 days later approximately 42 mi. (68 km) north of the training event location (Danil and St. Ledger 2011; approximately Oceanside, California). It is not known when this fourth dolphin died, but certainly sometime between the training event and the discovery at the stranding location. Location details, such as individual dolphins' depth and distance from the explosive at the time of detonation, could not be estimated from the 250 yd. (229 m) standoff point of the observers in the dive boat or the safety boat.

These dolphin mortalities are the only known occurrence of a U.S. Navy training event involving impulsive energy (underwater detonation) that has resulted in injury to a marine mammal. Despite this being a rare occurrence, the Navy has reviewed training requirements, safety procedures, and potential mitigation measures and, along with NMFS, is determining appropriate changes to implement to reduce the potential for this to occur in the future. Discussions of procedures associated with these and other training events are presented in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring), which details all mitigations.

In comparison to potential strandings or injury resulting from events associated with Navy activities, marine mammal strandings and injury from commercial vessel ship strike (e.g., Berman-Kowalewski et al. 2010, Silber et al. 2010), impacts from urban pollution (e.g., Hooker et al. 2007, Murata et al. 2009, O'Shea and Brownell 1997), and annual fishery-related entanglement, bycatch, injury, and mortality to cetaceans and pinnipeds (e.g., Baird and Gorgone 2005, Forney and Kobayashi 2007, Saez et al. 2013; Carretta et al. 2013b) that have been estimated worldwide to be orders of magnitude greater than the few potential injurious impacts that could be possible as a result of Navy activities (hundreds of thousands of animals versus 3 animals under Alternative 2 for example) (Culik 2002, International Council for the Exploration of the Sea 2005b, Read et al. 2006). This does not negate the potential influence of mortality or additional stressor to small, regionalized sub-populations that may be at greater risk from human-related mortalities (fishing, vessel strike, sound) than populations with larger oceanic level distributions, but overall the Navy's impact in the oceans and inland water areas where training and testing occurs is small in comparison to other human activities.

⁶ During this underwater detonation training event, which is not a proposed activity in the Study Area, a pod of 100–150 dolphins were observed moving toward the explosive event's 700 yd. (640 m) exclusion zone monitored by a personnel in a safety boat and participants in a dive boat. Within the exclusion zone, approximately 5 minutes remained on a timed fuse connected to a single 8.76 lb. (3.97 kg) explosive charge weight (C-4 and detonation cord) set at a depth of 48 ft. (72.7 m), approximately 0.5–0.75 nm from shore. Although the dive boat was placed between the pod and the explosive in an effort to guide the dolphins away from the area, that effort was unsuccessful.

3.8.3.1.3 Long-Term Consequences to the Individual and the Population

Long-term consequences to a population are determined by examining changes in the population growth rate. Individual effects that could lead to a reduction in the population growth rate include mortality or injury (that removes animals from the reproductive pool), loss in hearing sensitivity (which depending on severity could impact navigation, foraging, predator avoidance, or communication), chronic stress (which could make individuals more susceptible to disease), displacement of individuals (especially from preferred foraging or mating grounds), and disruption of social bonds (due to masking of conspecific signals or displacement). However, the long-term consequences of any of these effects are difficult to predict because individual experience and time can create complex contingencies, especially for intelligent, long-lived animals like marine mammals. While a lost reproductive opportunity could be a measureable cost to the individual, the outcome for the animal, and ultimately the population, can range from insignificant to significant. Any number of factors, such as maternal inexperience, years of poor food supply, or predator pressure, could produce a cost of a lost reproductive opportunity, but these events may be “made up” during the life of a normal healthy individual. The same holds true for exposure to human-generated sound sources. These biological realities must be taken into consideration when assessing risk, uncertainties about that risk, and the feasibility of preventing or recouping such risks. All too often, the long-term consequence of relatively trivial events like short-term masking of a conspecific’s social sounds, or a single lost feeding opportunity, is exaggerated beyond its actual importance by focus on the single event and not the important variable, which is the individual and its lifetime parameters of growth, reproduction and survival.

The linkage between a stressor such as sound and its immediate behavioral or physiological consequences for the individual, and then the subsequent effects on that individual’s vital rates (growth, survival and reproduction), and the consequences, in turn, for the population have been reviewed in National Research Council (2005). The Population Consequences of Acoustic Disturbance (PCAD) model (see National Research Council 2005) proposed a quantitative methodology for determining how changes in the vital rates of individuals (i.e., a biologically significant consequence to the individual) translate into biologically significant consequences to the population. In 2009, the U.S. Office of Naval Research set up a working group to transform the PCAD framework into mathematical model and include other stressors potentially causing disturbance in addition to noise. The model, now called Population Consequences of Disturbance (PCoD), has been used for case studies involving bottlenose dolphins, North Atlantic right whales, beaked whales, and southern elephant seals (Harwood and King 2014; Hatch et al. 2012; King et al. 2015; New et al. 2013a, 2013b, 2014), but the model is still in the preliminary stages of development.

Population models are well known from many fields in biology including fisheries and wildlife management. These models accept inputs for the population size and changes in vital rates of the population such as the mean values for survival age, lifetime reproductive success, and recruitment of new individuals into the population. The time-scale of the inputs in a population model for long-lived animals such as marine mammals is on the order of seasons, years, or life stages (e.g., neonate, juvenile, reproductive adult), and are often concerned only with the success of individuals from one time period or stage to the next. Unfortunately, for acoustic and explosive impacts to marine mammal populations, many of the inputs required by population models are not known.

Establishing a causal link between anthropogenic noise, animal communication, and individual impacts as well as population viability will be difficult to quantify and assess (McGregor et al. 2013; Reed et al. 2014). Reed et al. (2014) for instance reviewed select terrestrial literature on individual and population

response to sound as well as discuss a necessary framework in order to assess future direct and indirect fitness impacts. The difficulty with assessing marine behavioral noise effects individually and cumulatively is the confounding nature of the issue where there may or may not be indirect effects with a complex interactive dependence based on age class, prior experience, and behavioral state at the time of exposure, as well as influences by other non-sound related factors (Ellison et al. 2011; Knight and Swaddle 2011; Goldbogen et al. 2013; McGregor et al. 2013; Reed et al. 2014; Williams et al. 2014). McGregor et al. (2013) summarized some studies on sound impacts and described two types of possible effects based on the studies they reviewed: 1) an apparent effect of noise on communication, but with a link between demonstrated proximate cost and ultimate cost in survival or reproductive success being inferred rather than demonstrated, and 2) studies showing a decrease in population density or diversity in relation to noise, but with a relationship that is usually a correlation, so factors other than noise or its effect on communication might account for the relationship (McGregor et al. 2013). Within the ocean environment, there is a complex interaction of considerations needed in terms of defining cumulative anthropogenic impacts that has to also be considered in context of natural variation and climate change (Boyd and Hutchins 2012). These can include environmental enhancers that improve fitness, additive effects from two or more factors, multiplicity where response from two or more factors is greater than the sum of individual effects, synergism between factors and response, antagonism as a negative feedback between factors, acclimation as a short-term individual response, and adaptation as a long-term population change (Boyd and Hutchins 2012). To address determination of cumulative effects and responses change due to processes such as habituation, tolerance, and sensitization, future experiments over an extended period of time still need further research (Bejder et al. 2009, Blickley et al. 2012, Reed et al. 2014).

Claridge (2013) studied differences in Blainsville's beaked whale abundance and demographics between two sites in the Bahamas. One site was a Navy range regularly used for sonar exercises (AUTEC), and the other site was located in an area without regular military sonar use (Abaco). The sites were located 170 km apart and differed in bathymetry and potentially productivity. Fewer beaked whales were present and the female to calf ratio was lower at the AUTEC site. Claridge (2013) hypothesized that low birth recruitment at AUTEC could be due to chronic stress from sonar exposure, but also hypothesized that lower abundance at the AUTEC site could be due to lower productivity at AUTEC compared to Abaco due to differences in upwelling. Turnover (the portion of animals that emigrate then return to an area) was estimated to be similar for both sites. Claridge (2013) also conducted a long-term population study at Abaco, which included periods before and after a beaked whale stranding event attributed to exposure to a mid-frequency hull-mounted sonar exercise in 2000. No change in population dynamics was noted at the Abaco site in the years following that stranding event.

In an effort to understand beaked whale responses to stressors, New et al. (2013b) developed a mathematical model simulating a functional link between foraging energetics and requirements for survival and reproductions for 21 species of beaked whale. The simulations in this first order attempt at a population model suggested that adults will survive but not reproduce if anthropogenic disturbances resulted in them being displaced to areas of "impaired foraging."

Ecological modeling provides an important tool for exploring the properties of an animal's use of the environment and the factors that drive or contribute to survivorship and reproduction. The ability of any model to accurately predict real ecological processes is partly dictated by the ability of the modeler to correctly parameterize the model and incorporate assumptions that do not violate real-world conditions. Assumptions and parameters identified by New et al. (2013b) that likely have a large effect on the model output include the period of reproduction (i.e., inter-calf interval) and prey selection (i.e.,

energy acquisition). Although New et al. (2013b) concluded that anthropogenic disturbances might impair foraging through animal displacement and ultimately impact reproduction, the parameter values need to be revisited, as do assumptions that habitat capable of sustaining a beaked whale is limited in proximity to where any disturbance has occurred (i.e., beaked whales are likely not always in the most optimal foraging location).

While the New et al. (2013b) model provides a test case for future research, the model has little of the critical data necessary to form conclusions applicable to current management decisions. The Navy continues to fund the behavioral response studies in the Bahamas and Southern California specifically to better understand, via direct field observations, the potential for anthropogenic activities to disturb marine mammals. In cooperation with NMFS, the Navy will continue to develop the most effective management and conservation actions needed to protect marine mammals while accomplishing the Navy's mission to train and test safely and effectively.

The best assessment of long-term consequences from training activities will be to monitor the populations over time within the Study Area. A recent U.S. workshop on Marine Mammals and Sound (Fitch et al. 2011) indicated a critical need for baseline biological data on marine mammal abundance, distribution, habitat, and behavior over sufficient time and space to evaluate impacts from human-generated activities on long-term population survival. The Navy has developed monitoring plans for protected marine mammals and sea turtles occurring on Navy ranges and within the TMAA with the goal of assessing the impacts of training and testing activities on marine species and the effectiveness of the Navy's current mitigation practices. Continued monitoring efforts over time will be necessary to begin to completely evaluate the long-term consequences of exposure to sound sources.

3.8.3.1.4 Thresholds and Criteria for Predicting Acoustic and Explosive Impacts on Marine Mammals

If proposed Navy activities introduce sound or explosive energy into the marine environment, an analysis of potential impacts to marine mammals is conducted. To do this, information about the numerical sound and energy levels that are likely to elicit certain types of physiological and behavioral reactions is needed.

3.8.3.1.4.1 Frequency Weighting

Frequency-weighting functions are used to adjust the received sound level based on the sensitivity of the animal to the frequency of the sound. The weighting functions de-emphasize sound exposures at frequencies to which marine mammals are not particularly sensitive. This effectively makes the acoustic thresholds frequency-dependent, which means they are applicable over a wide range of frequencies and therefore applicable for a wide range of sound sources. Frequency-weighting functions, deemed "M-weighting" functions by Southall et al. (2007), were proposed to account for the frequency bandwidth of hearing in marine mammals. These M-weighting functions were derived for each marine mammal hearing group based on an algorithm using the range of frequencies that are within 80 dB of an animal or group's best hearing sensitivity at any frequency (Southall et al. 2007). The Southall et al. (2007) M-weighting functions are nearly flat between the lower and upper cutoff frequencies, and thus were believed to represent a conservative approach to assessing the effects of sound (Figure 3.8-11). For the purposes of this analysis, the Navy will refer to these as Type I auditory weighting functions. Otariid seal thresholds and weighting functions were applied to sea otter as described in Finneran and Jenkins (2012).

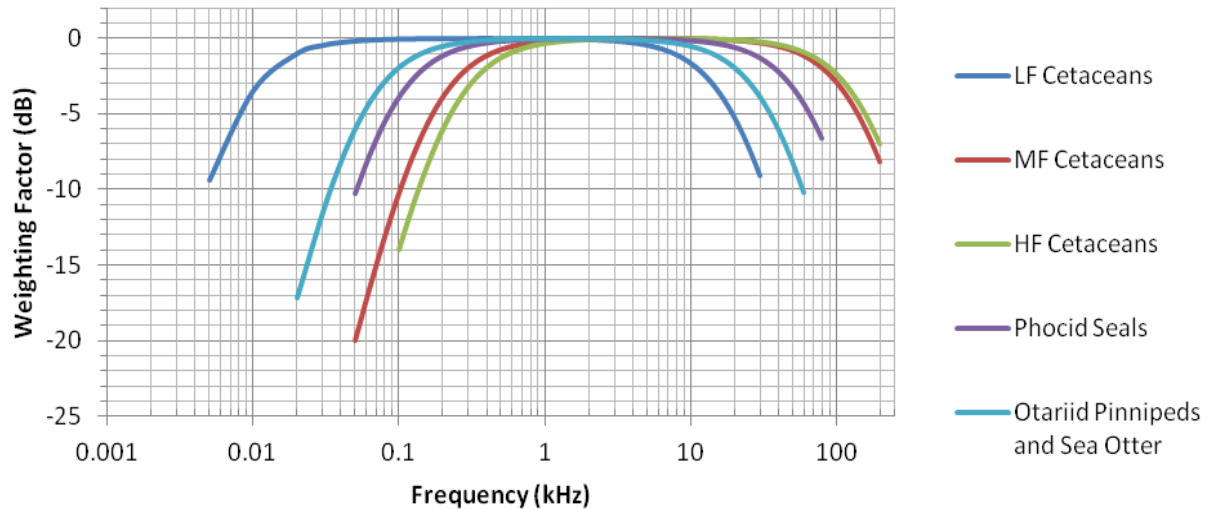


Figure 3.8-11: Type I Auditory Weighting Functions Modified from the Southall et al. (2007) M-Weighting Functions

Finneran and Jenkins (2012) considered data since Southall et al. (2007) to determine if any adjustments to the weighting functions were appropriate. Only two published experiments suggested that modification of the mid-frequency cetacean auditory weighting function was necessary (see Finneran and Jenkins [2012] for more details on that modification not otherwise provided below). The first experiment measured TTS in a bottlenose dolphin after exposure to pure tones with frequencies from 3 to 28 kHz (Finneran et al. 2010). These data were used to derive onset-TTS values as a function of exposure frequency and demonstrate that the use of a single numeric threshold for onset-TTS, regardless of frequency, is not correct. The second experiment examined how subjects perceived the loudness of sounds at different frequencies to derive equal loudness contours (Finneran and Schlundt 2011).

Frequency Weighting Example:

A common dolphin, a mid-frequency cetacean (Section 3.8.2.3.2), receives a 10 kHz ping from a sonar with a sound exposure level of 180 dB re 1 $\mu\text{Pa}^2\text{-s}$. To discern if this animal may suffer a TTS, the received level must first be adjusted using the appropriate Type II auditory weighting function for mid-frequency cetaceans (Section 3.8.2.3.2). At 10 kHz, the weighting factor for mid-frequency cetaceans is -3 dB, which is then added to the received level (180 dB re 1 $\mu\text{Pa}^2\text{-s}$ + (-3 dB) = 177 dB re 1 $\mu\text{Pa}^2\text{-s}$) to yield the weighted received level. This is compared to the Non-Impulsive Mid-Frequency Cetacean TTS threshold (178 dB re 1 $\mu\text{Pa}^2\text{-s}$; see Table 3.8-3). Since the adjusted received level is less than the threshold, TTS is not likely for this animal from this exposure.

These data are important because human auditory weighting functions are based on equal loudness contours. The dolphin equal loudness contours provide a means to generate auditory weighting functions in a manner directly analogous to the approach used to develop safe exposure guidelines for people working in noisy environments (National Institute for Occupational Safety and Health 1998).

Taken together, the recent higher-frequency TTS data and equal loudness contours provide the underlying data necessary to develop new weighting functions, referred to as Type II auditory weighting functions, to improve accuracy and avoid underestimating the impacts on animals at higher frequencies as shown on Figure 3.8-12. To generate the new Type II weighting functions, Finneran and Schlundt

(2011) substituted lower and upper frequency values, which differ from the values used by Southall et al. (2007). The new Type II weighting curve predicts appreciably higher susceptibility for frequencies above 3 kHz. Since data below 3 kHz are not available, the original Type I weighting functions from Southall et al. (2007) were substituted below this frequency. Low- and high-frequency cetacean weighting functions were extrapolated from the dolphin data as well because of the suspected similarities of greatest susceptibility at best frequencies of hearing. Similar type II weighting curves were not developed for pinnipeds because their hearing is markedly different from cetaceans and they do not hear as well at higher frequencies; therefore, their weighting curves did not require the same adjustment (see Finneran and Jenkins 2012 for additional details).

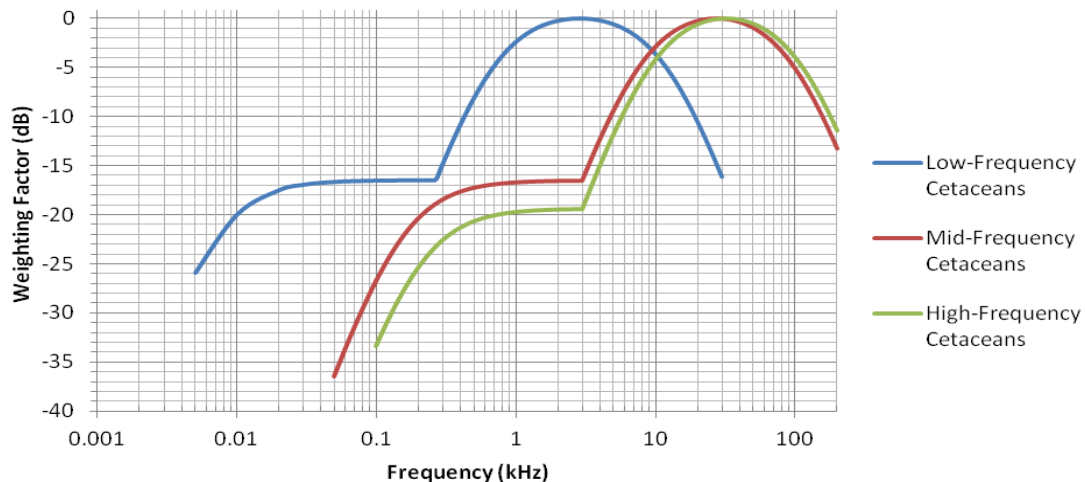


Figure 3.8-12: Type II Weighting Functions for Low-, Mid-, and High-Frequency Cetaceans

The Type II auditory cetacean weighting functions (Figure 3.8-12) are applied to the received sound level before comparing it to the appropriate sound exposure level thresholds for TTS or PTS, or the impulsive behavioral response threshold (note that for pinnipeds and sea otters, the Southall et al. [2007] weighting functions [Figure 3.8-8] would be used in lieu of any new weighting functions). For some criteria, received levels are not weighted before being compared to the thresholds to predict effects. These include the peak pressure criteria for predicting TTS and PTS from underwater explosions, the acoustic impulse metrics used to predict onset-mortality and slight lung injury, and the thresholds used to predict behavioral responses from harbor porpoises and beaked whales from sonar and other active acoustic sources.

3.8.3.1.4.2 Summation of Energy From Multiple Sources

In most cases, an animal's received level will be the result of exposure to a single sound source. In some scenarios, however, multiple sources will be operating simultaneously, or nearly so, creating the potential for accumulation of energy from multiple sources. Energy is summed for multiple exposures of similar source types. For sonars, including use of multiple systems within any scenario, energy will be summed for all exposures within a frequency band, with the cumulative frequency exposure bands defined as 0–1.0 kHz (low-frequency sources), 1.1–10.0 kHz (mid-frequency sources), 10.1–100.0 kHz (high-frequency sources), and 100.1–200.0 kHz (very high frequency sources). Sources operated at frequencies above 200 kHz are considered to be inaudible to all groups of marine mammals and are not analyzed in the quantitative modeling of exposure levels. After the energy has been summed within each frequency band, the band with the greatest amount of energy is used to evaluate the onset of PTS

or TTS. For explosives, including use of multiple explosives in a single scenario, energy is summed across the entire frequency band.

3.8.3.1.4.3 Temporary and Permanent Threshold Shift – Loss of Hearing Sensitivity

Criteria for physiological effects from sonar and other active acoustic sources are based on temporary and permanent threshold shift with thresholds based on cumulative sound exposure levels (see Table 3.8-3). The onset of temporary or permanent threshold shift from exposure to impulsive sources is predicted using a sound exposure level-based threshold in conjunction with a peak pressure threshold (see Table 3.8-4). The horizontal ranges are then compared, with the threshold producing the longest range being the one used to predict effects. For multiple exposures within any 24-hour period, the received sound exposure level for individual events is accumulated for each animal.

Table 3.8-4: Acoustic Criteria and Thresholds for Predicting Physiological Effects to Marine Mammals Underwater from Sonar and Other Active Acoustic Sources

Hearing Group	Species	Onset temporary threshold shift	Onset permanent threshold shift
Low-Frequency Cetaceans	All mysticetes	178 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II weighting)	198 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II weighting)
Mid-Frequency Cetaceans	Dolphins, beaked whales, and medium and large toothed whales	178 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II weighting)	198 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II weighting)
High-Frequency Cetaceans	Porpoises and <i>Kogia</i> spp.	152 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II weighting)	172 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II weighting)
Phocid Seals (underwater)	Northern Elephant and Harbor Seals	183 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type I weighting)	197 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type I weighting)
Otariidae (underwater)	Sea Lions and Fur Seals	206 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type I weighting)	220 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type I weighting)
Mustelidae (underwater)	Sea Otters		

Notes: $\mu\text{Pa}^2\text{-s}$ = micropascal squared second, dB = decibels, re = referenced to, SEL = Sound Exposure Level

Since no studies have been designed to intentionally induce PTS in marine mammals due to the moral and ethical issues inherent in such a study, onset-PTS levels have been estimated using empirical TTS data obtained from marine mammals and relationships between TTS and PTS established in terrestrial mammals.

Temporary and permanent threshold shift thresholds are based on TTS onset values for impulsive and non-impulsive sounds obtained from representative species of mid- and high-frequency cetaceans and pinnipeds. This data are then extended to the other marine mammals for which data are not available. The Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis technical report (Finneran and Jenkins 2012) provides a detailed explanation of the selection of criteria and derivation of thresholds for temporary and permanent loss in hearing sensitivity for marine mammals. Section 3.8.3.1.2.3 (Hearing Loss) provided the specific meanings of temporary and permanent threshold shift as used in this Supplemental EIS/OEIS. Table 3.8-4 provides a summary of acoustic thresholds for TTS and PTS for marine mammals.

In December 2013, NOAA released for public comment a “Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals: Acoustic Threshold Levels for Onset of Permanent and

Temporary Threshold Shifts” (National Oceanic and Atmospheric Administration 2013c; 78 FR 78822). The Draft Guidance was generally consistent with the Navy’s PTS/TTS criteria used in this EIS/OEIS and detailed within Finneran and Jenkins (2012). Prior to the finalization of this guidance by NOAA, the Navy suggested revisions to the criteria (i.e., auditory weighting functions and PTS/TTS thresholds) based on a number of newly available studies. In January 2015, the Navy submitted a draft proposal (Finneran 2015) to NOAA staff for their consideration.

Finneran (2015) proposed new weighting functions and thresholds for predicting PTS/TTS in marine mammals. The methodologies presented within this paper build upon the methodologies used to develop the criteria used within this EIS/OEIS (Finneran and Jenkins, 2012) and incorporate relevant auditory research made available since 2012. While Finneran and Jenkins (2012) presented a conservative approach to development of auditory weighting functions where data was limited, Finneran (2015) synthesizes a wide range of auditory data, including newly available studies, to predict refined auditory weighting functions and corresponding TTS thresholds across the complete hearing ranges of functional hearing groups. Finneran (2015) also developed updated threshold shift growth functions to facilitate the development of new PTS thresholds.

During the development process of NOAA’s Draft Guidance, NOAA chose to incorporate Finneran (2015) into its Draft Guidance prior to its finalization. As part of NOAA’s development process, the Navy’s proposal (Finneran 2015) was submitted for peer review by external subject matter experts. Peer review comments were received by NOAA in April 2015. NOAA subsequently developed a Peer Review Report, which was published on its website on 31 July 2015. The published report documents the Navy’s proposal (Finneran 2015) that underwent peer review, the peer-review comments, and NOAA responses to those comments (National Oceanic and Atmospheric Administration 2015c). NOAA then incorporated this information into revised Draft Guidance, which was recently published in the Federal Register for public review and comment (National Oceanic and Atmospheric Administration 2015d, 2015e; 80 FR 45642). The auditory weighting functions and PTS/TTS thresholds provided in that revised Draft Guidance will not be adopted by NOAA or applied to applicants until the revised Draft Guidance has undergone a second public comment and response period and issued as final guidance. At the time of printing for this Final SEIS/OEIS, the final guidance had not been issued. Therefore, the Navy has not adopted these proposed criteria in this Final SEIS/OEIS. However, the underlying science contained within Finneran (2015) has been addressed qualitatively within the applicable sections of this Final SEIS/OEIS.

If the proposed criteria in Finneran (2015) were adopted by NOAA, incorporated into its Final Guidance, and applied to the Navy in the future, predicted numbers of PTS/TTS would change for most functional hearing groups. However, because Finneran (2015) relies on much of the same data as the auditory criteria presented in this SEIS/OEIS, these changes would not be substantial, and in most cases would result in a reduction in the predicted impacts. Predicted PTS/TTS would be reduced over much to all of their hearing range for low frequency cetaceans and phocids. Predicted PTS/TTS for mid-frequency and high-frequency cetaceans would be reduced for sources with frequencies below about 3.5 kHz and remain relatively unchanged for sounds above this frequency. Predicted auditory effects on otariids would increase for frequencies between about 1 kHz and 20 kHz and decrease for frequencies above and below these points; although otariids remain the most insensitive marine mammals to potential PTS/TTS. Overall, predicted auditory effects within this SEIS/OEIS would not change significantly; consequently, conclusions would remain unchanged in light of these proposed criteria changes.

3.8.3.1.4.4 Temporary Threshold Shift for Sonar and Other Active Acoustic Sources

TTS involves no tissue damage, is by definition temporary, and therefore is not considered injury. Temporary threshold shift values for mid-frequency cetaceans exposed to non-impulsive sound are derived from multiple studies (Finneran and Schlundt 2010; Finneran et al. 2005, 2010a, 2010b; Mooney et al. 2009b; Schlundt et al. 2000) from two species, bottlenose dolphins and beluga whales. Especially notable are data for frequencies above 3 kHz, where bottlenose dolphins have exhibited lower TTS onset thresholds than at 3 kHz (Finneran and Schlundt 2010, 2011). This difference in TTS onset at higher frequencies is incorporated into the weighting functions.

Previously, there were no direct measurements of TTS from non-impulsive sound in high frequency cetaceans. Lucke et al. (2009) measured TTS in a harbor porpoise exposed to a small seismic air gun, and those results are reflected in the current impulsive sound TTS thresholds described below. The beluga whale, which had been the only species for which both impulsive and non-impulsive TTS data existed, has a non-impulsive TTS onset value about 6 dB above the (weighted) impulsive threshold (Finneran et al. 2002, Schlundt et al. 2000). Therefore, 6 dB was added to the harbor porpoise impulsive temporary thresholds shift threshold demonstrated by Lucke et al. (2009) to derive the non-impulsive TTS threshold used in the current Navy modeling for high frequency cetaceans. Report on the first direct measurements of TTS from non-impulsive sound has been recently presented by Kastelein et al. (2012b) for harbor porpoise. This new data are consistent with the current harbor porpoise thresholds used in the modeling of effects from non-impulsive sources.

There are no direct measurements of TTS or hearing abilities for low-frequency cetaceans. The Navy uses mid-frequency cetacean thresholds to assess PTS and TTS for low-frequency cetaceans, since mid-frequency cetaceans are the most similar to the low-frequency cetacean group (see Finneran and Jenkins [2012] on the development of the thresholds and criteria).

Pinniped TTS criteria are based on data provided by Kastak et al. (2005) for representative species of both of the pinniped hearing groups: harbor seals (*Phocidae*) and California sea lions (*Otariidae*). Kastak et al. (2005) used octave band noise centered at 2.5 kHz to extrapolate an onset-TTS threshold. More recently, Kastelein et al. (2012c) used octave band noise centered at 4 kHz to obtain TTS thresholds in the same two species, resulting in similar levels causing onset-TTS as those found in Kastak et al. (2005). For sea otter, the otariid TTS threshold and weighting function are applied due to similarities in taxonomy and auditory performance. Recent research using sound at 4 kHz on harbor seal (Kastelein et al. 2012a) has findings consistent with the Navy's current criteria and thresholds.

The appropriate frequency weighting function for each species group is applied when using the sound exposure level-based thresholds to predict TTS.

3.8.3.1.4.5 Temporary Threshold Shift for Explosives

The TTS sound exposure level thresholds for cetaceans are consistent with thresholds approved by NMFS for the USS MESA VERDE ship shock trial (73 FR 143: 43130–43138, 24 July 2008) and are more representative of TTS induced from impulses (Finneran et al. 2002) rather than pure tones (Schlundt et al. 2000). In most cases, a total weighted sound exposure level is more conservative than greatest sound exposure level in one-third octave bands, which was used prior to the USS MESA VERDE ship shock trials. There are no data on TTS obtained directly from low-frequency cetaceans, so mid-frequency cetacean impulse threshold criteria from Finneran et al. (2002) have been used. High-frequency cetacean TTS thresholds are based on research by Lucke et al. (2009), who exposed harbor porpoises to pulses from a single air gun.

Pinniped criteria were not included for prior ship shock trials, as pinnipeds were not expected to occur at the shock trial sites, and TTS criteria for previous Navy EISs/OEISs also were not differentiated between cetaceans and pinnipeds (National Marine Fisheries Service 2008b). Temporary threshold shift values for impulsive sound criteria have not been obtained for pinnipeds, but there are TTS data for octave band sound from representative species of both major pinniped hearing groups (Kastak et al. 2005). Impulsive sound TTS criteria for pinnipeds were estimated by applying the difference between mid-frequency cetacean TTS onset for impulsive and non-impulsive sounds to the pinniped non-impulsive TTS data (Kastak et al. 2005), a methodology originally developed by Southall et al. (2007). Therefore, the TTS criterion for impulsive sounds from explosions for pinnipeds is 6 dB less than the non-impulsive onset-TTS criteria derived from Kastak et al. (2005).

For sea otters, the otariid temporary and permanent threshold shift criteria and weighting function would be applied due to similarities in taxonomy and the likely hearing ability of sea otters when underwater (Finneran and Jenkins 2012).

3.8.3.1.4.6 Permanent Threshold Shift for Sonar and Other Active Acoustic Sources

There are no direct measurements of PTS onset in marine mammals. Well understood relationships between TTS and PTS in terrestrial mammals have been applied to marine mammals. Threshold shifts up to 40–50 dB have been induced in terrestrial mammals without resultant PTS (Miller et al. 1963; Ward et al. 1958, 1959a). These data would suggest that a PTS criteria of 40 dB would be reasonable for conservatively predicting (overestimating) PTS in marine mammals. Data from terrestrial mammal testing (Ward et al. 1958; 1959a, b) show growth of TTS by 1.5–1.6 dB for every 1 dB increase in exposure level (EL). The difference between measureable TTS onset (6 dB) and the selected 40 dB upper safe limit of TTS yields a difference in TTS of 34 dB, which, when divided by a TTS growth function of 1.6 indicates that an increase in exposure of 21 dB would result in 40 dB of TTS. For simplicity and additional conservatism we have rounded that number down to 20 dB (Southall et al. 2007).

Therefore, exposures to sonar and other active acoustic sources with levels 20 dB above those producing TTS are assumed to produce a PTS. For example, an onset-TTS criteria of 195 dB re 1 $\mu\text{Pa}^2\text{-s}$ would have a corresponding onset-PTS criteria of 215 dB re 1 $\mu\text{Pa}^2\text{-s}$. This extrapolation process is identical to that recently proposed by Southall et al. (2007). The method overestimates or predicts greater effects than have actually been observed in tests on a bottlenose dolphin (Finneran et al. 2010, Schlundt et al. 2006).

Kastak et al. (2007) obtained different TTS growth rates for pinnipeds than Finneran and colleagues obtained for mid-frequency cetaceans. NMFS recommended reducing the estimated PTS criteria for both groups of pinnipeds, based on the difference in TTS growth rate reported by Kastak et al. (2007) (14 dB instead of 20 dB).

The appropriate frequency weighting function for each species group is applied when using the sound exposure level-based thresholds to predict PTS.

3.8.3.1.4.7 Permanent Threshold Shift for Explosives

As marine mammal PTS data from impulsive exposures do not exist, onset-PTS levels for these animals are estimated by adding 15 dB to the sound exposure level-based TTS criteria and by adding 6 dB to the peak pressure based thresholds. These relationships were derived by Southall et al. (2007) from impulsive noise TTS growth rates in chinchillas. The appropriate frequency weighting function for each species group is applied when using the resulting sound exposure level-based thresholds, as shown in Table 3.8-5, to predict PTS.

Table 3.8-5: Criteria and Thresholds for Physiological Effects to Marine Mammals Underwater for Explosives

Group	Species	Onset TTS	Onset PTS	Onset Slight GI Tract Injury	Onset Slight Lung Injury ¹	Onset Mortality ¹
Low Frequency Cetaceans	All mysticetes	172 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II weighting) or 224 dB re 1 μPa Peak SPL (unweighted)	187 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II weighting) or 230 dB re 1 μPa Peak SPL (unweighted)	237 dB re 1 μPa (unweighted)	Note 1	Note 2
Mid-Frequency Cetaceans	Most delphinids, medium and large toothed whales	172 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II weighting) or 224 dB re 1 μPa Peak SPL (unweighted)	187 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II weighting) or 230 dB re 1 μPa Peak SPL (unweighted)			
High Frequency Cetaceans	Porpoises and <i>Kogia</i> spp.	146 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II weighting) or 195 dB re 1 μPa Peak SPL (unweighted)	161 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II weighting) or 201 dB re 1 μPa Peak SPL (unweighted)			
Phocidae	Elephant, and harbor seal	177 dB re 1 $\mu\text{Pa}^2\text{-s}$ (Type I weighting) or 212 dB re 1 μPa Peak SPL (unweighted)	192 dB re 1 $\mu\text{Pa}^2\text{-s}$ (Type I weighting) or 218 dB re 1 μPa Peak SPL (unweighted)			
Otariidae	Sea lions and fur seals	200 dB re 1 $\mu\text{Pa}^2\text{-s}$ (Type I weighting) or 212 dB re 1 μPa Peak SPL (unweighted)	215 dB re 1 $\mu\text{Pa}^2\text{-s}$ (Type I weighting) or 218 dB re 1 μPa Peak SPL (unweighted)			
Mustelidae	Sea Otters					

Note 1

$$= 39.1M^{\frac{1}{3}} \left(1 + \frac{D_{Rm}}{10.081} \right)^{\frac{1}{2}} \text{ Pa} - \text{sec}$$

Note 2

$$= 91.4M^{\frac{1}{3}} \left(1 + \frac{D_{Rm}}{10.081} \right)^{\frac{1}{2}} \text{ Pa} - \text{sec}$$

¹ Impulse calculated over a delivery time that is the lesser of the initial positive pressure duration or 20 percent of the natural period of the assumed-spherical lung adjusted for animal size and depth.

Notes: μPa = micropascal, $\mu\text{Pa}^2\text{-s}$ = micropascal squared second, dB = decibels, D_{Rm} = depth of receiver (animal) in meters, GI = gastrointestinal, M = mass of animals in kilograms, PTS = Permanent Threshold Shift, re = referenced to, SEL = Sound Exposure Level, SPL = Sound Pressure Level (re 1 μPa), TTS = Temporary Threshold Shift

3.8.3.1.4.8 Mortality and Injury from Explosives

There is a considerable body of laboratory data on actual injury for impulsive sound, usually from explosive pulses, obtained from tests with a variety of lab animals (mice, rats, dogs, pigs, sheep, and other species). Onset Slight Gastrointestinal (GI) Tract Injury, Onset Slight Lung Injury, and Onset

Mortality (a 50 percent lung injury with mortality occurring in 1 percent of those having this injury) represent a series of effects with increasing likelihood of serious injury or lethality. Primary impulse injuries from explosive blasts are the result of differential compression and rapid re-expansion of adjacent tissues of different acoustic properties (e.g., between gas-filled and fluid-filled tissues or between bone and soft tissues). These injuries usually manifest themselves in the gas-containing organs (lung and gut) and auditory structures (e.g., rupture of the eardrum across the gas-filled spaces of the outer and inner ear) (Craig and Hearn 1998, Craig Jr. 2001).

Criteria and thresholds for predicting injury and mortality to marine mammals from impulsive sources were initially developed for the U.S. Navy ship shock trials of the SEAWOLF submarine (Craig and Hearn 1998) and WINSTON S. CHURCHILL surface ship (Craig Jr. 2001). These criteria and thresholds were also adopted by NMFS in several Final Rules issued under the MMPA (63 FR 230, 66 FR 87, 73 FR 121, 73 FR 199). These criteria and thresholds were revised as necessary based on new science and used for the ship shock trial of the U.S. Navy amphibious transport dock ship MESA VERDE (Finneran and Jenkins 2012), and were subsequently adopted by NMFS in its MMPA Final Rule authorizing the MESA VERDE shock trial (73 FR 143). Upper and lower frequency limits of hearing are not applied for lethal and injurious exposures. These criteria and their origins are explained in greater detail in Finneran and Jenkins (2012), which covered the development of the thresholds and criteria for assessment of impacts.

Onset of Gastrointestinal Tract Injury

Evidence indicates that gas-containing internal organs, such as lungs and intestines, are the principal damage sites from shock waves in submerged terrestrial mammals (Clark and Ward 1943, Greaves et al. 1943, Richmond et al. 1973, Yelverton et al. 1973). Furthermore, slight injury to the gastrointestinal tract may be related to the magnitude of the peak shock wave pressure over the hydrostatic pressure and would be independent of the animal's size and mass (Goertner 1982).

There are instances where injury to the gastrointestinal tract could occur at a greater distance from the source than slight lung injury, especially for animals near the surface. Gastrointestinal tract injury from small test charges (described as "slight contusions") was observed at peak pressure levels as low as 104 pounds per square inch, equivalent to a sound pressure level of 237 dB re 1 μ Pa (Richmond et al. 1973). This criterion was previously used by the Navy and NMFS for ship shock trials (63 FR 230, 66 FR 87, 73 FR 143, U.S. Department of the Navy 2008).

Slight Lung Injury and Mortality

The most commonly reported internal bodily injury from impulse energy is hemorrhaging in the fine structure of the lungs. Biological damage is governed by the impulse of the underwater blast (pressure integrated over time), not peak pressure or energy (Richmond et al. 1973; Yelverton and Richmond 1981; Yelverton et al. 1973, 1975). Therefore, impulse was used as a metric upon which internal organ injury could be predicted.

Species-specific minimal animal masses are used for determining impulse-based thresholds of slight lung injury and mortality. The Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis technical report (Finneran and Jenkins 2012) provides a nominal conservative body mass for each species based on newborn weights. In some cases, body masses were extrapolated from similar species rather than the listed species. The scaling of lung volume to depth is conducted for all species because data are from experiments with terrestrial animals held near the water's surface.

Because the thresholds for onset of mortality and onset of slight lung injury are proportional to the cube root of body mass, the use of all newborn, or calf/pup, weights rather than representative adult weights results in an overestimate of effects to animals near an explosion. The range to onset mortality for a newborn compared to an adult animal of the same species can range from less than twice to over four times as far from an explosion, depending on the differences in calf/pup versus adult sizes for a given species and the size of the explosion. Considering that injurious high pressures due to explosions propagate away from detonations in a roughly spherical manner, the volumes of water in which the threshold for onset mortality may be exceeded are generally less than a fifth for an adult animal versus a calf or pup.

The use of onset mortality and onset slight lung injury is a conservative method to estimate potential mortality and recoverable (non-mortal, non-PTS) injuries. When analyzing impulse-based effects, all animals within the range to these thresholds are assumed to experience the effect. The onset mortality and onset slight lung injury criteria are based on the impulse at which these effects are predicted for 1 percent of animals; the portion of animals affected would increase closer to the explosion. As discussed above, due to these conservative criteria used to predict these effects, it is likely that fewer animals would be affected than predicted under the Navy's acoustic analysis. Therefore, these criteria conservatively overestimate the number of animals that could be killed or injured.

Impulse thresholds for onset mortality and slight injury are indexed to 75 and 93 lb. (34 and 42 kg) for mammals, respectively (Richmond et al. 1973). The regression curves based on these experiments were plotted such that a prediction of mortality to larger animals could be determined as a function of positive impulse and mass (Craig Jr. 2001). After correction for atmospheric and hydrostatic pressures and based on the cube root scaling of body mass, as used in the Goertner injury model (Goertner 1982), the minimum impulse for predicting onset of extensive (50 percent) lung injury for "1 percent Mortality" (defined as most survivors had moderate blast injuries and should survive on their own) and slight lung injury for "zero percent Mortality" (defined as no mortality, slight blast injuries) (Yelverton and Richmond 1981) were derived for each species. As the mortality threshold, the Navy chose to use the minimum impulse level predictive of 50 percent lung injury, even though this injury is likely to result in mortality to only 1 percent of exposed animals. Because the mortality criteria represent a threshold at which 99 percent of exposed animals would be expected to recover, this analysis overestimates the impact on individuals and populations from exposure to impulsive sources.

3.8.3.1.5 Behavioral Responses

The behavioral response criteria are used to estimate the number of animals that may exhibit a behavioral response. In this analysis, animals may be behaviorally harassed in each modeled scenario (using the NAEMO) or within each 24-hour period, whichever is shorter. Therefore, the same animal could have a behavioral reaction multiple times over the course of a year.

Sonar and Other Active Acoustic Sources

Potential behavioral effects from in-water sound from sonar and other active acoustic sources were predicted using a behavioral response function for most animals. The received sound level is weighted with Type I auditory weighting functions (Southall et al. 2007; see Table 3.8-11) before the behavioral response function is applied. Harbor porpoise and beaked whale non-impulsive behavioral criteria are used unweighted (without weighting the received level before comparing it to the threshold; see Finneran and Jenkins 2012).

Behavioral Response Functions

The Navy worked with NMFS to define a mathematical function used to predict potential behavioral effects to mysticetes (Figure 3.8-13) and odontocetes (Figure 3.8-14) from mid-frequency sonar (National Marine Fisheries Service 2008a; National Oceanic and Atmospheric Administration 2013b). This effects analysis assumes that the potential consequences of exposure to sonar and other active acoustic sources on individual animals would be a function of the received sound pressure level (SPL; dB re 1 μ Pa). The behavioral response function applied to mysticetes differs from that used for odontocetes in having a shallower slope, which results in the inclusion of more behavioral events at lower amplitudes, consistent with observational data from North Atlantic right whales (Nowacek et al. 2007). Although the response functions differ, the intercepts on each figure highlight that each function has a 50 percent probability of harassment at a received level of 165 dB SPL. These analyses assume that sound poses a negligible risk to marine mammals if they are exposed to sound pressure levels below a certain basement value.

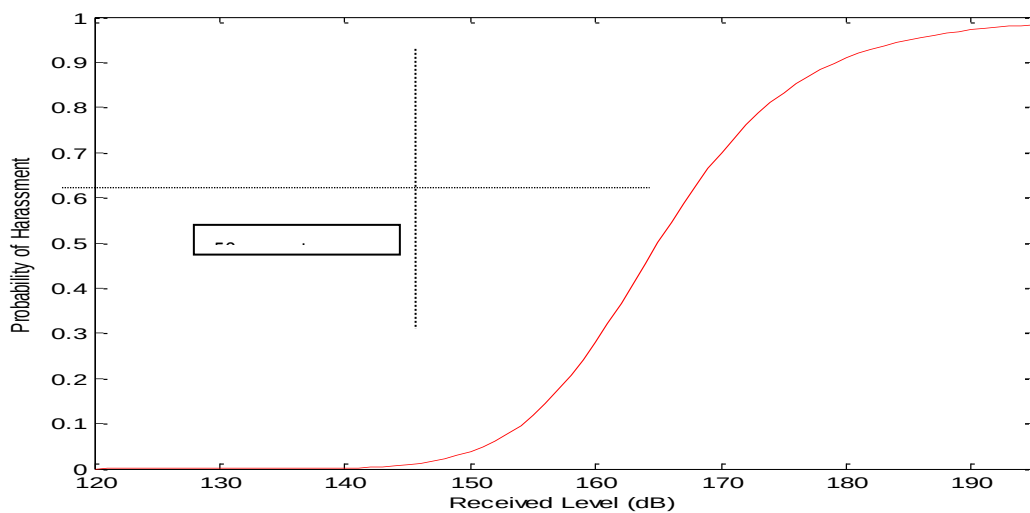


Figure 3.8-13: Behavioral Response Function Applied to Mysticetes

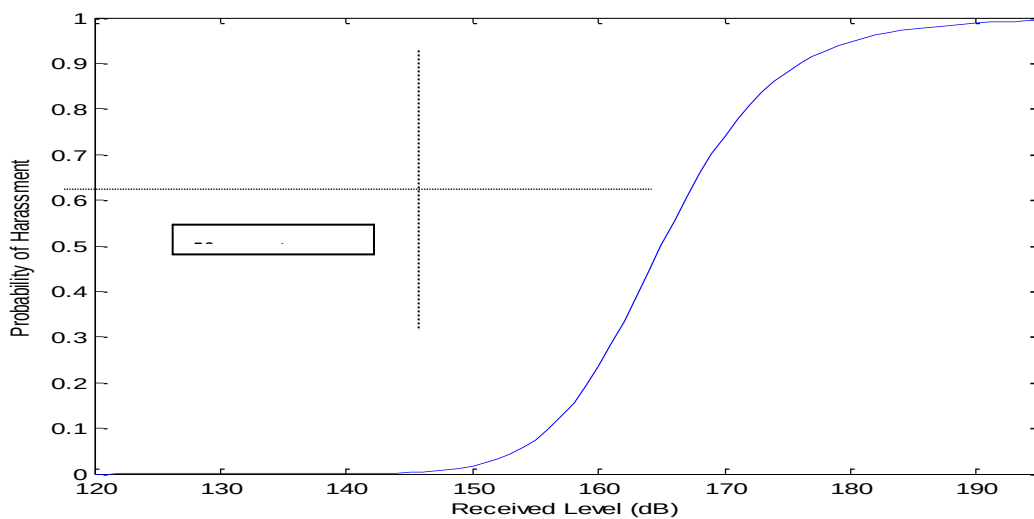


Figure 3.8-14: Behavioral Response Function Applied to Odontocetes, Pinnipeds, and Sea Otters

The values used in this analysis are based on three sources of data: behavioral observations during TTS experiments conducted at the Navy Marine Mammal Program and documented in Finneran et al. (2001, 2003, 2005) and 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 (Fromm 2004a, b; National Marine Fisheries Service 2005b; U.S. Department of the Navy 2004), 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). 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, Southall et al. 2007, 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. Therefore, the behavioral response functions represent a relationship that is deemed to be generally accurate, but may not be true in specific circumstances.

Specifically, the behavioral response function treats the received level as the only variable that is relevant to a marine mammal's behavioral response. However, many other variables, such as the marine mammal's gender, age, and prior experience; the activity it is engaged in during a sound exposure; 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). Currently available data do not allow for incorporation of these other variables in the current behavioral response functions; however, the response function represents the best use of the data that are available. Furthermore, the behavioral response functions do not differentiate between different types of behavioral reactions (i.e., area avoidance, diving avoidance, or alteration of natural behavior) or provide information regarding the predicted consequences of the reaction.

The behavioral response 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 MFA sonar) at a given received level of sound (Table 3.8-6). For example, at 165 dB SPL (dB re 1 μ Pa rms), the risk (or probability) of harassment is defined according to this function as 50 percent. This means that 50 percent of the individuals exposed at that received level would be predicted to exhibit a behavioral response.

Table 3.8-6: Summary of Behavioral Thresholds for Marine Mammals

Hearing Group	Behavioral Thresholds for Sonar and Other Active Acoustic Sources	Behavioral Thresholds for Explosives
Low-Frequency Cetaceans	SPL: BRF (Type I Weighting)	167 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II Weighting)
Mid-Frequency Cetaceans	SPL: BRF (Type I Weighting)	167 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II Weighting)
High-Frequency Cetaceans	SPL: BRF (Type I Weighting)	141 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II Weighting)
Phocid Seals (underwater)	SPL: BRF (Type I Weighting)	172 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type I Weighting)
Otariid and Mustelid (underwater)	SPL: BRF (Type I Weighting)	172 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type I Weighting)
Beaked Whales	(Unweighted) SPL 140 dB re 1 μPa	167 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II Weighting)
Harbor Porpoises	(Unweighted) SPL 120 dB re 1 μPa	141 dB re 1 $\mu\text{Pa}^2\text{-s}$ SEL (Type II Weighting)

Notes: BRF = Behavioral Response Function, dB re 1 $\mu\text{Pa}^2\text{-s}$ = decibels referenced to 1 micropascal squared second, SPL = Sound Pressure Level, SEL = Sound Exposure Level

Harbor Porpoises

The information currently available regarding this species suggests a very low threshold level of response for both captive and wild animals. Threshold levels at which both captive (Kastelein et al. 2000, 2005b) and wild harbor porpoises (Johnston 2002) responded to sound (e.g., acoustic harassment devices, acoustic deterrent devices, or other non-impulsive sound sources) are very low (e.g., approximately 120 dB re 1 μPa). Therefore, a sound pressure level of 120 dB re 1 μPa is used in this analysis as a threshold for predicting behavioral responses in harbor porpoises.

Beaked Whales

The inclusion of a special behavioral response criterion for beaked whales of the family Ziphiidae is new to these Phase II criteria. It has been speculated for some time that beaked whales might have unusual sensitivities to sound due to strandings which occurred in conjunction with mid-frequency sonar use, even in areas where other species were more abundant (D'Amico et al. 2009), but there were not sufficient data to support a separate treatment for beaked whales until recently. With the recent publication of results from beaked whale monitoring and experimental exposure studies on the Navy's instrumented range in the Bahamas (McCarthy et al. 2011, Tyack et al. 2011), there are now statistically strong data demonstrating that beaked whales tend to avoid both actual naval mid-frequency sonar in real anti-submarine training scenarios as well as playbacks of killer whale vocalizations, and other anthropogenic sounds. Tyack et al. (2011) report that, in reaction to sonar playbacks, most beaked whales stopped echolocation, made long slow ascents, and moved away from the sound. During an exercise using mid-frequency sonar, beaked whales avoided the area at a distance from the sonar where the received level was "around 140 dB" (SPL) and once the exercise ended, beaked whales re-inhabited the center of exercise area within 2–3 days (Tyack et al. 2011). The Navy has therefore adopted a 140 dB re 1 μPa sound pressure level threshold for behavioral effects for all beaked whales (see Table 3.8-6).

Since the development of the criterion, analysis of the data from the 2010 and 2013 field seasons of the SOCAL Behavioral Responses Study have been published (Southall et al. 2009b, 2012a, 2012b, 2013, 2014). One paper from the study (De Ruiter et al. 2013a) provides similar evidence of Cuvier's beaked whale sensitivities to sound based on two controlled exposures. Two whales, one in each season, were tagged and exposed to simulated MFA sonar at distances of 3.4–9.5 km. The 2011 whale was also incidentally exposed to MFA sonar from a distant naval exercise (~ 118 km away). Received levels from the MFA sonar signals during the controlled and incidental exposures were calculated as 84–144 and

78–106 dB re 1 μ Pa rms, respectively. Both whales showed responses to the controlled exposures, ranging from initial orientation changes to avoidance responses characterized by energetic fluking and swimming away from the source. However, the authors did not detect similar responses to incidental exposure from distant naval sonar exercises at comparable received levels, indicating that context of the exposures (e.g., source proximity, controlled source ramp-up) may have been a significant factor. Because the sample size was limited (controlled exposures during a single dive in both 2010 and 2011), baseline behavioral data was obtained from different stocks and geographic areas (i.e., Hawaii and Mediterranean Sea). The Navy relied on the studies at the AUTECH that analyzed beaked whale responses to actual naval exercises using MFA sonar to evaluate potential behavioral responses by beaked whales to training and testing activities using sonar and other active acoustic sources.

Explosives

If more than one explosive event occurs within any given 24-hour period within a training activity, criteria are applied to predict the number of animals that may have a behavioral reaction. For events with multiple explosions, the behavioral threshold used in this analysis is 5 dB less than the TTS onset threshold (in sound exposure level) (see Table 3.8-5). This value is derived from observed onsets of behavioral response by test subjects (bottlenose dolphins) during non-impulsive TTS testing (Schlundt et al. 2000).

Some multiple explosion events, such as certain gunnery exercises, may be treated as a single impulsive event because a few explosions occur closely spaced within a very short time (a few seconds). For single explosions at received sound levels below hearing loss thresholds, the most likely behavioral response is a brief alerting or orienting response. Since no further sounds follow the initial brief impulses, significant behavioral reactions would not be expected to occur. This reasoning was applied to previous ship shock trials (63 FR 230, 66 FR 87, 73 FR 143) and is extended to the criteria used in this analysis.

Since impulsive events can be quite short, it may be possible to accumulate multiple received impulses at sound pressure levels considerably above the energy-based criterion and still not be considered a behavioral take. The Navy treats all individual received impulses as if they were 1 second long for the purposes of calculating cumulative sound exposure level for multiple impulsive events. For example, five air gun impulses, each 0.1 second long, received at a Type II weighted sound pressure level of 167 dB would equal a cumulative 164 dB sound exposure level and would not be predicted as leading to a significant behavioral response in mid-frequency (MF) or high-frequency (HF) cetaceans. However, if the five 0.1-second pulses are treated as a 5-second exposure, it would yield an adjusted sound exposure level of approximately 169 dB, exceeding the behavioral threshold of 167 dB sound exposure level. For impulses associated with explosions that have durations of a few microseconds, this assumption greatly overestimates effects based on sound exposure level metrics such as TTS, PTS, and behavioral responses.

Appropriate weighting values will be applied to the received impulse in one-third octave bands and the energy summed to produce a total weighted sound exposure level value. For impulsive behavioral criteria, the new weighting functions (Figure 3.8-15) are applied to the received sound level before being compared to the threshold.

3.8.3.1.6 Quantitative Analysis

The Navy performed a quantitative analysis to estimate the number of marine mammals that could be affected by acoustic sources or explosives used during training activities. Inputs to the quantitative analysis include marine mammal density estimates; marine mammal depth occurrence distributions;

oceanographic and environmental data; marine mammal hearing data; and criteria and thresholds for levels of potential effects. The quantitative analysis consists of computer modeled estimates and a post-model analysis to determine the number of potential mortalities and harassments. The model calculates sound energy propagation from sonar, other active acoustic sources, and explosives during naval activities; the sound or impulse received by animal dosimeters representing marine mammals distributed in the area around the modeled activity; and whether the sound or impulse received by a marine mammal exceeds the thresholds for effects. The model estimates are then further analyzed to consider animal avoidance and implementation of mitigation measures, resulting in final estimates of potential effects due to the proposed training activities.

Various computer models and mathematical equations can be used to predict how energy spreads from a sound source (e.g., sonar or underwater detonation) to a receiver (e.g., dolphin or sea turtle). See Appendix C (Acoustics Primer) for background information about how sound travels through the water. Basic underwater sound models calculate the overlap of energy and marine life using assumptions that account for the many, variable, and often unknown factors that can influence the result. Assumptions in previous and current Navy models have intentionally erred on the side of overestimation when there are unknowns or when the addition of other variables was not likely to substantively change the final analysis. For example, because the ocean environment is extremely dynamic and information is often limited to a synthesis of data gathered over wide areas and requiring many years of research, known information tends to be an average of a seasonal or annual variation. El Niño Southern Oscillation events of the ocean-atmosphere system are an example of dynamic change where unusually warm or cold ocean temperatures are likely to redistribute marine life and alter the propagation of underwater sound energy. Previous Navy modeling therefore made some assumptions indicative of a maximum theoretical propagation for sound energy (such as a perfectly reflective ocean surface and a flat seafloor). More complex computer models build upon basic modeling by factoring in additional variables in an effort to be more accurate by accounting for such things as variable bathymetry and an animal's likely presence at various depths.

- NAEMO accounts for the variability of the sound propagation data in both distance and depth when computing the received sound level on the animals. Previous models captured the variability in sound propagation over range and used a conservative approach to account for only the maximum received sound level within the water column.
- NAEMO bases the distribution of animals (virtual representation of an animal) over the operational area on density maps, which provides a more natural distribution of animals. Previous models assumed a uniform distribution of animals over the operational area.
- NAEMO distributes animals throughout the three-dimensional water space proportional to the known time that animals of that species spend at varying depths. Previous models assumed animals were placed at the depth where the maximum sound received level occurred for each distance from a source.
- NAEMO conducts a statistical analysis to compute the estimated effects on animals. Previous models assumed all animals within a defined distance would be affected by the sound.

The Navy has developed a set of data and new software tools for quantification of estimated marine mammal acoustic effects from Navy activities. This new approach is the resulting evolution of the basic model previously used by Navy (e.g., U.S. Department of the Navy 2011a) and reflects a more complex modeling approach as described below. Although this more complex computer modeling approach accounts for various environmental factors affecting acoustic propagation, the current software tools do not consider the likelihood that a marine mammal would attempt to avoid repeated exposures to a

sound or avoid an area of intense activity where a training or testing event may be focused. Additionally, the software tools do not consider the implementation of mitigation (e.g., stopping sonar transmissions when a marine mammal is within a certain distance of a ship or mitigation zone clearance prior to detonations). In both of these situations, naval activities are modeled as though an activity would occur regardless of proximity to marine mammals and without any horizontal movement by the animal away from the sound source or human activities. Therefore, the final step of the quantitative analysis of acoustic effects is to consider the implementation of mitigation and the possibility that marine mammals would avoid continued or repeated sound exposures. This final step in the modeling process is meant to better quantify the predicted effects by accounting for likely animal avoidance behavior and implementation of standard Navy mitigations (see Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring, for details). In short, naval activities are modeled as though an activity would occur regardless of proximity to detected marine mammals and without any horizontal movement by the animal away from the sound source or human activities (e.g., without accounting for likely animal avoidance) because the science necessary to support that level of modeling complexity is beyond what is currently available. Therefore, the final step of the quantitative analysis of acoustic effects is to consider the implementation of mitigation and the possibility that marine mammals would avoid continued or repeated sound exposures.

Additional details regarding the NAEMO (see Marine Species Modeling Team 2015) and the incorporation of avoidance and mitigation into the analysis of acoustic stressors are presented below.

3.8.3.1.6.1 Marine Species Density Data

A quantitative analysis of impacts on a species requires data on the abundance and distribution of the species population in the potentially impacted area. The most appropriate unit of metric for this type of analysis is density, which is described as the number of animals present per unit area.

There is no single source of density data for every area, species, and season because of the fiscal costs, resources, and effort involved in NMFS providing enough survey coverage to sufficiently estimate density. Navy has funded two previous marine mammals surveys in the TMAA to supplement existing data on marine mammals in the area (Rone et al. 2009, 2014). Therefore, to characterize the marine species density for areas such as the TMAA, the Navy needed to compile data from multiple sources. To develop a database of marine species density estimates, the Navy, in consultation with NMFS experts at the three science centers (Alaska Fisheries Science Center, Southwest Fisheries Science Center, and Pacific Islands Fisheries Science Center) having species ranges overlapping the TMAA, adopted a protocol to select the best available data sources based on species, area, and season (see Navy's Pacific Marine Species Density Database Technical Report; U.S. Department of the Navy et al. 2014a). The resulting Geographic Information System (GIS) database includes one single spatial and seasonal density value for every marine mammal present within the Study Area.

The Navy Marine Species Density Database includes a compilation of the best available density data from several primary sources and published works including survey data from NMFS within the U.S. EEZ. NMFS is the primary agency responsible for estimating marine mammal and sea turtle density within the U.S. EEZ. NMFS publishes annual SARs or various regions of U.S. waters and covers all stocks of marine mammals within those waters. The majority of species that occur in the TMAA are covered by the Alaska Region Stock Assessment Report (Allen and Angliss 2014) and Pacific Region Stock Assessment Report (Carretta et al. 2014). Other independent researchers often publish density data or research covering a particular marine mammal species, which is integrated into the NMFS SARs.

For most cetacean species, abundance is estimated using line-transect methods that employ a standard equation to derive densities based on sighting data collected from systematic ship or aerial surveys. More recently, habitat-based density models have been used effectively to model cetacean density as a function of environmental variables (e.g., Barlow et al. 2009). Where the data supports habitat-based density modeling, the Navy's database uses those density predictions. Habitat-based density models allow predictions of cetacean densities on a finer spatial scale than traditional line-transect analyses because cetacean densities are estimated as a continuous function of habitat variables (e.g., sea surface temperature, water depth). However, within most of the world's oceans, there have not been enough systematic surveys to allow for line-transect density estimation or the development of habitat models. To get an approximation of the cetacean species distribution and abundance for unsurveyed areas, in some cases it is appropriate to extrapolate data from areas with similar oceanic conditions where extensive survey data exist. Habitat Suitability Index or Relative Environmental Suitability have also been used in data-limited areas to estimate occurrence based on existing observations about a given species' presence and relationships between basic environmental conditions (Kaschner et al. 2006).

Methods used to estimate pinniped at-sea density are generally quite different than those described above for cetaceans. Pinniped abundance is generally estimated via shore counts of animals at known rookeries and haulout sites. For example, for species such as Steller sea lion, population estimates are based on counts of pups at the breeding sites (Allen and Angliss 2014). However, this method is not appropriate for other species such as harbor seals, whose pups enter the water shortly after birth. Population estimates for these species are typically made by counting the number of seals ashore and applying correction factors based on the proportion of animals estimated to be in the water (Allen and Angliss 2014). Population estimates for pinniped species that occur in the TMAA are provided in the Alaska Region Stock Assessment Report (Allen and Angliss 2014). Translating these population estimates to in-water densities presents challenges because the percentage of seals or sea lions at sea compared to those on shore is species-specific and depends on gender, age class, time of year (molt and breeding/pupping seasons), and for species such as harbor seal, time of day and tide level. Species specific foraging ranges from tracking data were also used when available (see Benoit-Bird et al. 2013, Boveng et al. 2008, Robinson et al. 2012, Womble and Gende 2013). These parameters identified from the literature were used to establish correction factors, which were then applied to estimate the proportion of pinnipeds that would be at sea within the Study Area for the time period of the Proposed Action.

Ribbon Seals

There is insufficient information available for the accurate derivation of a density or abundance representing the likely presence of ribbon seals in the Study Area. As presented in Section 3.8.2.25 (Ribbon Seals), satellite telemetry data presented by Boveng et al. (2008) suggests ribbon seals could be present in the Gulf of Alaska in summer although they would likely be very small in number. Given this, any derived density for the Study Area would be too low to be informative in acoustic modeling; predicting estimated effects much less than one (1.0) based on the low number of predicted effects for species that are much more numerous (e.g., gray whale), the Navy has determined possible effects to ribbon seals from Navy training in the Study Area are discountable and a density for the ribbon seal is therefore not required for the impact analyses which follow.

Northern Sea Otters

As presented in detail in Section 3.8.2.27 (Northern Sea Otter [*Enhydra lutris kenyoni*]), sea otters prefer rocky shorelines, relatively shallow water with kelp, and seldom range more than 1.2 mi. (2 km) from shore. Although some juvenile males may travel farther offshore, they would be the minority of the

population. Because the nearest shoreline (Kenai Peninsula) is located approximately 24 nm north of the TMAA's northern boundary, it is unlikely that sea otters would be present in the Study Area. Even if exposed to sound from Navy activities, research indicates sea otters often remained undisturbed, quickly become tolerant of various sounds, and even when purposefully harassed they generally moved only a short distance (100–200 m) before resuming normal activity (Davis et al. 1988). Off California at San Nicolas within the Navy's Point Mugu Sea Range, southern sea otters have been subjected to Navy activities for decades. The average growth rate for the population of sea otters at this Navy range has consistently been higher than that for the rest of the California population (U.S. Fish and Wildlife Service 2014). Therefore, the Navy has determined that possible effects to Northern sea otter from Navy training in the Study Area are discountable, and a density for the sea otter was therefore not required for the impact analyses that follow.

Modeling Effects Prorated by Stock

There are a number species of marine mammals having more than one overlapping stock in the Study Area (Table 3.8-1). Individual marine mammal densities cannot be derived for these stocks given the current inability during marine mammal surveys to visually distinguish which stocks animals belong to, in an area having overlapping stocks of the same species.

Humpback Whales - Extensive research and analysis involving the photo identification of individual humpback whales in the Study Area and elsewhere (see Calambokidis et al. 2008) does provide data on the presence of individual humpback whales from the three known stocks and three DPS. As detailed within Section 3.8.2.7 (Humpback Whale [*Megaptera novaeangliae*]), animals from the Central North Pacific stock; California, Washington, and Oregon stock; and the Western North Pacific stock are present in the SEIS/OEIS Study Area. Photo identification data indicates that almost all humpback whales in the Navy's Gulf of Alaska TMAA are likely to be from the Central North Pacific stock and the California, Washington, and Oregon stock. The Central North Pacific stock is comprised of humpback whales from the Hawaii DPS and the animals from the California, Washington, and Oregon stock are from the Mexico DPS (see also Barlow et al. 2011; Bettridge et al. 2015; Calambokidis et al. 2008)⁷. For example, Bettridge et al. (2015) indicate a complete overlap between the "Primary Feeding Range" for the Hawaii DPS and the Mexican DPS. For the Western North Pacific stock, data indicates that animals from the Western North Pacific DPS feed primarily off the Russian coast (Bettridge et al. 2015; Calambokidis et al. 2008). There is, however, discovery tag data from approximately 50 years ago (summarized and presented in Yamaguchi 2010) and the more recent SPLASH data (Calambokidis et al. 2008) that indicate a few whales from areas assigned to the Western North Pacific stock have been identified in the northern Gulf of Alaska near the TMAA (in addition to other feeding areas; Bering Sea, Aleutian Islands western Gulf of Alaska).

The SPLASH survey area of the northern Gulf of Alaska (see Calambokidis et al. 2008, Figure 1) covered approximately 269,000 square nautical miles. The TMAA is included in the northern Gulf of Alaska SPLASH survey area and in size is approximately 16 percent of the total square nautical miles of the SPLASH northern Gulf of Alaska area. SPLASH data identified 35 humpback whales from the Western North Pacific stock (see Table 10 in Calambokidis et al. 2008), but only 1 of these was present in the northern Gulf of Alaska. That same data indicated all the remaining 209 identified humpback whales in the northern Gulf of Alaska were from the Central North Pacific stock. Assuming that the ratio of

⁷ The most recent Alaska Stock Assessment report (Muto et al. 2016) is inconsistent with these three cited studies in determining the abundance of humpback whales comprising the Central North Pacific stock. The Stock Assessment Report is based only on the number of humpback whales found wintering in the Hawaii EEZ although whales from Mexico are a large part of the total humpback whale abundance in GOA.

identified whales to their stocks in the northern Gulf of Alaska reflects that of the total population, then 99 percent of the humpback whales in the TMAA are from the Central North Pacific stock (59 percent of these from the Hawaii DPS) and 40 percent from the California, Washington, and Oregon stock (the Mexican DPS; see Table 10 in Calambokidis et al. [2008]). The remaining 1 percent of humpback whales are from the Western North Pacific stock (and DPS). Using these ratios, modeling results for humpback whales in the TMAA can be prorated to the applicable three stocks.

There is no data comparable to the humpback whale SPLASH data for the other stocks of marine mammals in the Gulf of Alaska. For all other species having overlapping stocks in the Study Area, modeling for acoustic effects at the species level was prorated to each stock based on the relative abundance of each stock as provided in the Alaska and the Pacific Stock Assessment Reports (Muto and Angliss 2014; Carretta et al. 2014) as shown in Table 3.8-7.

Table 3.8-7: Abundance Ratios Used to Prorate Modeling Results on Species to Individual Stocks of Marine Mammals in the Study Area

Species Common Name	Stock	Number of Animals in Stock	Total for Species	Ratio of Total Modeled Effects for Species	Rounded Ratio for Prorating Modeled Effects
Blue whale	Eastern North Pacific	2,497	2,497	Estimate	0.99
	Central North Pacific	Not available		Estimate	0.01
Gray whale	Eastern North Pacific	19,126	19,281	0.992	0.99
	Western North Pacific	155		0.008	0.01
Killer whale	Alaska Resident	2,084	2,854	0.730	0.73
	Offshore	211		0.073	0.07
	AT1 Transient	7		0.002	0.01
	Gulf of Alaska, Aleutian Island, and Bering Sea Transient	552		0.193	0.19
Harbor porpoise	Gulf of Alaska	31,046	42,192	0.736	0.74
	Southeast Alaska	11,146		0.264	0.26
Steller sea lion	Eastern U.S.	52,847	98,763	0.535	0.54
	Western U.S.	45,916		0.465	0.46
Harbor seal	N. Kodiak	4,509	75,145	0.060	0.06
	S. Kodiak	11,117		0.148	0.15
	Prince William Sound	31,503		0.419	0.42
	Glacier Bay/Icy Strait	5,042		0.067	0.07
	Sitka/Chatham	8,586		0.114	0.11
	Dixon/Cape Decision	14,388		0.191	0.19

Note: U.S. = United States

3.8.3.1.6.2 Upper and Lower Frequency Limits

The Navy adopted a single frequency cutoff at each end of a functional hearing group's frequency range, based on the most liberal interpretations of their composite hearing abilities (see Finneran and Jenkins [2012] for details involving derivation of these values). These are not the same as the values used to calculate weighting curves, but instead exceed the demonstrated or anatomy-based hypothetical upper

and lower limits of hearing within each group. Table 3.8-8 provides the lower and upper frequency limits for each species group. Sounds with frequencies below the lower frequency limit, or above the upper frequency limit, are not analyzed with respect to auditory effects for a particular group.

Table 3.8-8: Lower and Upper Cutoff Frequencies for Marine Mammal Functional Hearing Groups Used in this Acoustic Analysis

Functional Hearing Group	Limit (Hz)	
	Lower	Upper
Low-Frequency Cetaceans	5	30,000
Mid-Frequency Cetaceans	50	200,000
High-Frequency Cetaceans	100	200,000
Phocid seals (underwater)	50	80,000
Otariid pinniped and sea otter (underwater)	50	60,000

Note: Hz = Hertz

3.8.3.1.6.3 Navy Acoustic Effects Model

For this analysis of training activities at sea, the Navy developed a set of software tools and compiled data for the quantification of predicted acoustic impacts to marine mammals. These databases and tools collectively form the NAEMO. Details of this model's processes and the description and derivation of the inputs are presented in the Navy's Determination of Acoustic Effects Technical Report (Marine Species Modeling Team 2015).

The NAEMO improves upon previous modeling efforts (e.g., U.S. Department of the Navy 2008, 2011a) in several ways. First, unlike earlier methods that modeled sources individually, the NAEMO has the capability to run all sources within a scenario simultaneously, providing a more realistic depiction of the potential effects of an activity. Second, previous models calculated sound received levels within set volumes of water and spread animals uniformly across the volumes; in the NAEMO, animats (virtual animals) are distributed nonuniformly based on higher resolution species-specific density, depth distribution, and group size information, and animats serve as dosimeters, recording energy received at their location in the water column. Third, a fully three-dimensional environment is used for calculating sound propagation and animat exposure in the NAEMO, rather than a two-dimensional environment where the worst case sound pressure level across the water column is always encountered. Finally, current efforts incorporate site-specific bathymetry, sound speed profiles, wind speed, and bottom properties into the propagation modeling process rather than the flat-bottomed provinces used during earlier modeling (Marine Species Modeling Team 2015). The following paragraphs provide an overview of the NAEMO process and its more critical data inputs.

Using the best available information on the predicted density of marine mammals in the area being modeled, the NAEMO derives an abundance (total number of individuals) and distributes the resulting number of animats into an area bounded by the maximum distance that energy propagates out to a criterion threshold value (energy footprint). For example, for non-impulsive sources, all animats that are predicted to occur within a range that could receive sound pressure levels greater than or equal to 120 dB re 1 μ Pa are distributed within the modeling predicted sound energy footprint. These animats are distributed based on density differences across the area, the group (pod) size, and known depth distributions (dive profiles; see Marine Species Modeling Team 2015). Animats change depths every

4 minutes but do not otherwise mimic actual animal behaviors, such as avoidance or attraction to a stimulus (horizontal movement), or foraging, social, or traveling behaviors.

Schecklman et al. (2011) argue that static distributions underestimate acoustic exposure compared to a model with fully three-dimensionally moving animals. However, their static method is different from the NAEMO in several ways. First, they distribute the entire population at depth with respect to the species-typical depth distribution histogram, and those animals remain static at that position throughout the entire simulation. In the NAEMO, animals are placed horizontally dependent on nonuniform density information, and then move up and down over time within the water column by integrating species-typical depth distribution information. Second, for the static method, they calculate acoustic received level for designated volumes of the ocean and then sum the animals that occur within that volume, rather than using the animals themselves as dosimeters, as in the NAEMO. Third, Schecklman et al. (2011) ran 50 iterations of the moving distribution to arrive at an average number of exposures, but because they rely on uniform horizontal density (and static depth density), only a single iteration of the static distribution is realized. In addition to moving the animals vertically, the NAEMO overpopulates the animals over a nonuniform density and then resamples the population a number of times to arrive at an average number of exposures as well. Tests comparing fully moving distributions and static distributions with vertical position changes at varying rates were carried out during development of the NAEMO. For position updates occurring more frequently than every 5 minutes, the number of estimated exposures was similar between the NAEMO and the fully moving distribution; however, computational time was much longer for the fully moving distribution.

The NAEMO calculates the likely propagation for various levels of energy (sound or pressure) resulting from each non-impulsive or impulsive source in use during the Carrier Strike Group exercise. This is done by taking into account the actual bathymetric relief and bottom types (e.g., reflective), and estimated sound speeds and sea surface roughness at an event's location. Platforms (such as a ship using one or more sound sources) are modeled as moving across in a manner consistent with the modeled activity. The model uses typical platform speeds and event durations. Moving source platforms either travel along a predefined track or move along straight-line tracks from a random initial course, reflecting at the edges of a predefined boundary. Static sound sources are stationary in a fixed location for the duration of a scenario.

All activities⁸ involving sonar and other active acoustic sources in use during the Carrier Strike Group exercise are modeled as occurring at the same 21-day period of the exercise in an integrated manner. As a result, the total acoustic energy from all sonar and other active acoustic sources is summed within each 24-hour period so the cumulative sound energy has been accounted for. Events involving use of explosives would not occur in the same location within the TMAA where anti-submarine warfare training using sonar and other active acoustic sources are being used. Events involving the use of explosives⁹ are therefore modeled as individual independent events even though they would be taking place within the TMAA. Given the level of activity within the TMAA over the period of the Carrier Strike Group exercise and the likely avoidance of the general area by some species (e.g., beaked whales) as a result of that activity, it is likely modeling overestimates the predicted effects from use of explosives.

Modeling locations were chosen based on regulatory restrictions (such as where a Sinking Exercise can occur), where training events are likely to occur so as not to interfere with commercial aircraft routes

⁸ These include the four Anti-Submarine Warfare Tracking Exercises: (1) Helicopter, (2) Marine Patrol Aircraft, (3) Surface Ship, (4) Submarine, and (5) involving active torpedo sonar during a Sinking Exercise.

⁹ Bombing, Surface-to-Surface Gunnery, Sinking Exercise, and Tracking Exercise using Extended Echo Ranging sonobuoys

and other non-participatory vessels, and in an effort to be representative of the entire TMAA by including all the environmental variation within the Study Area.

The NAEMO then records the energy received by each animat within the sound energy footprint of the event and calculates the number of animats having received levels of energy exposures that fall within defined impact thresholds. Predicted effects to the animats are then converted using actual marine mammal densities, and the highest order effect predicted for a given animal is assumed. Each 24-hour day for events involving sonar and other active acoustic sources and each activity for events involving explosives are modeled as independent of all others, and therefore, the same individual marine mammal animat could be modeled as impacted multiple times during the 21-day Carrier Strike Group exercise. Although the activities themselves all occur within the Study Area, sound may propagate beyond the boundary of the Study Area. Any exposures occurring outside the boundary of the Study Area are included in the model-estimated impacts presented for the Proposed Action. The NAEMO provides the initial predicted impacts to marine species (based on application of multiple conservative assumptions which are assumed to overestimate impacts), which are then further analyzed to produce final estimates used in the Navy's MMPA application for Letter of Authorization (LOA) and ESA risk analyses (Section 3.8.3.3.1.2, Avoidance Behavior and Mitigation Measures as Applied to Sonar and Other Active Acoustic Sources, provides further information on additional analyses).

3.8.3.1.6.4 Model Assumptions and Limitations

There are limitations to the data used in the NAEMO, and the results must be interpreted with consideration for these known limitations. Output from the NAEMO relies heavily on the quality of both the input parameters and impact thresholds and criteria. When there was a lack of definitive data to support an aspect of the modeling (such as lack of well-described diving behavior for all marine species), modeling assumptions believed to overestimate the number of exposures were chosen:

- Marine mammals (animats) are modeled as being underwater and facing the source and therefore always predicted to receive the maximum sound level (e.g., the model does not account for conditions such as body shading, porpoising out of the water, or an animal raising its head above water). Some odontocetes have been shown to have directional hearing, with best hearing sensitivity facing a sound source and higher hearing thresholds for sounds propagating toward the rear or side of an animal (Au and Moore 1984, Kastelein et al. 2005c, Mooney et al. 2008, Popov and Supin 2009).
- Animats do not move horizontally (but change their position vertically within the water column), which may overestimate physiological effects such as hearing loss, especially for slow moving or stationary sound sources in the model.
- Animats are stationary horizontally and therefore are not modeled as moving away from any sound source, unlike in the wild where animals would most often avoid exposures at higher sound levels close to the source, especially those exposures that may result in PTS.
- Animats are assumed to receive the full impulse of the initial positive pressure wave due to an explosion, although the impulse-based thresholds (onset mortality and onset slight lung injury) assume an impulse delivery time adjusted for animal size and depth. Therefore, these impacts are overestimated at farther distances and increased depths.
- Multiple exposures within any 24-hour period are considered one continuous exposure for the purposes of calculating the temporary or permanent hearing loss, because there are not sufficient data to estimate a hearing recovery function for the time between exposures.
- Mitigation measures which are implemented during many training activities were not factored into the initial model output (see Chapter 5, Standard Operating Procedures, Mitigation, and

Monitoring). In reality, sound-producing activities would be reduced, stopped, or delayed if marine mammals are detected within the mitigation zones around sound sources.

Because of these inherent model limitations and simplifications, initial model-estimated results must be further analyzed, considering such factors as the range to specific effects, animal avoidance, and the likelihood of successfully implementing mitigation measures. This analysis uses a number of factors in addition to the acoustic model results to predict acoustic effects to marine mammals, as presented in the following section.

There is no modeling method currently available that would predict and quantify each type of potential response to underwater sound and predict the long-term consequences for the marine mammals affected by that sound. This is because the nature of an animal's response to underwater sound is a function of a range of variables that presently cannot be reduced to a mathematical formula. In its analysis, the Navy uses a model that assumes that behavioral response is a function of the received sound level with an increasing probability of a response the higher the received sound level. Therefore, the numerical model outputs predict a number of behavioral responses, but do not provide any indication of the severity of those responses. The Navy instead examines the numerical model output, and the available published science, and the findings from behavioral response studies and monitoring of actual training and testing events to provide a qualitative assessment of the likely impacts to individual marine mammals and the stock or population for each species present in a given area.

3.8.3.1.7 Marine Mammal Avoidance of Sound Exposures

Marine mammals may avoid sound exposures by either avoiding areas with high levels of anthropogenic activity or moving away from a sound source. Because the NAEMO does not consider horizontal movement of animals, including avoidance of human activity or sounds, it overestimates the number of marine mammals that would be exposed to sound sources that could cause injury. Therefore, the potential for avoidance is considered in the post-model analysis. The consideration of avoidance during use of sonar and other active acoustic sources and during use of explosives is described below and discussed in more detail in Section 3.8.3.1.2 (Analysis Background and Framework).

3.8.3.1.7.1 Avoidance of Human Activity

Cues preceding the commencement of an event (e.g., multiple vessel presence and movement, aircraft overflight) may result in some animals departing the immediate area, even before active sound sources begin transmitting. Harbor porpoises and beaked whales have been observed to be especially sensitive to human activity, which is accounted for by using a low threshold for behavioral disturbance due to exposure to sonars and other active acoustic sources. Both finless porpoises (Li et al. 2008) and harbor porpoises (Barlow 1988, Evans et al. 1994, Palka and Hammond 2001, Polacheck and Thorpe 1990) routinely avoid and swim away from large motorized vessels. The vaquita, which is closely related to the harbor porpoise, appears to avoid large vessels at about 2,995 ft. (913 m) (Jaramillo-Legorreta et al. 1999). The assumption is that the harbor porpoise would respond similarly to large Navy vessels. Beaked whales have been observed to be especially sensitive to human activity (Tyack et al. 2011; Pirota et al. 2012), which is accounted for by using a low threshold for behavioral disturbance due to exposure to sonar and other active acoustic sources (Section 3.8.3.1.2, Analysis Background and Framework).

Therefore, for certain naval activities preceded by high levels of vessel activity (multiple vessels) or hovering aircraft, harbor porpoise and beaked whales are assumed to avoid the activity area prior to the start of a sound-producing activity. Model-estimated effects during these types of activities are adjusted so that high-level sound impacts to harbor porpoise and beaked whales (those causing PTS during use of

sonar and other active acoustic sources and those causing mortality due to explosives) are considered to be TTS and recoverable injury, respectively, due to animals moving away from the activity and into a lower effect range.

3.8.3.1.7.2 Avoidance of Repeated Exposures

Marine mammals would likely avoid repeated high level exposures to a sound source that could result in injuries (i.e., PTS). Therefore, the model-estimated effects are adjusted to account for marine mammals swimming away from a sonar or other active sources and away from multiple explosions to avoid repeated high level sound exposures. Avoidance of repeated exposures is discussed further in Section 3.8.3.3.1.2 (Avoidance Behavior and Mitigation Measures as Applied to Sonar and Other Active Acoustic Sources). All adjusted effects resulting from likely avoidance behaviors are quantified (added) as Level B harassment and are part of the requested annual effects to marine mammals.

3.8.3.1.8 Implementing Mitigation to Reduce Sound Exposures

The Navy implements mitigation measures (described in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) during sound-producing activities, including halting or delaying use of a sound source or explosives when marine mammals are observed in the mitigation zone. These measures and procedures have been previously and recently analyzed, reviewed, and subject to public comment (U.S. Department of the Navy 2013d) and authorized by NMFS pursuant to the MMPA (National Oceanic and Atmospheric Administration 2013b) for other identical Navy training activities in the Pacific. The NAEMO estimates acoustic effects without taking into account any shutdown or delay of the activity when marine mammals are detected; therefore, the model overestimates impacts to marine mammals within mitigation zones. The post-model analysis considers the potential for mitigation to reduce the likelihood or risk of PTS due to exposure to sonar and other active acoustic sources and injuries and mortalities due to explosives. A detailed explanation of this analysis is provided in the technical report *Post-Model Quantitative Analysis of Animal Avoidance Behavior and Mitigation Effectiveness for Gulf of Alaska Training* (U.S. Department of the Navy 2014b). Two factors are considered when quantifying the effectiveness of mitigation: (1) the sightability of each species that may be present in the mitigation zone, which is affected by species-specific characteristics; and (2) the extent to which the type of mitigation proposed for a sound-producing activity (e.g., active sonar) allows for observation of the mitigation zone prior to and during the activity. The mitigation zones proposed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) encompass the estimated ranges to injury (including the range to mortality for explosives) for a given source.

Mitigation is considered in the acoustic effects analysis when the mitigation zone can be fully or mostly observed up to and during a sound-producing activity. Mitigation for each activity is considered in its entirety, taking into account the different scenarios that may take place as part of that activity (some scenarios involve different mitigation zones, platforms, or number of Lookouts). The ability to observe the range to mortality (for explosive activities only) and the range to potential injury (for all sound-producing activities) was estimated for each training event. Mitigation was considered in the acoustic analysis as follows:

- If the entire mitigation zone can be continuously visually observed based on the surveillance platform(s), number of Lookouts, and size of the range to effects zone, the mitigation is considered fully effective (Effectiveness = 1).
- If over half of the mitigation zone can be continuously visually observed or if there is one or more of the scenarios within the activity for which the mitigation zone cannot be continuously

visually observed (but the range to effects zone can be visually observed for the majority of the scenarios), the mitigation is considered mostly effective (Effectiveness = 0.5).

- If less than half of the mitigation zone can be continuously visually observed or if the mitigation zone cannot be continuously visually observed during most of the scenarios within the activity due to the type of surveillance platform(s), number of Lookouts, and size of the mitigation zone, the mitigation is not considered in the acoustic effects analysis.

In the case of Navy Carrier Strike Group training in the Gulf of Alaska, the events using sonar and other active acoustic sources are all modeled as occurring during 21 consecutive days and involving multiple surface ships, a submarine, planes, and helicopters operating in proximity to each other or otherwise involving the same general event area. Because there will be multiple watch personnel on board vessels and aircraft observing a mitigation zone and given there will be multiple platforms having opportunities at detecting any marine mammals that may be in the area, it is therefore assumed that the entire PTS mitigation zone for events involving sonar and other active acoustic sources can be continuously observed. For the events involving use of explosives, the assessment of the mitigation effectiveness in observation of the serious injury and mortality zones are variable (for details, see Table 3.8-19).

The ability of Lookouts to detect marine mammals in or approaching the mitigation zone is determined by the animal's presence at the surface and the characteristics of the animal that influence its sightability. The Navy considered what applicable data were available to numerically approximate the sightability of marine mammals and determined that the standard "detection probability" referred to as $g(0)$ was most appropriate. The abundance of marine mammals is typically estimated using line-transect analyses (Buckland et al. 2001), in which $g(0)$ is the probability of detecting an animal or group of animals on the transect line (the straight-line course of the survey ship or aircraft). This detection probability is derived from systematic line-transect marine mammal surveys based on species-specific estimates for vessel and aerial platforms. Estimates of $g(0)$ are available from peer-reviewed marine mammal line-transect survey reports, generally provided through research conducted by the National Marine Fisheries Service Science Centers.

There are two separate components of $g(0)$: perception bias and availability bias (Marsh and Sinclair 1989). Perception bias accounts for marine mammals that are on the transect line and detectable, but were simply missed by the observer. Various factors influence the perception bias component of $g(0)$, including species-specific characteristics (e.g., behavior and appearance, group size, and blow characteristics), viewing conditions during the survey (e.g., sea state, wind speed, wind direction, wave height, and glare), observer characteristics (e.g., experience, fatigue, and concentration), and platform characteristics (e.g., pitch, roll, speed, and height above water).

To derive estimates of perception bias, typically an independent observer is present who looks for marine mammals missed by the primary observers. Mark-recapture methods are then used to estimate the probability that animals are missed by the primary observers. Availability bias accounts for animals that are missed because they are not at the surface at the time the survey platform passes by, which generally occurs more often with deep diving whales (e.g., sperm whales and beaked whales). The availability bias portion of $g(0)$ is independent of prior marine mammal detection experience since it only reflects the probability of an animal being at the surface within the survey track and therefore available for detection.

Some $g(0)$ values are estimates of perception bias only, some are estimates of availability bias only, and some reflect both, depending on the species and data that are currently available. The Navy used $g(0)$

values with both perception and availability bias components if that data was available. If both components were not available for a particular species, the Navy determined that $g(0)$ values reflecting perception bias or availability bias, but not both, still represent the best statistically-derived factor for assessing the likelihood of marine mammal detection by Navy Lookouts.

As noted above, line-transect surveys and subsequent analyses are typically used to estimate cetacean abundance. To systematically sample portions of an ocean area (such as the coastal waters off California or the east coast), marine mammal surveys are designed to uniformly cover the survey area and are conducted at a constant speed (generally 10 knots for ships and 100 knots for aircraft). Survey transect lines typically follow a pattern of straight lines or grids. Generally, there are two primary observers searching for marine mammals. Each primary observer looks for marine mammals in the forward 90-degree quadrant on their side of the survey platform. Based on data collected during the survey, scientists determine the factors that affected the detection of an animal or group of animals directly along the transect line.

Visual marine mammal surveys (used to derive $g(0)$) are conducted during daylight.¹⁰ Marine mammal surveys are typically scheduled for a season when weather at sea is more likely to be good, however, observers on marine mammal surveys will generally collect data in sea state conditions up to Beaufort 6 and do encounter rain and fog at sea which may also reduce marine mammal detections (see Barlow 2006). For most species, $g(0)$ values are based on the detection probability in conditions from Beaufort 0 to Beaufort 5, which reflects the fact that marine mammal surveys are often conducted in less than ideal conditions (see Barlow 2003, Barlow and Forney 2007). The ability to detect some species (e.g., small beaked whales and Dall's porpoise) decreases dramatically with increasing sea states, so $g(0)$ estimates for these species are usually restricted to observations in sea state conditions of Beaufort 0 to 2 (Barlow 2003).

Navy training events differ from systematic line-transect marine mammal surveys in several respects. These differences suggest the use of $g(0)$, as a sightability factor to quantitatively adjust model-predicted effects based on mitigation is likely to result in an underestimate of the protection afforded by the implementation of mitigation as follows:

- Mitigation zones for training events are significantly smaller (typically less than 1,000 yd. radius) than the area typically searched during line-transect surveys, which includes the maximum viewable distance out to the horizon.
- The case of Navy Carrier Strike Group training in the Gulf of Alaska, events involve more than one vessel or aircraft (or both) operating in proximity to each other or otherwise covering the same general area. Additional vessels and aircraft can result in additional watch personnel observing the mitigation zone (e.g., a Sinking Exercise). This would result in more observation platforms and observers looking at the mitigation zone than the two primary observers used in marine mammal surveys upon which $g(0)$ is based.
- A systematic marine mammal line-transect survey is designed to sample broad areas of the ocean, and generally does not retrace the same area during a given survey. Therefore, in terms of $g(0)$, the two primary observers have only a limited opportunity to detect marine mammals that may be present during a single pass along the trackline (i.e., deep diving species may not be present at the surface as the survey transits the area). In contrast, many training activities involve area-focused events (e.g., anti-submarine warfare tracking exercise), where participants

¹⁰ At night, passive acoustic data may still be collected during a marine mammal survey.

are likely to remain in the same general area during an event. In other cases training activities are stationary (e.g., use of dipping sonar), which allows Lookouts to focus on the same area throughout the activity. Both of these circumstances result in a longer observation period of a focused area with more opportunities for detecting marine mammals than are offered by a systematic marine mammal line-transect survey that only passes through an area once.

Although Navy Lookouts on ships have hand-held binoculars and, on some ships, pedestal mounted binoculars very similar to those used in marine mammal surveys, there are differences between the scope and purpose of marine mammal detections during research surveys along a trackline and Navy Lookouts observing the water proximate to a Navy training activity to facilitate implementation of mitigation. The distinctions required careful consideration when comparing the Navy Lookouts to marine mammal surveys.¹¹

- A marine mammal observer is responsible for detecting marine mammals in their quadrant of the trackline out to the limit of the available optics. Although Navy Lookouts are responsible for observing the water for safety of ships and aircraft, during specific training activities, they need only detect marine mammals in the relatively small area that surrounds the mitigation zone (in most cases less than 1,000 yd. from the ship) for mitigation to be implemented.
- Navy Lookouts, personnel aboard aircraft and on watch onboard vessels at the surface will have less experience detecting marine mammals than marine mammal observers used for line-transit survey. However, Navy personnel responsible for observing the water for safety of ships and aircraft do have significant experience looking for objects (including marine mammals) on the water's surface and Lookouts are trained using the NMFS-approved Marine Species Awareness Training.

Although there are distinct differences between marine mammal surveys and the proposed training activities, the use of $g(0)$ as an approximate sightability factor for quantitatively adjusting model-predicted impacts due to mitigation (mitigation effectiveness $\times g(0)$) is an appropriate use of the best available science based on the way it has been applied. Consistent with the Navy's impact assessment processes, the Navy applied $g(0)$ in a conservative manner (erring on the side of overestimating the

¹¹ Barlow and Gisiner (2006) provide a description of typical marine mammal survey methods from ship and aircraft and then provide "a crude estimate" of the difference in detection of beaked whales between trained marine mammal observers and seismic survey mitigation, which is not informative with regard to Navy mitigation procedures for the following reasons. The authors note that seismic survey differs from marine mammal surveys in that "(1) seismic surveys are also conducted at night; (2) seismic surveys are not limited to calm sea conditions; (3) mitigation observers are primarily searching with unaided eyes and 7x binoculars; and (4) typically only one or possibly two observers are searching." When the Navy implements mitigation for which adjustments to modeling output were made, the four conditions Barlow and Gisiner (2006) note are not representative of Navy procedures nor necessarily a difference in marine mammal line-transect survey procedures. The Navy accounts for reduced visibility (i.e., activities which occur at night, etc.) by assigning a lower value to the mitigation effectiveness factor. Additionally, in the TMAA during the proposed mid-summer training there should be 18–19 hours of daylight. On Navy ships, hand-held binoculars are always available and pedestal mounted binoculars, very similar to those used in marine mammal surveys, are generally available to Navy Lookouts on board vessels over 60 ft. Also, like marine mammal observers, Navy Lookouts are trained to use a methodical combination of unaided eye and optics as they search the surface around a vessel. The implication that marine mammal surveys only occur in "calm sea conditions" is not accurate since the vast majority of marine mammal surveys occur and data are collected in conditions up to sea states of Beaufort 5. The specific $g(0)$ values analyzed by Barlow and Gisiner (2006) were derived from survey data for Cuvier's and *Mesoplodon* beaked whale that were detected in sea states of Beaufort 0–2 during daylight hours. However, marine mammal surveys are not restricted to sea states of Beaufort 0–2, many species $g(0)$ values are based on conditions up to and including Beaufort 5 and, therefore, the conclusions reached by Barlow and Gisiner (2006) regarding the effect of sea state conditions on sightability do not apply to other species. Finally, when Lookouts are present, there are always more than the "one or two personnel" described by Barlow and Gisiner (2006) observing the area ahead of a Navy vessel (additional bridge watch personnel are also observing the water around the vessel).

number of impacts) to quantitatively adjust model-predicted effects to marine mammals within the applicable mitigation zones during training activities. Conservative application of $g(0)$ include:

- In addition to a sightability factor (based on $g(0)$), the Navy also applied a mitigation effectiveness factor to acknowledge the uncertainty associated with applying the $g(0)$ values derived from marine mammal surveys to specific Navy training and testing activities where the ability to observe the whole mitigation zone is less than optimal (generally due to the size of the mitigation zone).
- For activities that can be conducted at night, the Navy assigned a lower value to the mitigation effectiveness factor. For example, if an activity can take place at night half the time, then the mitigation effectiveness factor was only given a value of 0.5 (note this will occur less often in the TMAA during the mid-summer training when there should be 18–19 hours of daylight).
- The Navy did not quantitatively adjust model-predicted effects for activities that were given a mitigation effectiveness factor of zero. A mitigation effectiveness factor of zero was given to activities where less than half of the mitigation zone can be continuously visually observed or if the mitigation zone cannot be continuously visually observed during most of the scenarios within the activity due to the type of surveillance platform(s), number of Lookouts, and size of the mitigation zone. However, some protection from applied mitigation measures would be afforded during these activities, even though they are not accounted for in the quantitative reduction of model-predicted impacts.
- The Navy did not quantitatively adjust model-predicted effects based on detections made by other personnel that may be involved with an event (such as support personnel aboard a boat towing a target or onboard support aircraft), even though information about marine mammal sightings are shared among units participating in the training or activity. In other words, the Navy only quantitatively adjusted the model-predicted effects based on the required number of Lookouts as specified in established mitigation measures.
- The Navy only quantitatively adjusted model-predicted effects within the range to mortality (explosives only) and injury (all sound-producing activities) (see Chapter 11 for a comparison of the range to effects for PTS, TTS, and the recommended mitigation zone). Despite employing the required mitigation measures during an activity that will also reduce some TTS exposures, the Navy did not quantitatively adjust the model-predicted TTS effects or other predicted behavioral effects as a result of implemented mitigation.
- The total model-predicted number of animals affected is not reduced by the post-model mitigation analysis, since all reductions in mortality and injury effects are then added to and counted as TTS effects.
- Mitigation involving a power-down or cessation of sonar, or delay in use of explosives, as a result of a marine mammal detection, protects the observed animal and all unobserved (below the surface) animals in the vicinity. The quantitative adjustments of model-predicted impacts, however, assumes that only animals on the water surface, approximated by considering the species-specific $g(0)$ and activity-specific mitigation effectiveness factor, would be protected by the applied mitigation (i.e., a power down or cessation of sonar or delaying the event). The quantitative post-model mitigation analysis, therefore, does not capture the protection afforded to all marine mammals that may be near or within the mitigation zone.

The Navy recognizes that $g(0)$ values are estimated specifically for line-transect analyses; however, $g(0)$ is still the best statistically-derived factor for assessing the likely marine mammal detection abilities of Navy Lookouts. This sightability factor is then used in post-modeling adjustments to account for the reduced potential for mortality and injury to occur as a result of implemented mitigation. Based on the

points summarized above, as a factor used in accounting for the implementation of mitigation, $g(0)$ is therefore considered to be the best available scientific basis for Navy's representation of the sightability of a marine mammal as used in this analysis.

The $g(0)$ value used in the mitigation analysis is based on the platform(s) with Lookouts utilized in the activity. In the case of multiple platforms, the higher $g(0)$ value for either the aerial or vessel platform is selected. For species for which there is only a single published value for each platform, that individual value is used. For species for which there is a range of published $g(0)$ values, an average of the values, calculated separately for each platform, is used. A $g(0)$ of zero is assigned to species for which there is no data available, unless a $g(0)$ estimate can be extrapolated from similar species/guilds based on the published $g(0)$ values. The $g(0)$ values used in this analysis are provided in Table 3.8-9. The post-model acoustic effects quantification process is summarized in Table 3.8-10.

Table 3.8-9: Sightability Based on $g(0)$ Values for Marine Mammal Species in Temporary Maritime Activities Area

Species/Stocks	Family	Vessel Sightability	Aircraft Sightability
Baird's Beaked Whale	Ziphiidae	0.96	0.18
Blue Whale, Fin Whale; Sei Whale	Balaenopteridae	0.921	0.407
California Sea Lion, Northern Fur Seal, Steller Sea Lion	Zalophus, Otariidae, Otariidae	0.299	0.299
Cuvier's Beaked Whale	Ziphiidae	0.23	0.074
Dall's Porpoise	Phocoenidae	0.822	0.221
Gray Whale	Eschrichtiidae	0.921	0.482
Harbor Porpoise	Phocoenidae	0.769	0.292
Harbor Seal, Ribbon Seal	Phoca vitulina, Phocidae	0.281	0.281
Humpback Whale	Balaenopteridae	0.921	0.495
Killer Whale	Delphinidae	0.921	0.95
Minke Whale	Balaenopteridae	0.856	0.386
North Pacific Right Whale	Eubalaena	0.645	0.41
Northern Elephant Seal	Mirounga	0.105	0.105
Pacific White-Sided Dolphin	Delphinidae	0.856	0.67
Sperm Whale	Physeteridae	0.87	0.32
Stejneger's Beaked Whale	Mesoplodon	0.23	0.074

Notes: When there was no value available for vessels, the $g(0)$ for aircraft was used as a conservative underestimate of sightability following the assumption that the availability bias from a slower moving vessel should result in a higher $g(0)$. The $g(0)$ for Cuvier's beaked whale was used for Stejneger's beaked whale given there is no data available for Stejneger's. The published California Sea Lion aircraft $g(0)$ is used for Steller Sea Lion and Northern Fur Seal since all are in the otariidae family and there is no $g(0)$ data for these other species. The published Harbor Seal aircraft $g(0)$ is used for Ribbon Seal since they are in the phocid family and there is no $g(0)$ data for ribbon seal. North Atlantic right whale data (Palka 2005) has been used for North Pacific right whale.

Sources: Barlow 2006, Barlow and Forney 2007, Barlow et al. 2006, Carretta et al. 2000, Forney and Barlow 1998, Laake et al. 1997, Palka 2005

Table 3.8-10: Post-Model Acoustic Effects Quantification Process

Sonar or other active acoustic source	Explosives
S-1. Is the activity preceded by multiple vessel activity or hovering helicopter? Species sensitive to human activity (i.e., harbor porpoise and beaked whales) are assumed to avoid the activity area, as the participants arrive and prepare for the event and before sonar activities and the use of explosives commence, putting them out of the range to Level A harassment. Model-estimated PTS to these species during these activities are unlikely to actually occur and, therefore, are considered to be TTS (animal is assumed to move into the range of potential TTS). The Carrier Strike Group exercise is modeled as having multiple vessel movements, planes, and hovering helicopters as part of the exercise events.	E-1. Is the activity preceded by multiple vessel activity or hovering helicopter? Species sensitive to human activity (i.e., harbor porpoise and beaked whales) are assumed to avoid the activity area, putting them out of the range to mortality. Model-estimated mortalities to these species during these activities are unlikely to actually occur and, therefore, are considered to be injuries (animal is assumed to move into the range of potential injury). For this analysis, the Sinking Exercise (SINKEX) is the only activity modeled as being preceded by multiple vessel movements and hovering helicopters.
S-2. Can Lookouts observe the activity-specific mitigation zone (see Chapter 5) up to and during the sound-producing activity? If Lookouts are able to observe the mitigation zone up to and during a sound-producing activity, the sound-producing activity would be halted or delayed if a marine mammal is observed and would not resume until the animal is thought to be out of the mitigation zone. Therefore, model-estimated PTS are reduced by the portion of animals that are likely to be seen [Mitigation Effectiveness (1, 0.5, or 0) x Sightability, g(0)]. Any animals removed from the model-estimated PTS are instead assumed to be TTS (animal is assumed to move into the range of TTS). The g(0) value is associated with the platform (vessel or aircraft) with the Lookout(s). For activities with Lookouts on both platforms, the higher g(0) is used for analysis. The g(0) values are provided in Table 3.8-8. The Mitigation Effectiveness during the Carrier Strike Group exercise is given a factor of 1, since the activities are modeled as involving multiple vessels, planes, and helicopters operating in a coordinated manner. Marine mammals in the mid-frequency hearing group would have to be close to the most powerful moving source (less than 10 m) to experience PTS. These model-estimated PTS of mid-frequency cetaceans are unlikely to actually occur and, therefore, are considered to be TTS (animal is assumed to move into the range of TTS).	E-2. Can Lookouts observe the activity-specific mitigation zone (see Chapter 5) up to and during the sound-producing activity? If Lookouts are able to observe the mitigation zone up to and during an explosion, the explosive activity would be halted or delayed if a marine mammal is observed and would not resume until the animal is thought to be out of the mitigation zone. Therefore, model-estimated mortalities and injuries are reduced by the portion of animals that are likely to be seen [Mitigation Effectiveness (1, 0.5, or 0) x Sightability, g(0)]. Any animals removed from the model-estimated mortalities or injuries are instead assumed to be injuries or behavioral disturbances, respectively (animals are assumed to move into the range of a lower effect). The g(0) value is associated with the platform (vessel or aircraft) with the Lookout(s). For activities with Lookouts on both platforms, the higher g(0) is used for analysis. The g(0) values are provided in Table 3.8-8. The Mitigation Effectiveness values for explosive activities are given in Table 3.8-19.
S-3. Does the activity cause repeated sound exposures which an animal would likely avoid? The Navy Acoustic Effects Model assumes that animals do not move away from a sound source and receive a maximum sound exposure level. In reality, an animal would likely avoid repeated sound exposures that would cause PTS by moving away from the sound source. Therefore, only the initial exposures resulting in model-estimated PTS to high-frequency cetaceans, low frequency cetaceans, and phocids are expected to actually occur (after accounting for mitigation in step S-2). Model estimates of PTS beyond the initial pings are considered to actually be behavioral disturbances, as the animal is assumed to move out of the range to PTS and into the range of TTS. Given that the Carrier Strike Group exercise involves multiple vessels, planes, and helicopters operating in a coordinated manner during the anti-submarine warfare events, the training involves multiple sound sources an animal would likely avoid.	E-3. Does the activity cause repeated sound exposures which an animal would likely avoid? The Navy Acoustic Effects Model assumes that animals do not move away from multiple explosions and receive a maximum sound exposure level. In reality, an animal would likely avoid repeated sound exposures that would cause PTS by moving away from the site of multiple explosions. Therefore, only the initial exposures resulting in model-estimated PTS are expected to actually occur (after accounting for mitigation in step E-2). Model estimates of PTS are reduced to account for animals moving away from an area with multiple explosions, out of the range to PTS, and into the range of TTS. Activities with multiple explosions are listed in Table 3.8-20.

The post-model acoustic effect analysis quantification process is summarized in Table 3.8-10 and presented in detail in the technical report Post-Model Quantitative Analysis of Animal Avoidance Behavior and Mitigation Effectiveness for the Gulf of Alaska Training Activities (U.S. Department of the Navy 2014b). In brief, the mitigation effectiveness score for an event is multiplied by the estimated sightability of each species to quantify the number of animals that were originally modeled as a mortality (explosives only) or injury (all sound-producing activities) exposure but would, in reality, be observed by Lookouts or shore-based observers prior to or during a sound-producing activity. Observation of marine mammals prior to or during a sound-producing event would be followed by stop or delay of the sound-producing activity, which would reduce actual marine mammal sound exposures. The final quantified results of the acoustic effects analysis for non-impulsive sources are presented in Section 3.8.3.3.2 (Model Predicted Effects from use of Sonar and Other Active Acoustic Sources) and for explosive sources in Section 3.8.3.3.7 (Model Predicted Effects from use of Explosives) for the three alternatives.

The incorporation of mitigation factors for the reduction of predicted effects used a conservative approach (erring on the side of overestimating the number of effects) since reductions as a result of implemented mitigation were only applied to those events having a very high likelihood of detecting marine mammals. It is important to note that there are additional protections offered by mitigation procedures, which will further reduce effects to marine mammals, but these are not considered in the quantitative adjustment of the model predicted effects.

3.8.3.1.9 Marine Mammal Monitoring During Navy Training

The current behavioral exposure criteria under the response function also assumes there will be a range of reactions from minor or inconsequential to severe. Section 3.8.5.1 (Alaska Specific Monitoring and Research) summarizes the monitoring data that has been collected thus far within the Study Area. There is, in addition, other relevant monitoring and research that has been completed across the Navy since 2006 and that is summarized for the Pacific in Section 3.8.5 (Summary of Observations During Previous Navy Activities). Results of monitoring may provide indications that the severity of reactions has also been overestimated.

3.8.3.2 Application of the Marine Mammal Protection Act to Potential Acoustic Effects

The MMPA prohibits the unauthorized harassment of marine mammals and provides the regulatory processes for authorization for any such incidental harassment that might occur during an otherwise lawful activity. Harassment that may result from training activities described in this Supplemental EIS/OEIS is unintentional and incidental to those activities.

For military readiness activities, MMPA 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 this Supplemental EIS/OEIS, is the destruction or loss of biological tissue from a marine mammal. 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 Supplemental EIS/OEIS assumes that all injury is qualified as a physiological effect and, to be consistent with prior actions and rulings (National Marine Fisheries Service 2001b, 2008a, 2008b; National Oceanic and Atmospheric Administration 2013b), all injuries (except those serious enough to be expected to result in mortality) are considered MMPA Level A harassment.

PTS is non-recoverable and, by definition, results from the irreversible impacts to auditory sensory cells, supporting tissues, or neural structures within the auditory system. PTS therefore qualifies as an injury and is classified as Level A harassment under the wording of the MMPA. 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 MMPA Level A exposure zone. Model predicted slight lung injury and gastrointestinal tract injuries are considered MMPA Level A harassment in this analysis.

Public Law 108–136 (2004) amended the MMPA definitions of, Level B harassment for military readiness activities to be “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 MMPA Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause MMPA Level B harassment.

TTS is recoverable and is considered to result from the temporary, non-injurious fatigue of hearing-related tissues. 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 MMPA Level B exposure zone attributable to physiological effects. Short term reduction in hearing acuity could be considered a temporary decrement, similar in scope to a period of hearing masking or behavioral disturbance. As such, it is considered by the Navy and NMFS as a Level B effect overlapping the range of sounds producing behavioral effects.

As noted previously, the TTS and PTS criteria used by the Navy in the quantification of MMPA effects parallels the recent National Oceanic and Atmospheric Administration’s draft “Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals.” This criteria was proposed in December 2013 and is still in review as of October 2015. Details can be found at www.nmfs.noaa.gov/pr/acoustics/guidelines.htm.

The harassment status of slight behavior disruption has been addressed in workshops, previous actions, and rulings (National Marine Fisheries Service 2001b, 2008a, 2008b; National Oceanic and Atmospheric Administration 2013b; U.S. Department of Defense 2001). The conclusion is that a momentary behavioral reaction of an animal to a brief, time-isolated acoustic event does not qualify as MMPA Level B harassment. However, as explained in Section 3.8.3.1.6.4 (Model Assumptions and Limitations), the model cannot predict the severity of the behavioral response. This analysis uses behavioral criteria to predict the number of animals likely to experience a behavioral reaction, and therefore a MMPA Level B harassment. Consistent with the analysis of identical Navy training activities elsewhere, the majority of the Level B harassment takes are expected to be in the form of milder responses that are not expected to have deleterious impacts on the fitness of any individuals or long-term consequences to populations of marine mammals (National Oceanic and Atmospheric Administration 2015g).

NMFS also includes mortality, or serious injury likely to result in mortality, as a possible outcome to consider in addition to MMPA Level A and MMPA Level B harassment. An individual animal predicted to experience simultaneous multiple injuries, multiple disruptions, or both, is typically counted as a single take (National Marine Fisheries Service 2001b, 2006, 2008a; National Oceanic and Atmospheric Administration 2009; 2013b). There are many possible temporal and spatial combinations of activities, stressors, and responses, for which multiple reasonable methods can be used to quantify take by Level B

harassment on a case-specific basis. NMFS generally considers it appropriate for applicants to consider multiple modeled exposures of an individual animal to levels above the behavioral harassment threshold within one 24-hour period as a single MMPA take. Behavioral harassment, under the response function presented in this request, uses received sound pressure level over a 24-hour period as the metric for determining the probability of harassment.

3.8.3.2.1 Application of the Endangered Species Act to Marine Mammals

Generalized information on definitions and the application of the ESA are presented in Chapter 3 (General Approach to Analysis) along with the acoustic conceptual framework used in this analysis. Consistent with NMFS analysis for Section 7 consultation under the ESA (e.g., see National Oceanic and Atmospheric Administration 2013b), the spatial and temporal overlap of activities with the presence of listed species is assessed in this Supplemental EIS/OEIS. The definitions used by the Navy in making the determination of effect under Section 7 of the ESA are based on the USFWS and NMFS *Endangered Species Consultation Handbook* (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998), and recent NMFS Biological Opinions involving many of the same activities and species.

- “No effect” is the appropriate conclusion when a listed species or its designated critical habitat will not be affected, either because the species will not be present or because the project does not have any elements with the potential to affect the species or modify designated critical habitat. “No effect” does not include a small effect or an effect that is unlikely to occur.
- If effects are insignificant (in size) or discountable (extremely unlikely), a “may affect” determination is still appropriate. “May affect” is appropriate when animals are within a range where they could potentially detect or otherwise be affected by the sound (e.g., the sound is above background ambient levels).
 - Insignificant effects relate to the size of the impact and should never reach the scale where take occurs.
 - Discountable effects are those extremely unlikely to occur and based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.
- If a stressor and species presence overlap, and a predicted effect is not insignificant, discountable, or beneficial, a “may affect, likely to adversely affect” determination is appropriate.

There are no harassment or injury criteria established for marine mammals under the ESA because the ESA requires an assessment starting with mere exposure potential (resulting in a “may affect” determination under the ESA). Acoustic modeling is used to predict the number of ESA-listed marine mammals exposed to sound resulting from training activities, without any behavioral or physiological criteria applied. In order to determine if adverse effects may result pursuant to the ESA, the Navy assumed that any exposures that resulted in MMPA harassment equated to “may affect, likely to adversely affect” when the definition of “take” under both statutes were taken into consideration.

3.8.3.3 Analysis of Effects on Marine Mammals

3.8.3.3.1 Impacts from Sonar and Other Active Acoustic Sources

Sonar and other active acoustic sources proposed for use are transient in most locations as active sonar activities move throughout the Study Area. Sonar and other active acoustic sound sources emit sound waves into the water to detect objects, safely navigate, and communicate. General categories of sonar systems are described in Section 2.2.1 (Classification of Non-Impulsive and Impulsive Sources).

Exposure of marine mammals to non-impulsive sources such as active sonar is not likely to result in primary blast injuries or barotraumas given the power output of the sources and the proximity to the source that would be required. Sonar induced acoustic resonance and bubble formation phenomena are also unlikely to occur under realistic conditions in the ocean environment, as discussed in Section 3.8.3.1.2.1 (Direct Injury). Direct injury from sonar and other active acoustic sources would not occur under conditions present in the natural environment and therefore is not considered further in this analysis.

Research and observations of auditory masking in marine mammals is discussed in Section 3.8.3.1.2.4 (Auditory Masking). Anti-submarine warfare sonar can produce intense underwater sounds in the Study Area associated with the Proposed Action. These sounds are likely within the audible range of most cetaceans but are normally very limited in the temporal, frequency, and spatial domains. The duration of individual sounds is short; sonar pulses can last up to a few seconds each, but most are shorter than 1 second. The duty cycle is low, with most tactical anti-submarine warfare sonar typically transmitting about once per minute. Furthermore, events are geographically and temporally dispersed, and most events are limited to a few hours. Tactical sonar has a narrow frequency band (typically less than one-third octave). These factors reduce the likelihood of sources causing significant auditory masking in marine mammals.

Some sound sources (i.e., submarine navigation sonar) have a high duty cycle producing up to a few pings per second. Such sonar typically employs high frequencies (above 10 kHz) that attenuate rapidly in the water, thus producing only a small area of potential auditory masking. These higher-frequency systems are typically outside the hearing and vocalization ranges of mysticetes (Section 3.8.2.3, Vocalization and Hearing of Marine Mammals); therefore, mysticetes are unlikely to be able to detect the higher frequency systems, and these systems would not interfere with their communication or detection of biologically relevant sounds. Odontocetes may experience some limited masking at closer ranges as the frequency band of many higher frequency systems overlaps the hearing and vocalization abilities of some odontocetes; however, the frequency band of these systems is narrow, limiting the likelihood of auditory masking. With any of the activities using these systems, the limited duration and dispersion of the activities in space and time reduce the potential for auditory masking effects from proposed activities on marine mammals.

The most probable effects from exposure to sonar and other active acoustic sources are PTS, TTS, and behavioral harassment (Section 3.8.3.1.2.3, Hearing Loss, and Section 3.8.3.1.2.6, Behavioral Reactions). The NAEMO is used to produce initial estimates of the number of animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. These are discussed below in the following sections.

Another concern is the number of times an individual marine mammal is exposed and potentially reacts to a sonar or other active acoustic source associated with Navy training within the TMAA. Repeated and chronic noise exposures to marine mammals and their observed reactions are discussed in this analysis where applicable; however, the sound producing activities associated with a Carrier Strike Group exercise are of limited extent and duration and will not constitute a source of long-term chronic noise exposure such as those stressors (whale watching, commercial vessel noise, etc.) discussed in Section 3.8.3.1.2.6 (Behavioral Reactions).

3.8.3.3.1.1 Range to Effects

The following section provides range (distance) over which specific physiological or behavioral effects are expected to occur based on the acoustic criteria (see Finneran and Jenkins 2012) and the acoustic propagation calculations from the NAEMO (Section 3.8.3.1.6.3, Navy Acoustic Effects Model). The range to specific effects are used to assess model results and determine adequate mitigation ranges to avoid higher level effects, especially physiological effects. Additionally, these data can be used to analyze the likelihood of an animal being able to avoid an oncoming sound source by simply moving a short distance (i.e., within a few hundred meters). Figure 3.8-15 shows a representation of effects with distance from a hypothetical sonar source; notice the proportion of animals that are likely to have a behavioral response (yellow block; “response-function”) decreases with increasing distance from the source.

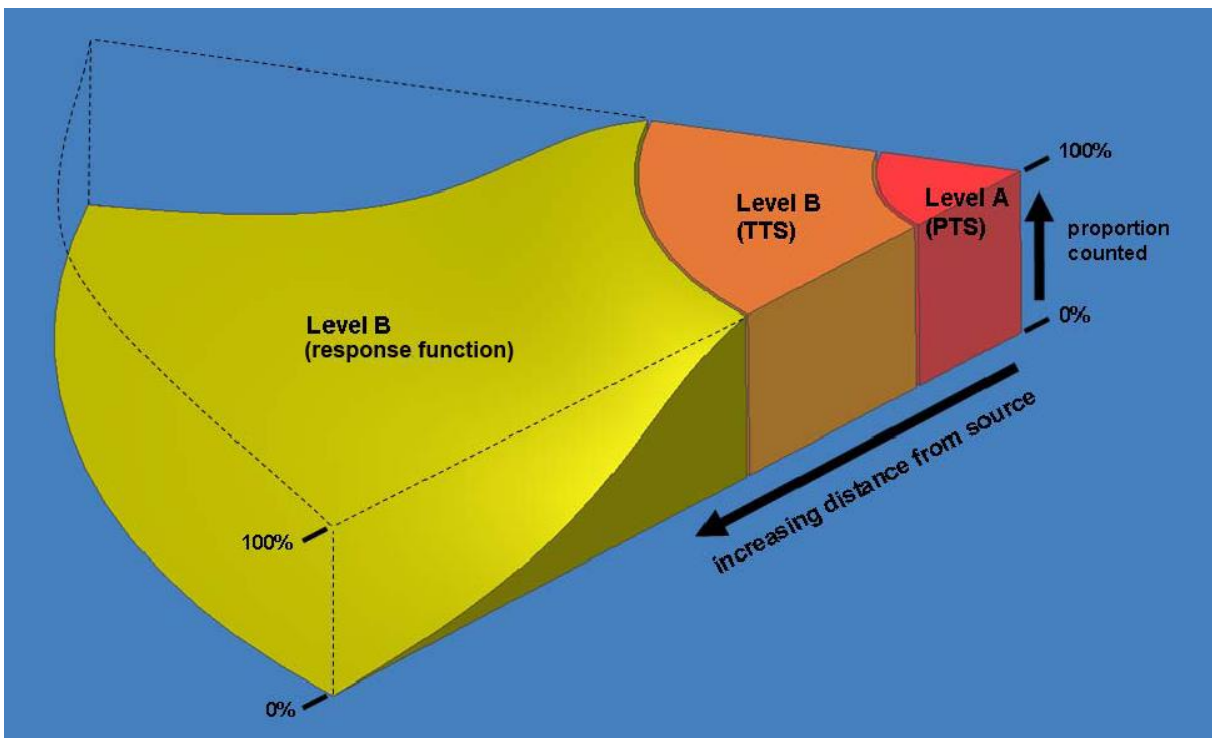


Figure 3.8-15: Hypothetical Range to Specified Effects for a Sonar Source

Although the Navy uses a number of sonar and other non-impulsive sources, the three source class bins provided below (MF1, MF4, and MF5) represent three of the most powerful sources (see Section 2.2.1, Classification of Non-Impulsive and Impulsive Sources, for a discussion of sonar and other non-impulsive source bins included in this analysis). The sources in these three bins are often the dominant source in an activity in which they are included, especially for smaller unit level training activities. Therefore, these ranges provide realistic maximum distances over which the specific effects would be possible.

PTS: The ranges to the PTS threshold are shown in Table 3.8-11 are relative to the marine mammal's functional hearing group (Navy's high frequency sources have a lower source level and more energy loss over distance than these mid-frequency examples and therefore have a shorter range to effects). For a SQS-53C sonar transmitting for 1 second at 3 kHz and a source level of 235 dB re $1 \mu\text{Pa}^2\text{-s}$ at 1 m, the range to PTS for the most sensitive species (the high-frequency cetaceans) extends from the source to a range of approximately 100 m (109 yd.).

Table 3.8-11: Approximate Ranges to Permanent Threshold Shift Criteria for Each Functional Hearing Group for a Single Ping from Three of the Most Powerful Sonar Systems within Representative Ocean Acoustic Environments

Functional Hearing Group	Ranges to the Onset of PTS for One Ping (meters) ¹		
	Sonar Bin MF1 (e.g., SQS-53; ASW Hull-Mounted Sonar)	Sonar Bin MF4 (e.g., AQS-22; ASW Dipping Sonar)	Sonar Bin MF5 (e.g., SSQ-62; ASW Sonobuoy)
Low-Frequency Cetaceans	70	10	< 2
Mid-Frequency Cetaceans	10	< 2	< 2
High-Frequency Cetaceans	100	20	10
Phocid Seals	80	10	< 2
Otariid Seals & Sea Lions; Mustelid (Sea Otters)	10	< 2	< 2

¹ PTS ranges extend from the sonar or other active acoustic sound source to the indicated approximate distance. These approximate ranges are based on spherical spreading (Transmission Loss = 20 log R, where R = range in meters).

Notes: ASW = Anti-Submarine Warfare, PTS = Permanent Threshold Shift

Since any surface vessel using hull-mounted anti-submarine warfare sonar, such as the SQS-53, engaged in anti-submarine warfare training would be moving at between 10 and 15 knots (5.1 and 7.7 m/second) and nominally pinging every 50 seconds, the vessel will have traveled a minimum distance of approximately 280 yd. (257 m) during the time between those pings (note: 10 knots is the speed used in the NAEMO). As a result of the vessel moving forward, there is little overlap of PTS footprints from successive pings, indicating that in most cases, an animal predicted to receive PTS would do so from a single exposure (i.e., ping). For all other functional hearing groups (low-frequency cetaceans and mid-frequency cetaceans, phocid, otariid, and mustelid) single-ping PTS zones are within 110 yd. (100 m) of the sound source. A scenario could be imagined where an animal does not leave the vicinity of a ship or travels a course parallel to the ship within the PTS zone; however, as indicated in Table 3.8-10 the sustained proximity to the ship required make it unlikely there would be exposures resulting in PTS from any subsequent pings. For a Navy vessel moving at a nominal 10 knots, it is unlikely a marine mammal could maintain the speed to parallel the ship and receive adequate energy over successive pings to result in a PTS exposure. For all sources except hull-mounted sonar (e.g., SQS-53 and BQQ-10) ranges to PTS are well within 55 yd. (50 m), even for multiple pings (up to five pings examined) and the most sensitive functional hearing group (high-frequency cetaceans).

Under average environmental conditions for the most powerful active acoustic sources, hull-mounted anti-submarine warfare sonar (e.g., Bin MF1; SQS-53C), for a single ping the range to the onset of PTS for otariid seals and sea lions and sea otter does not exceed 2 yd. (2 m); for mid-frequency cetaceans (the majority of species present) it does not exceed 11 yd. (10 m); for low-frequency cetaceans does not exceed 77 yd. (70 m); for phocid seals does not exceed and 87 yd. (80 m); and for high-frequency cetaceans does not exceed 109 yd. (100 m). In the Study Area the high-frequency cetaceans include harbor porpoise and Dall's porpoise. Harbor porpoise are known to avoid areas of human activity and underwater noise. Likewise, all other species are assumed to avoid the area immediately around an active sound source, beyond the ranges where PTS would be possible.

TTS: Table 3.8-12 illustrates the ranges to the onset of TTS (i.e., the maximum distances to which TTS would be expected) for one, five, and ten pings from four representative source bins and sonar systems. Due to the lower acoustic thresholds for TTS versus PTS, ranges to TTS are longer; this can also be thought of as a larger volume acoustic footprint for TTS effects. Because the effects threshold is total

summed sound energy and because of the longer distances, successive pings can add together, further increasing the range to onset-TTS.

Table 3.8-12: Approximate Maximum Ranges to the Onset of Temporary Threshold Shift for Three Representative Sonar Over a Representative Range of Ocean Environments

Functional Hearing Group	Approximate Range to Onset TTS (meters)								
	Sonar Bin MF1 (e.g., SQS-53; ASW Hull-Mounted Sonar)			Sonar Bin MF4 (e.g., AQS-22; ASW Dipping Sonar)			Sonar Bin MF5 (e.g., SSQ-62; ASW Sonobuoy)		
	One Ping	Five Pings	Ten Pings	One Ping	Five Pings	Ten Pings	One Ping	Five Pings	Ten Pings
Low-frequency cetaceans	560–2,280	1,230–6,250	1,620–8,860	220–240	490–1,910	750–2,700	110–120	240–310	340–1,560
Mid-frequency cetaceans	150–180	340–440	510–1,750	< 50	< 50	< 50	< 50	< 50	< 50
High-frequency cetaceans	2,170–7,570	4,050–15,350	5,430–19,500	90	180–190	260–950	< 50	< 50	< 50
Otariid seals, sea lion, and Mustelid (sea otter)	230–570	1,240–1,300	1,760–1,780	< 50	< 50	< 50	< 50	< 50	< 50
Phocid seals	70–1,720	200–3,570	350–4,850	< 50	100	150	< 50	< 50	< 50

Notes: ASW = Anti-Submarine Warfare, TTS = Temporary Threshold Shift

Behavioral: The distances over which the sound pressure level from three representative sonar sources is within the indicated 6 dB bins, and the percentage of animals that may exhibit a behavioral response under the mysticete and odontocete behavioral response function, are shown in Table 3.8-13 and Table 3.8-14, respectively. See Section 3.8.3.1.2 (Analysis Background and Framework) for details on the derivation and use of the behavioral response function as well as the step function thresholds for harbor porpoise and beaked whales of 140 dB re 1 μ Pa.

Range to 120 dB re 1 μ Pa varies by system, but can reach 97 nm for the most powerful hull-mounted sonar; however, only a very small percentage of animals would be predicted to react at received levels between 120 and 130 dB re 1 μ Pa, with the exception of harbor porpoises. All harbor porpoises that are predicted to receive 120 dB re 1 μ Pa or greater would be assumed to exhibit a behavioral response. Likewise, beaked whales would be predicted to have behavioral reactions at distances out to approximately 42 nm.

Table 3.8-13: Range to Received Sound Pressure Level in 6-Decibel Increments and Percentage of Behavioral Harassments for Low-Frequency Cetaceans under the Mysticete Behavioral Response Function for Three Representative Source Bins for the Study Area

Received Level in 6 dB Increments for Low-Frequency Cetaceans	Source Bin MF1 (e.g., SQS-53; Anti-Submarine Warfare Hull-Mounted Sonar)		Source Bin MF4 (e.g., AQS-22; Anti-Submarine Warfare Dipping Sonar)		Source Bin MF5 (e.g., SSQ-62; Anti-Submarine Warfare Sonobuoy)	
	Approximate Distance (m)	Behavioral Harassment % from SPL Increment	Approximate Distance (m)	Behavioral Harassment % from SPL Increment	Approximate Distance (m)	Behavioral Harassment % from SPL Increment
120 ≤ SPL < 126	185,400–160,325	0%	91,363–70,650	0%	20,463–12,725	0%
126 ≤ SPL < 132	160,325–138,400	0%	70,650–49,125	0%	12,725–7,575	0%
132 ≤ SPL < 138	138,400–118,100	0%	49,125–28,950	4%	7,575–3,813	5%
138 ≤ SPL < 144	118,100–85,400	2%	28,950–10,800	29%	3,813–2,200	15%
144 ≤ SPL < 150	85,400–61,288	7%	10,800–4,250	29%	2,200–638	51%
150 ≤ SPL < 156	61,288–42,750	19%	4,250–2,013	19%	638–250	18%
156 ≤ SPL < 162	42,750–20,813	43%	2,013–638	16%	250–100	9%
162 ≤ SPL < 168	20,813–4,375	26%	638–200	3%	100–< 50	3%
168 ≤ SPL < 174	4,375–1,825	1%	200–100	0%	< 50	0%
174 ≤ SPL < 180	1,825–750	0%	100–< 50	0%	< 50	0%
180 ≤ SPL < 186	750–375	0%	< 50	0%	< 50	0%
186 ≤ SPL < 192	375–200	0%	< 50	0%	< 50	0%
192 ≤ SPL < 198	200–100	0%	< 50	0%	< 50	0%

Notes: dB = decibels, m = meters, SPL = Sound Pressure Level

Table 3.8-14: Range to Received Sound Pressure Level in 6-Decibel Increments and Percentage of Behavioral Harassments under the Odontocete* Response Function for Three Representative Source Bins

Received Level in 6 dB Increments for Odontocetes and Pinnipeds	Source Bin MF1 (e.g., SQS-53; Anti-Submarine Warfare Hull-Mounted Sonar)		Source Bin MF4 (e.g., AQS-22; Anti-Submarine Warfare Dipping Sonar)		Source Bin MF5 (e.g., SSQ-62; Anti-Submarine Warfare Sonobuoy)	
	Approximate Distance (m)	Behavioral Harassment % from SPL Increment	Approximate Distance (m)	Behavioral Harassment % from SPL Increment	Approximate Distance (m)	Behavioral Harassment % from SPL Increment
120 ≤ SPL < 126	185,450–160,475	0%	93,075–71,275	0%	21,288–14,200	0%
126 ≤ SPL < 132	160,475–138,750	0%	71,275–50,938	0%	14,200–8,238	0%
132 ≤ SPL < 138	138,750–123,113	0%	50,938–29,075	1%	8,238–4,350	1%
138 ≤ SPL < 144	123,113–85,450	1%	29,075–11,050	14%	4,350–2,425	6%
144 ≤ SPL < 150	85,450–61,363	4%	11,050–4,250	25%	2,425–1,213	24%
150 ≤ SPL < 156	61,363–42,763	14%	4,250–2,013	24%	1,213–250	54%
156 ≤ SPL < 162	42,763–21,025	44%	2,013–638	28%	250–150	7%
162 ≤ SPL < 168	21,025–4,475	35%	638–200	7%	150–< 50	9%
168 ≤ SPL < 174	4,475–1,850	2%	200–100	1%	< 50	0%
174 ≤ SPL < 180	1,850–763	0%	100–< 50	0%	< 50	0%
180 ≤ SPL < 186	763–400	0%	< 50	0%	< 50	0%
186 ≤ SPL < 192	400–200	0%	< 50	0%	< 50	0%
192 ≤ SPL < 198	200–100	0%	< 50	0%	< 50	0%

* Note the Odontocete Behavioral Risk Function is used for mid-frequency and high-frequency cetaceans and pinnipeds; see Finneran and Jenkins (2012) for discussion of this approach.

Notes: dB = decibels, m = meters, SPL = Sound Pressure Level

3.8.3.3.1.2 Avoidance Behavior and Mitigation Measures as Applied to Sonar and Other Active Acoustic Sources

As discussed above, within the NAEMO, animats (virtual animals representing individual marine mammals) do not move horizontally or react in any way to avoid sound or any other disturbance. In reality, various researchers have demonstrated that cetaceans can perceive the movement of a sound source (e.g., vessel, seismic source, etc.) relative to their own location and react with responsive movement away from the source, often at distances of a kilometer or more (Au and Perryman 1982, Jansen et al. 2010, Palka and Hammond 2001, Richardson et al. 1995, Tyack 2009, Tyack et al. 2011,

Watkins 1986, Wursig et al. 1998). See Section 3.8.3.1.5 (Behavioral Responses) for a review of research and observations of marine mammals' reactions to sound sources including sonar, ships, and aircraft. The behavioral criteria used as a part of this analysis acknowledge that a behavioral reaction is likely to occur at levels below those required to cause a loss in hearing sensitivity (TTS or PTS) or higher order physiological impacts. At close ranges and high sound levels approaching those that could cause PTS, avoidance of the area immediately around intense activity associated with a sound source (such as a low hovering helicopter) or a sound source or both is assumed in most cases. Additionally, the NAEMO does not account for the implementation of mitigation, which would prevent many of the model-estimated PTS effects. Therefore, the model-estimated PTS effects due to sonar and other active acoustic sources are further analyzed considering avoidance and implementation of mitigation measures described in Section 3.8.3.1.6 (Quantitative Analysis) and using identical procedures to those described in the technical report *Post-Model Quantitative Analysis of Animal Avoidance Behavior and Mitigation Effectiveness for the Gulf of Alaska Training* (U.S. Department of the Navy 2014b).

For example, if sound-producing activities are preceded by multiple vessel traffic or hovering aircraft, harbor porpoise and beaked whales are assumed to move beyond the range to PTS before sound transmission begins, as discussed above in Section 3.8.3.1.7.1 (Avoidance of Human Activity). Table 3.8-10 shows the ranges to PTS for three of the most common and powerful sound sources proposed for use when training in the Study Area. The source class Bin MF1 includes the most powerful anti-submarine warfare system for a surface combatant, the SQS-53. The range to PTS for all systems is generally much less than 50 m (55 yd.), with the exception of high-frequency cetaceans exposed to Bin MF1 with a PTS range of approximately 100 m (110 yd.). Because the NAEMO does not include avoidance behavior, the preliminary model-estimated effects are based on unlikely behavior for these species—that they would tolerate staying in an area of high human activity. The Carrier Strike Group exercise events involving sonar and other active acoustic sources are undertaken in a coordinated manner and therefore involve multiple vessels, aircraft, and hovering helicopters operating together while conducting Anti-Submarine Warfare training. Harbor porpoise and beaked whales that were model-estimated to experience PTS due to sonar and other active acoustic sources are assumed to actually move away from the activity and into the range of TTS prior to the start of the sound production due to the high level of activity associated with the Carrier Strike Group exercise.

The NAEMO does not consider implemented mitigation measures (as presented in detail in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring)). To account for the implementation of mitigation measures, the acoustic effects analysis assumes a model-estimated PTS would not occur if an animal at the water surface would likely be observed during those activities with Lookouts up to and during use of the sound source, considering the sightability of a species based on $g(0)$ (see Table 3.8-8 in Section 3.8.3.1.8, Implementing Mitigation to Reduce Sound Exposures), the range to PTS for each hearing group by source (see examples in Table 3.8-10, and mitigation effectiveness). Given that the use of sonar and other active acoustic sources during the Carrier Strike Group exercise would occur in a coordinated manner involving multiple platforms (ships, fixed-wing aircraft, and helicopters), it is likely that there would be multiple opportunities to detect marine mammals in the immediate area of the coordinated activity. The range to PTS is generally less than 50 m (55 yd.), and the largest single ping range to PTS for the most powerful sonar system is approximately 100 m (109 yd.), so Lookouts need only to detect animals before they are within a very close range of a sound source to prevent PTS. For the Carrier Strike Group exercise use of sonar and other active acoustic sources, the mitigation is assumed to be effective (the Mitigation Adjustment Factor is equal to 1). The preliminary model-estimated PTS numbers are reduced by the portion of animals that are likely to be seen (Mitigation Adjustment Factor x Sightability). Model predicted PTS effects are adjusted based on these

factors and added to the model predicted TTS exposures. This is a conservative approach that will still result in an overestimation of PTS effects since the range to PTS is generally much less than 55 yd. (50 m), Lookouts need only detect animals before they are within this very close range to implement mitigation to prevent PTS, and the $g(0)$ detection probabilities used as a sightability factor are based on having to detect animals at much greater distance (many kilometers; as presented previously in Section 3.8.3.1.8, Implementing Mitigation to Reduce Sound Exposures).

Marine mammals that are encountered in groups have a higher potential for being visually detected since there are more sighting opportunities when there are multiple animals present. Additionally, detection of any one animal in a group can result in implementation of mitigation for the entire group including animals that may not have been otherwise detected. Data from the GOALS II survey (Rone et al. 2013) provided observed group sizes for the species encountered in and around the Study Area as presented in Table 3.8-15.

Table 3.8-15: Marine Mammals Sightings from the Gulf of Alaska Line-Transect Survey (GOALS) II

Species	Total Sightings	Total Individuals	Average Group Size	Group Size	
				Min	Max
Baird's beaked whale	7	58	8.3	2	16
Blue whale	5	7	1.4	1	2
Cuvier's beaked whale	1	1	1.0	1	1
Dall's porpoise	337	907	2.7	1	25
Elephant seal	16	16	1.0	1	1
Fin whale	200	392	2.0	1	13
Fin/Sei whale	1	1	1.0	1	1
Gray whale	1	25	25.0	25	25
Harbor porpoise	8	11	1.4	1	2
Humpback whale	106	331	3.1	1	15
Killer whale	21	138	6.6	1	45
Minke whale	3	6	2.0	1	3
Northern fur seal	78	83	1.1	1	2
Sperm whale	19	22	1.2	1	2
Unidentified beaked whale	5	8	1.6	1	2
Unidentified dolphin	3	4	1.3	1	2
Unidentified large whale	122	160	1.3	1	5
Unidentified small whale	4	4	1.0	1	1
Unidentified pinniped	6	6	1.0	1	1
Unidentified porpoise	22	87	4.0	1	10
Total	965	2,267			

Note: Numbers presented in the table above were derived from data presented in Rone et al. (2013).

The unpublished group size data from the Study Area and adjacent waters as derived from Rone et al. (2013) have been considered in the analysis of predicted exposures as presented subsequently in

Section 3.8.3.3.2 (Model Predicted Exposures from Use of Sonar and Other Active Acoustic Sources) and Section 3.8.3.3.2 (Model Predicted Exposures from Use of Explosives). Note that the new and unpublished group size data in Table 3.8-15 were not used as input to the NAEMO since they only represent data from one survey as opposed to the more rigorous dataset presented in Watwood and Buonantony (2012). The group size numbers presented in Table 3.8-15 above are, however, within the range of values¹² used in the NAEMO (Marine Species Modeling Team 2015).

Animal avoidance of the area immediately around the sonar or other active acoustic system, coupled with mitigation measure designed to avoid exposing animals to high energy levels, would make the majority of model-estimated PTS to mid-frequency cetaceans unlikely. The maximum ranges to onset PTS for mid-frequency cetaceans (Table 3.8-10) do not exceed 10 m (11 yd.) in any environment modeled for the most powerful non-impulsive acoustic sources, hull-mounted sonar (e.g., Bin MF1; SQS-53C). Ranges to PTS for low-frequency cetaceans and high-frequency cetaceans (Table 3.8-10) do not exceed approximately 77 and 110 yd. (70 m and 100 m), respectively. Considering vessel speed during anti-submarine warfare activities normally exceeds 10 knots, and sonar pings occur about every 50 seconds, even for the MF1 an animal would have to maintain a position within a 22 yd. (20 m) radius in front of, or alongside the moving the ship for over 3 minutes (given the time between five pings) to experience PTS. In addition, the animal(s) or pod would have to remain unobserved; otherwise implemented mitigation would result in the sonar transmissions being shut down and thus ending any further exposure. Finally, the majority of marine mammals likely to be present in the Study Area (odontocetes) have been demonstrated to have directional hearing, with best hearing sensitivity when facing a sound source (Kastelein et al. 2005b, Mooney et al. 2008, Popov and Supin 2009). An odontocete avoiding a source would receive sounds along a less sensitive hearing orientation (its tail pointed toward the source), potentially reducing impacts. All model-estimated PTS exposures of mid-frequency cetaceans, therefore, are considered to actually be TTS due to the likelihood that an animal would be observed if it is present within the very short range to PTS effects.

The NAEMO does not account for several factors (see Section 2.2.1, Classification of Non-Impulsive and Impulsive Sources, and Section 3.8.3.3.1.2, Avoidance Behavior and Mitigation Measures as Applied to Sonar and Other Active Acoustic Sources) that must be considered in the overall acoustic analysis. The results in the following tables are the predicted exposures from the NAEMO adjusted by the animal avoidance and mitigation factors discussed in the section above (Section 3.8.3.3.1.2, Avoidance Behavior and Mitigation Measures as Applied to Sonar and Other Active Acoustic Sources). Mitigation measures are discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) and provide additional protections that are not considered in the numerical results below.

Marine mammals in other functional hearing groups (i.e., low-frequency cetaceans and high-frequency cetaceans, and pinnipeds) if present but not observed by Lookouts, are assumed to leave the area near the sound source after the first few pings, thereby reducing sound exposure levels and the potential for PTS. Based on nominal marine mammal swim speeds and normal operating parameters for Navy vessels it was determined that an animal can easily avoid PTS zones within the timeframe it takes an active sound source to generate one to two pings. As a conservative measure, and to account for activities where there may be a pause in sound transmission, PTS was accounted for over three to four pings of an

¹² The Navy's acoustic effects modeling used group size estimates provided in Watwood and Buonantony (2012) to distribute animals within an acoustic impact modeling location. Groups of animals were distributed using the mean group size and standard deviations into species-typical groups for modeling purposes (see Marine Species Modeling Team 2015). Each species specific group size presented in Table 3.8-15 (derived from Rone et al. 2013), is well within one standard deviation of the mean presented in Watwood and Buonantony (2012) and as used in the acoustic modeling's prediction of exposures.

activity. Additionally, and as presented above, during the first few pings of an event, or after a pause in sonar operations, if animals are caught unaware and it was not possible to implement mitigation measures (e.g., animals are at depth and not visible at the surface), it is possible that they could receive enough acoustic energy for that to result in a PTS exposure. Only these initial PTS exposures at the beginning of the activity or after a pause in sound transmission are expected to actually occur. The remaining model-estimated PTS are considered to be TTS due to animal avoidance.

3.8.3.3.2 Model Predicted Effects from Use of Sonar and Other Active Acoustic Sources

Table 3.8-15 and Table 3.8-16 present the predicted effects to marine mammals under Alternative 1 and Alternative 2 for training activities involving the use of sonar and other active acoustic sources. The predicted effects are the result of the acoustic analysis, including acoustic effects modeling followed by consideration of animal avoidance of multiple exposures, avoidance by sensitive species of areas with a high level of activity, and Navy mitigation measures. Mitigation measures are discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring). These measures provide additional protections, many of which are not considered in the numerical results below since reductions as a result of implemented mitigation were only applied to those events having a very high likelihood of detecting marine mammals. It is important to note that there are additional protections offered by mitigation procedures which would further reduce effects to marine mammals, but are not considered in the quantitative adjustment of the model predicted effects.

It is also important to note that effects presented in Table 3.8-15 and Table 3.8-16 are the total number of annual effects and not necessarily the number of individuals exposed. As discussed in Section 3.8.1.2.6 (Behavioral Reactions), an animal could be predicted to receive more than one predicted effect over the course of a year.

In addition, acoustic modeling indicates that under some alternatives there would be zero predicted effects to some species. In some cases the species may be absent in the season an activity is to occur, or activities under an alternative take place in locations a species does not inhabit. In other cases with zero predicted effects, marine mammals may be exposed to a stressor associated with an activity (such as the acoustic energy from a distant but audible underwater sound source), but the predicted exposure is of insufficient sound pressure level or too brief to rise in energy above an established impact threshold and criteria (see Section 3.8.3.1.4, Thresholds and Criteria for Predicting Acoustic and Explosive Impacts on Marine Mammals). In short, because some exposures do not exceed the current impact thresholds, they are considered insignificant and quantified as zero effects.

There is no designated critical habitat located in the TMAA. As detailed previously (see Section 3.4.2.7.3, Distribution, concerning North Pacific right whale feeding and Section 3.4.2.12.3, Distribution, concerning gray whale migration), NMFS has identified (see Ferguson et al. 2015b) a North Pacific right whale feeding area and a gray whale migration area that spatially overlap the TMAA boundary. As was noted in a prior section, NMFS recognition of an area as the location for important feeding or migrating behavior does not cause the area to rise to level of designated critical habitat. Additionally, these identified areas were not intended as exclusionary zones, nor were they meant to be locations that serve as sanctuaries from human activity, or areas analogous to marine protected areas (Ferguson et al. 2015a).

It is very unlikely that Navy training would occur in these nearshore locations adjacent to the TMAA boundary where the overlap occurs. To ensure that the Navy is able to conduct realistic training, Navy units must maintain sufficient room to maneuver. Therefore, training activities will typically take place

some distance away from an operating area boundary to ensure sufficient sea or air space is available for tactical maneuvers within an approved operating area such as the TMAA. The Navy also does not typically train next to any limiting boundary because it precludes tactical consideration of the adjacent sea space and airspace beyond the boundary from being a potential threat axis during activities such as anti-submarine warfare training. It is also the case that Navy training activities will generally not be located where it is likely there would be interference from civilian vessels and aircraft that are not participating in the training activity. The nearshore boundary of the TMAA is the location for multiple commercial vessel transit lanes, ship traffic, and low-altitude air routes, which all passing through the NMFS-identified feeding area and the identified migration area (Figure 3.8-16). This level of civilian activity may otherwise conflict with Navy training activities if those Navy activities were located at that margin of the TMAA and as a result such an area is generally avoided.

In short, the corners of and edge of the TMAA are seldom if ever a suitable location for sustained, realistic, and coordinated training using sonar and other active acoustic sources. The Navy has lookouts and mitigation in place to maneuver away from and around marine mammals, and Navy vessels and aircraft are no more likely to cause any impact to these species than any other non-Navy vessels or aircraft in the area. The Navy's stand-off distance for vessels of 500 yd. (457 m) and mitigation procedures (see Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring, for details) further reduce the potential for any biologically meaningful effect to feeding or migration should those animals be present and detected during a very unlikely Navy training event using sonar and other active acoustic sources in one of these overlapping NMFS-identified areas. Therefore, North Pacific right whales and gray whales in the NMFS-identified feeding or migration areas at these boundaries of the TMAA are very unlikely to have their feeding or migration activities affected by Navy training activities using sonar and other active acoustic sources. In summary: (1) Navy activities are very unlikely to occur in these NMFS-identified areas; (2) If Navy training was ever required in these areas, it would be a very minor component to the overall human presence there; (3) Navy activities are unlikely to affect, let alone have any biologically meaningful effect, to the North Pacific right whale feeding behavior or gray whale migration behavior if these animals happened to be present in these areas; and (4) there are activity specific mitigation measures in place to avoid or protect any detected marine mammals in any location where training may be occurring. This analysis of likely impacts within the NMFS-identified areas is applicable to Alternative 1 and Alternative 2 as discussed in the subsequent sections.

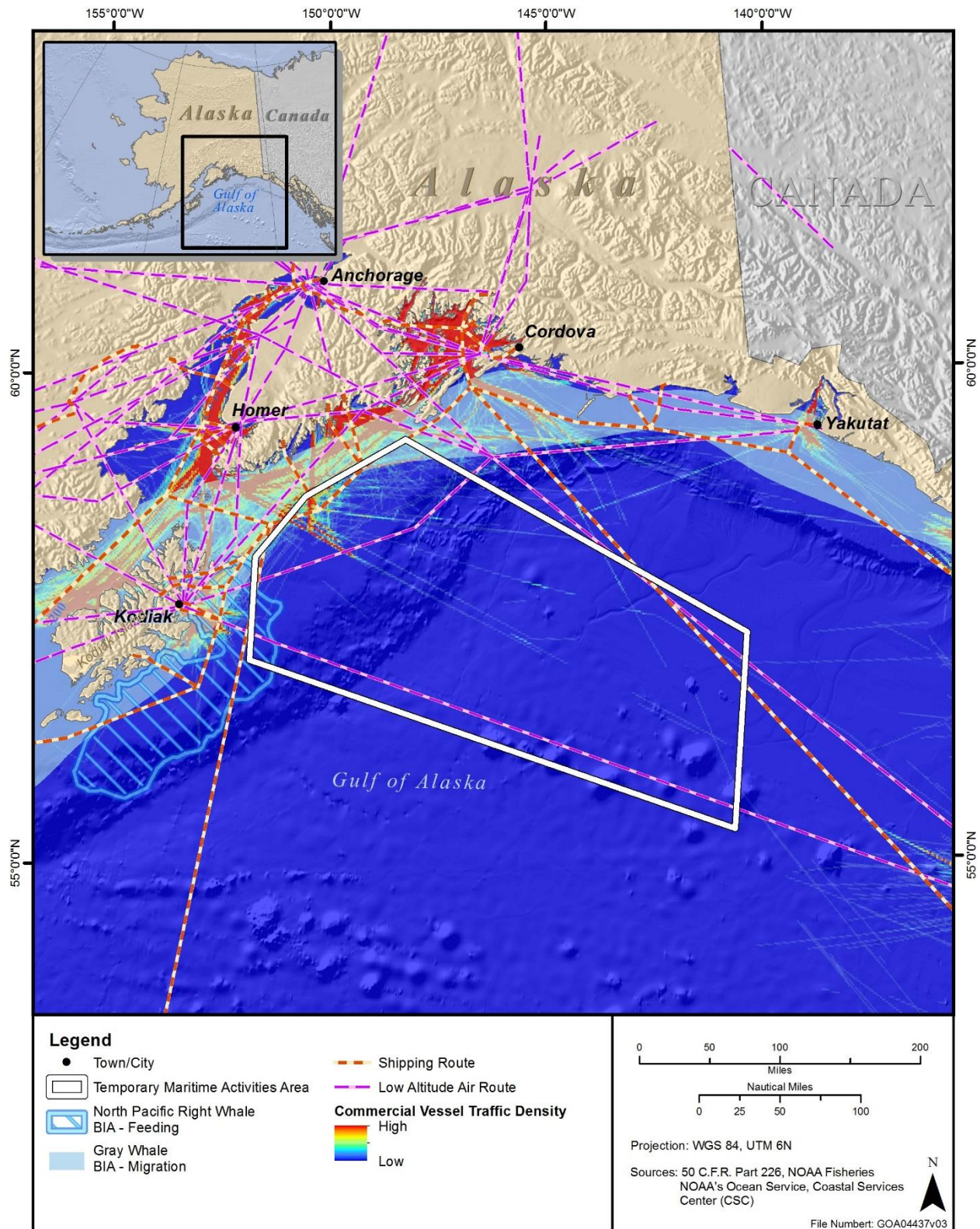


Figure 3.8-16: Commercial Vessel Transit Lanes, AIS Shipping Density, and Air Traffic Routes in Relation to the NMFS-identified North Pacific Right Whale Feeding Area and Gray Whale Migration Area Overlapping the TMAA

3.8.3.3.3 No Action Alternative

During the annual Carrier Strike Group exercise under the No Action Alternative, there would be no use of the sonar or other active acoustic sources as presented in Table 2.2-1 (as found in Section 2.2.1, Classification of Non-Impulsive and Impulsive Sources).

3.8.3.3.4 Alternative 1

Activities under Alternative 1 involving use of sonar and other active acoustic sources are described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.3-1, and Section 3.0.5.2.1.1, (Acoustic Stressors). Activities could occur throughout the TMAA but generally would not occur near the boundaries of the TMAA.

The predicted annual effects to marine mammals for activities involving use of sonar and other active acoustic sources are presented in Table 3.8-16. Annual totals presented in the table are the summation of all annual events occurring in a 12-month period. It is important to note that effect numbers presented in Table 3.8-16 are the total number of effects and not necessarily the number of separate individual marine mammals affected. As discussed in Section 3.8.3.1.5 (Behavioral Responses), an animal could be predicted to receive more than one effect over the course of the 21-day exercise period proposed to occur annually. The acoustic modeling and post-modeling analyses predict 18,195 marine mammal effects¹³ from sonar and other active acoustic sources resulting in Level B harassment and 1 exposure¹⁴ resulting in Level A harassment as defined under the MMPA for military training activities.

As described in Section 3.8.3.1.6.1 (Marine Species Density Data), in some cases (humpback whales, blue whale, gray whale, transient killer whale, harbor porpoise, Steller sea lion, and harbor seal) the density of marine mammals can be calculated for use in the NAEMO analysis; however, the number of whales from each stock contributing to that species density is unknown. To provide the number of effects by species and stock, the total modeled effects to the species were apportioned to each stock using derived ratios. These species/stock ratios were based on the relative abundances for each stock as provided in the applicable SARs (Allen and Angliss 2013, Carretta et al. 2013a). This method of apportionment is consistent with the Navy's approach in previous documents (U.S. Department of the Navy 2011a, 2013d) and as developed in consultation with NMFS as a cooperating agency; see Section 3.8.3.1.6.1 (Marine Species Density Data) regarding details on this approach for each applicable species.

¹³ This is the combined summation of all non-TTS and TTS effects (behavioral effects) for all species and stocks in the TMAA for an annual total (based on a 12-month period).

¹⁴ This is the combined summation of all PTS effects for all species and stocks in the TMAA for an annual total (based on a 12-month period).

Table 3.8-16: Annual Predicted Effects to Marine Mammals from Use of Sonar and Other Active Acoustic Sources under Alternative 1

Species	Stock	Behavioral	TTS	PTS
North Pacific right whale	Eastern North Pacific	2	1	0
Humpback whale	Western North Pacific	1	0	0
	Central North Pacific	31	10	0
	California, Washington, and Oregon	21	6	0
Blue whale	Eastern North Pacific	38	9	0
	Central North Pacific	0	0	0
Fin whale	Northeast Pacific	941	350	0
Sei whale	Eastern North Pacific	5	1	0
Minke whale	Alaska	35	8	0
Gray whale	Eastern North Pacific	0	0	0
	Western North Pacific	0	0	0
Sperm whale	North Pacific	98	0	0
Killer Whale	Alaskan Resident	269	12	0
	Eastern North Pacific Offshore	25	1	0
	AT1 Transient	0	0	0
	Gulf of Alaska, Aleutian Island, and Bering Sea Transient	69	3	0
Pacific white-sided dolphin	North Pacific	939	42	0
Harbor porpoise	Gulf of Alaska	2,742	0	0
	Southeast Alaska	963	0	0
Dall's porpoise	Alaska	1,099	6,967	1
Cuvier's beaked whale	Alaska	1,269	2	0
Baird's beaked whale	Alaska	200	0	0
Stejneger's beaked whale	Alaska	576	0	0
Steller sea lion	Eastern U.S.	335	0	0
	Western U.S.	286	0	0
California sea lion	U.S.	2	0	0
Northern fur seal	Eastern Pacific-Alaska	713	0	0
Northern elephant seal	California Breeding	100	22	0
Harbor seal	North Kodiak	0	0	0
	South Kodiak	1	0	0
	Prince William Sound	1	0	0
	Glacier Bay/Icy Strait	0	0	0
	Sitka/Chatham	0	0	0
	Dixon/Cape Decision	0	0	0
Ribbon seal	Alaska	0	0	0
Northern sea otter	Southeast Alaska	0	0	0
	Southcentral Alaska	0	0	0
	Southwest Alaska	0	0	0
Sub-Total		10,761	7,434	1
MMPA Totals		Level B		Level A
		18,195		1

Predicted acoustic effects to marine mammals from training activities from sonar and other active sound sources are, with the exception of two effects from torpedo use during a Sinking Exercise, all from anti-submarine warfare events involving multiple platforms and sensors operating in a coordinated manner. As discussed in Section 3.8.3.3.1 (Impacts from Sonar and Other Active Acoustic Sources), ranges to TTS for hull-mounted sonar (e.g., sonar Bin MF1; SQS-53 anti-submarine warfare hull-mounted sonar) can be on the order of several kilometers, whereas some behavioral effects could take place at distances exceeding 93 mi. (150 km), although biologically meaningful behavioral effects are much more likely at higher received levels within a few kilometers of the sound source.

All effects to marine mammals from sonar and other active acoustic sources are associated with the activities conducted during a Carrier Strike Group exercise; see Table 2.3-1). The exercise is a 21-day event composed of multiple, dispersed yet coordinated activities involving multiple platforms (e.g., ships, planes, helicopters, and submarines) that often require movement across or use of large portions of the Study Area. Some animals may be exposed to this activity multiple times over the course of a few days and leave the area, although these activities do not use the same locations day-after-day during multi-day activities. Therefore, displaced animals could return after the exercise moves away, allowing the animal to recover from any energy expenditure or missed resources.

For shorter-term exposures or those from distant sources, animals may stop vocalizing, break off feeding dives, or, alternatively, ignore the acoustic stimulus, especially if it is located more than a few kilometers away (see Section 3.8.3.1.2.6, Behavioral Reactions, for discussion of research and observations on the behavioral reactions of marine mammals to sonar and other active acoustic sources). A few behavioral reactions per year, even from a single individual, are unlikely to produce long-term consequences for that individual or the population. Furthermore, mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) would further reduce the predicted impacts since not all mitigations are accounted for in the adjustments to the acoustic effects modeling numbers.

3.8.3.3.4.1 Mysticetes

Predicted acoustic effects to mysticetes during the Carrier Strike Group exercise are from anti-submarine warfare events involving surface ships, aircraft, and submarines. As discussed in Section 3.8.3.3.1 (Impacts from Sonar and Other Active Acoustic Sources), ranges to TTS for hull-mounted sonar (e.g., sonar Bin MF1; SQS-53 anti-submarine warfare hull-mounted sonar) can be on the order of several thousand yards (kilometers); see Section 3.8.3.3.1.1 (Range to Effects) and Table 3.8-12 for details. If there was no background noise (such as that from vessel traffic, breaking waves, or other vocalizing marine mammals) masking the active ping occurring approximately every 50 seconds, the ping could reach and possibly be heard underwater at distances exceeding approximately 100 mi. (185 km; see, for example, Table 3.8-18). Although biologically meaningful behavioral effects are much more likely at higher received levels within a few kilometers of the sound source, the low received level (approximately 120 dB SPL) from the sonar at a distance exceeding approximately 100 mi. (185 km) conservatively assumes there is no masking background ambient noise and is modeled as having some behavioral effects.

Research by Risch et al. (2012) found that humpback whale vocalizations were reduced concurrent with pulses at low received levels from a low frequency source located approximately 100 mi. (161 km) away. None of the sources proposed for use in this Supplemental EIS/OEIS are comparable to the low frequency source recorded by Risch et al. (2012). Those findings do, however, validate use of the

Behavioral Response Function's low (120 dB SPL received level) threshold as criteria for MMPA Level B harassment for a percent of the population exposed to that level of sound.

As mentioned previously in Section 3.8.3.1.2.6 (Behavioral Reactions), Melcón et al. (2012) documented that blue whales decreased the proportion of time spent producing certain types of calls when mid-frequency simulated sonar was present. Changes in vocal response by marine mammals have been documented elsewhere (Noren et al. 2009, Potter et al. 2007), while blue whale feeding/social calls were found to increase when seismic exploration was underway (Di Iorio and Clark 2010), indicative of a potentially compensatory response to the increased noise level. Although long-term implications of disruption in call production to blue whale foraging and other behaviors are currently not well understood, sonar usage in the Gulf of Alaska (fathometers, fish-finders, research sonar, and Navy mid-frequency sonar during annual training) in narrow bands of the mid-frequency and high frequency spectrums is not likely to have long-term impacts on marine mammals believed to predominately use the low frequency sound.

Additionally, in Section 3.8.3.1.2.6 (Behavioral Reactions), Goldbogen et al. (2013) reported on the results of an ongoing Navy-funded behavioral response study in the waters of Southern California.¹⁵ Goldbogen et al. (2013) suggested that "frequent exposure to mid-frequency anthropogenic sounds may pose significant risks to the recovery rates of endangered blue whale populations." However, research along the U.S. west coast and Baja California reported by Calambokidis et al. (2009b) based on mark-recapture estimates "indicated a significant upward trend in abundance of blue whales" at a rate of increase just under 3 percent per year for the portion of the blue whale population in the Pacific that includes Southern California as part of its range. Data provided by Monnahan et al. (2014) indicate that the Eastern North Pacific blue whales may have recovered near to the estimated pre-whaling population size. The Eastern North Pacific stock (population), which is occasionally present in Southern California, is known to migrate from the northern Gulf of Alaska to the eastern tropical Pacific at least as far south as the Costa Rica Dome and has been increasingly found feeding to the north and south of the U.S. west coast during summer and fall (Carretta et al. 2014). Given this population's vast range and absent discussion of any other documented impacts, such as commercial ship strikes (Berman-Kowalewski et al. 2010), the suggestion by Goldbogen et al. (2013) that, since the end of commercial whaling, sonar use (in the fraction of time and area represented by Navy's training and testing in the SOCAL Range Complex) may be of significant risk to the blue whale's recovery in the Pacific is speculative at this stage given there is no clear populations trend where sonar use has been occurring for decades (for discussion of the trend in abundance in SOCAL, see Berman-Kowalewski et al. 2010, Calambokidis et al. 2009b, Calambokidis and Barlow 2013, Carretta et al. 2014).

To summarize, research and observations show that if mysticetes are exposed to sonar or other active acoustic sources they may react in a number of ways depending on the characteristics of the sound source, their experience with the sound source, and whether they are migrating or on seasonal grounds (i.e., breeding or feeding). Reactions may include changes in vocalization, alerting, breaking off feeding dives and surfacing, diving or swimming away, or no response at all.

¹⁵ Navy-funded Behavioral Response Study (BRS) investigations have been ongoing since 2007. The Navy is continuing funding the BRS research which for the first time in Southern California in fall 2013, experimentally exposed marine mammals to actual U.S. Navy mid-frequency sonar. Reported findings in addition to Goldbogen et al. (2013) and related to these behavioral response studies include De Ruiter et al. (2013); Melcón et al. (2012); Southall et al. (2011); and Schorr et al. (2014), which are also discussed elsewhere in this document.

Animals that do experience TTS may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations until their hearing recovers and is therefore as a condition potentially affecting an animal's behavior. Recovery from a threshold shift (i.e., TTS; temporary partial loss of hearing sensitivity) can take a few minutes to a few days depending on the severity of the initial shift. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal's ability to hear biologically relevant sounds. For exposures resulting in TTS, long-term consequences for individuals or populations of mysticetes would not be expected. This assessment of long-term consequences is based on findings from ocean areas where the Navy has been intensively training and testing with sonar and other active acoustic sources for decades. While there are many factors such as the end of large-scale commercial whaling complicating any analysis, there are no data suggesting any long-term consequences to mysticetes from exposure to sonar and other active acoustic sources. On the contrary, there are findings suggesting mysticete populations are increasing in the two primary locations (Southern California and Hawaii) where Navy's most intensively used range complexes are located. These findings include: (1) Calambokidis et al. (2009b) indicating a significant upward trend in abundance of for blue whales in SOCAL; (2) the recovery of gray whales that migrate through the Navy's SOCAL Range Complex twice a year; (3) work by Moore and Barlow (2011) indicating evidence of increasing fin whale abundance in the California Current area, which includes the SOCAL Range Complex; (4) the range expansion and increasing presence of Bryde's whales south of Point Conception in Southern California (Kerosky et al. 2012); and (5) the ocean area contained within the Hawaii Range Complex continuing to function as a critical breeding, calving, and nursing area to the point at which the overall humpback whale population in the North Pacific is now greater than some prior estimates of pre-whaling abundance (Barlow et al. 2011). Consistent with the Navy's analysis, the National Marine Fisheries Service has also concluded that the available scientific information does not provide evidence that exposure to acoustic stressors from Navy training activities are likely to impact the fitness of individual mysticetes and are not likely to result in adverse population- or species-level impacts (National Marine Fisheries Service 2015).

A review of the NMFS-identified feeding areas for mysticetes including North Pacific right whales, fin whales, humpback whales, and gray whales showed there is only minimal spatial overlap with the Navy TMAA and the North Pacific right whale feeding area southeast of Kodiak Island (Ferguson et al. 2015b; see details in Section 3.8.2.6.3, Distribution). North Pacific right whales feed on zooplankton (krill or small crustaceans) and there are no Navy activities that would significantly affect the availability of zooplankton for right whales. There is also minimal spatial overlap with the Navy TMAA and the NMFS-identified gray whale migration area offshore of Kenai Peninsula (Ferguson et al. 2015b; see details in Section 3.8.2.12.3, Distribution). In regard to these overlaps at the margins of the TMAA, it is important to understand that for the Navy to conduct realistic training, Navy units must maintain sufficient room to maneuver. Therefore, integrated training activities will typically take place some distance away from an operating area boundary to ensure sufficient sea or air space is available for tactical maneuvers by all participants. The TMAA's boundary for example, (or any limiting boundary) also precludes consideration of the adjacent sea-space and airspace beyond the boundary from being a potential threat axis during activities such as integrated anti-submarine warfare training. In short, locations adjacent to a boundary or corner of the training area are seldom if ever a suitable location for sustained, realistic, and coordinated training using sonar and other active acoustic sources. The corner overlap of the TMAA with the NMFS-identified North Pacific right whale feeding area and the corner overlap with a small portion of the gray whale migration area are very unlikely to have any Navy training activity. Therefore, if right whales or gray whales were present in those margins of the TMAA, their feeding activity or migration activity would be unlikely to be affected by Navy training activities using sonar and other active acoustic sources. Additionally, appropriate standard operating procedures and

mitigation measures (as detailed in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) would be implemented for any detected marine mammals and thus further reducing the potential for the feeding or migration activities to be affected.

North Pacific Right Whales (Endangered Species Act-Listed)

Satellite tagging of North Pacific right whales in the Bering Sea in 2004, 2008, and 2009 indicated none moved to the area in or around the TMAA (see Zerbini et al. 2010, 2015). However, using the conservative assumption that North Pacific right whales will be present in the TMAA coincident with Navy training using sonar and other active acoustic sources, the acoustic modeling predicts North Pacific right whales may be exposed to sonar or other active acoustic stressors that may result in one TTS and two behavioral reactions per year. These three predicted behavioral effects could be to the same animal on subsequent days, or be the result of exposures to two or three animals. As presented above for mysticetes in general, long-term consequences for individuals or the population would not be expected. Pursuant to the ESA, training activities in the Study Area may affect and are likely to adversely affect this species. There is no designated right whale critical habitat in the Study Area.

Blue Whales (Endangered Species Act-Listed)

Blue whales were visually detected five times during the GOALS II survey (Rone et al. 2013) both as single individuals and in pairs. Blue whales should be readily detectable; however, there was no adjustment to the model predicted impacts due to implemented mitigation or animal avoidance. Blue whales may be exposed to sonar or other active acoustic stressors that may result in 9 TTS and 38 behavioral reactions per year. For both stocks and as presented above for mysticetes in general, long-term consequences for individuals or the population would not be expected. Pursuant to the ESA, training activities in the Study Area may affect and are likely to adversely affect this species.

Humpback Whales (Endangered Species Act-Listed)

Humpback whales were visually detected during the GOALS II survey (Rone et al. 2013) and were typically in groups of two or more animals. Group sizes ranged from 1 to 15 individuals and the average group size was 3.12. Humpback whales should be readily detectable; however, there was no adjustment to the model predicted impacts due to implemented mitigation or animal avoidance. Humpback whales may be exposed to sonar or other active acoustic stressors that may result in 16 TTS and 53 behavioral reactions per year. For the stocks and as presented above for mysticetes in general, long-term consequences for individuals or the population would not be expected. Pursuant to the ESA, training activities in the Study Area may affect and are likely to adversely affect this species.

Sei Whales (Endangered Species Act-Listed)

Sei whales may be exposed to sonar or other active acoustic stressors that may result in 1 TTS and 5 behavioral reactions per year. As presented above for mysticetes in general, long-term consequences for individuals or the population would not be expected. Pursuant to the ESA, training activities in the Study Area may affect and are likely to adversely affect this species.

Fin Whales (Endangered Species Act-Listed)

Fin whales were visually detected during the GOALS II survey (Rone et al. 2013) approximately 54 percent of the time as single individuals and 46 percent in groups of two or more. Group sizes ranged from 1 to 13 individuals (the average group size was 1.96). Goldbogen et al. (2006) found that fin whales engaged in lunge feeding at depth had dive durations that averaged approximately 7 minutes so they should be available at the surface for detection by vessels, helicopters, and aircraft participating in training. Although fin whales should be readily detectable, however, there was no adjustment to the

model predicted impacts due to implemented mitigation or animal avoidance. Fin whales may be exposed to sonar or other active acoustic stressors that may result in 350 TTS and 941 behavioral reactions per year. As presented above for mysticetes in general, long-term consequences for individuals or the population would not be expected. Pursuant to the ESA, training activities in the Study Area may affect and are likely to adversely affect this species.

Gray Whales, Eastern North Pacific Stock and Endangered Species Act-Listed Western North Pacific Stock

No gray whales were detected in the TMAA Study Area during the GOALS II survey (Rone et al. 2013). Acoustic modeling indicates that gray whales would not be exposed to sonar or other active acoustic sources associated with training activities, which would exceed the current impact thresholds. A few gray whales of the Western North Pacific stock may migrate to the northern Gulf of Alaska and fewer still may come within the boundary of the TMAA although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur. Since gray whales of the Western North Pacific stock could potentially be present in the Study Area, they may be exposed to low levels of sound or energy. Pursuant to the ESA, training activities in the Study Area may affect and are not likely to adversely affect this species.

Minke Whales

Minke whales were visually detected during the GOALS II survey (Rone et al. 2013) on three occasions in groups of one, two, and three individuals. There was no adjustment to the model predicted impacts due to implemented mitigation or animal avoidance. Minke whales may be exposed to sonar or other active acoustic stressors that may result in 8 TTS and 35 behavioral reactions per year. As presented above for mysticetes in general, long-term consequences for individuals or the population would not be expected.

3.8.3.3.4.2 Odontocetes

Predicted impacts to odontocetes from training activities under Alternative 1 from sonar and other active acoustic sources are all from anti-submarine warfare events during the Carrier Strike Group exercise involving surface ships and hull-mounted sonar. As discussed in Section 3.8.3.3.1.1 (Range to Effects), for mid-frequency odontocetes (cetaceans constituting the majority of marine mammals present), ranges to TTS for hull-mounted sonar (e.g., sonar Bin MF1; SQS-53 anti-submarine warfare hull-mounted sonar) is within a maximum of approximately 200 yd. (200 m) for a single ping. For high-frequency cetaceans (i.e., Dall's porpoise and harbor porpoise), ranges to TTS for multiple pings can stretch to distances of over 5 mi. (8 km). If there was no background noise (such as that from vessel traffic, breaking waves, or other vocalizing marine mammals) masking the active ping occurring approximately every 50 seconds, the most powerful surface ship hull-mounted sonar could, under rather optimal conditions, reach and possibly be heard underwater at distances exceeding approximately 107 mi. (172 km). The low received level (approximately 120 dB SPL) at that distance is modeled as having some behavioral effects possible, although biologically meaningful behavioral effects are much more likely at higher received levels within a few kilometers of the sound source. Modeling predicts behavioral effects at long distance and low received levels but does not take into account background ambient noise levels or other competing biological sounds, which may mask sound from distant Navy sources. D'Spain and Batchelor (2006) measured a source spectral density of 105–120 dB re 1 $\mu\text{Pa}^2/\text{Hz}$ at 1 m (in the mid-frequency range) and calculated an estimated source level of 135–150 dB re 1 μPa at 1 m from various biologics (fish and marine mammals) contributing to those underwater ambient sound levels recorded to the southeast of San Clemente Island off San Diego, California.

Although involving species that are not present in the GOA Study Area, controlled exposure experiments in 2007 and 2008 in the Bahamas recorded responses of false killer whales, short-finned pilot whales, and melon-headed whales to simulated MFA sonar (De Ruiter et al. 2013b). The responses to exposures between species were variable. After hearing each MFA signal, false killer whales were found to “increase their whistle production rate and made more-MFA-like whistles” (De Ruiter et al. 2013b). In contrast, melon-headed whales had “minor transient silencing” after each MFA signal, while pilot whales had no apparent response.

Pilot whales or false killer whales in the Bahamas showed an avoidance response to controlled exposure playbacks (Southall et al. 2009b). Consistent with the findings of other previous research (see, for example Southall et al. 2007), De Ruiter et al. (2013b) found the responses were variable by species and with the context of the sound exposure. The assumption is that odontocete species in general, including those in the GOA Study Area, would have similar variable responses.

Activities involving anti-submarine warfare training in a Carrier Strike Group exercise involve multiple participants and activities associated with the event. More sensitive species of odontocetes such as beaked whales, Dall’s porpoises, and harbor porpoise may avoid the area for the duration of the event (see Section 3.8.3.1.2.6, Behavioral Reactions, for a discussion of these species observed reactions sonar and other active acoustic sources). After the event ends, displaced animals would likely return to the area within a few days as seen in the Bahamas study with Blainville’s beaked whales (Tyack et al. 2011). This would allow the animal to recover from any energy expenditure or missed resources, reducing the likelihood of long-term consequences for the individual or population.

Animals that do experience TTS may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations until their hearing recovers. Recovery from a threshold shift (i.e., TTS; temporary partial loss of hearing sensitivity) can take a few minutes to a few days depending on the severity of the initial shift. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal’s ability to hear biologically relevant sounds. For exposures resulting in TTS, long-term consequences for individuals or populations would not be expected.

There is one PTS effect predicted annually for a Dall’s porpoise. For PTS, it is uncertain whether some permanent loss of hearing sensitivity over a part of a marine mammal’s hearing range would have long-term consequences for that individual, given that natural hearing loss occurs in marine mammals as a result of disease, parasitic infestations, and age-related impairment (Ketten 2012). Furthermore, likely avoidance of intense activity and sound coupled with mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) would further reduce the potential for PTS exposures to occur. Considering these factors, long-term consequences for individuals or populations would not be expected.

Sperm Whales (Endangered Species Act-Listed)

Sperm whales were visually detected during the GOALS II survey (Rone et al. 2013) as single individuals or approximately 10 percent of the time in pairs. There was no adjustment to the model predicted impacts due to implemented mitigation or animal avoidance. Sperm whales (classified as mid-frequency cetaceans [Section 3.8.2.3.2, Mid-Frequency Cetaceans]) may be exposed to sonar or other active acoustic stressors associated with training activities that may result in 98 behavioral reactions per year.

Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that if sperm whales are exposed to sonar or other active acoustic sources they may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Sperm whales have shown resilience to acoustic and human disturbance, although they may react to sound sources and activities within a few kilometers. Sperm whales that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, avoid the area by swimming away or diving, or display aggressive behavior. Straley et al. (2014) reported on findings from satellite tags attached to 10 sperm whales in the Gulf of Alaska. The tags demonstrated that at least three of these animals went as far south as waters off Mexico. This suggests that potential behavioral disturbances resulting in avoidance of Navy events or acoustic sources is unlikely to have any meaningful consequences for animals that cover such distances. As presented above for odontocetes in general, long-term consequences for sperm whale individuals or populations would not be expected. Pursuant to the ESA, training activities involving the use of sonar and other active acoustic sources in the Study Area may affect and are likely to adversely affect this species.

Harbor Porpoises

Harbor porpoises were visually detected 8 times during the GOALS II survey (Rone et al. 2013) as single individuals or in pairs (approximately 38 percent of the time). Harbor porpoises may be exposed to sonar or other active acoustic stressors associated with training activities that may result in 2,742 behavioral reactions involving the Gulf of Alaska stock and 963 behavioral reactions involving the Southeast Alaska stock.

Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) of harbor porpoises show that this small species is very wary of human activity and will avoid anthropogenic sound sources in many situations at levels down to 120 dB re 1 μ Pa. This level was determined by observing harbor porpoise reactions to acoustic deterrent and harassment devices used to drive away animals from around fishing nets and aquaculture facilities. Avoidance distances typically were about 1 km or more, but it is unknown if animals would react similarly if the sound source were at a distance of tens or hundreds of kilometers. The behavioral response function is not used to estimate behavioral responses by harbor porpoises; rather, a single threshold is used. Because of this very low behavioral threshold (120 dB re 1 μ Pa) for harbor porpoises, animals at distances exceeding approximately 100 nm in some cases are predicted to have a behavioral reaction in this acoustic analysis. It is not known whether animals would actually react to sound sources at these ranges, regardless of the received sound level. Harbor porpoises may startle and leave the immediate area of the anti-submarine warfare training exercise but return within a few days after the cessation of the event. Behavioral reactions seem more likely than with most other odontocetes. Since these species are typically found in nearshore and inshore habitats, they should generally not be present in the TMAA. Animals that do exhibit a behavioral reaction would likely recover from any incurred costs, reducing the likelihood of long-term consequences for the individual or population.

There are no PTS or TTS exposures predicted for harbor porpoises.

Beaked Whales

Beaked whales (Baird's, Cuvier's, and Stejneger's beaked whales) may be exposed to sonar or other active acoustic stressors that may result in 2 TTS and 2,045 behavioral reactions annually (see Table 3.8-16 for details regarding predicted exposures for each species). Baird's beaked whales were visually detected during the GOALS II survey (Rone et al. 2013) in groups of 2 or more individuals (the average group size was 8.29), with group sizes ranging from 2 to 16 individuals. Only a single Cuvier's beaked

whale was visually detected during the GOALS II survey; Stejneger's beaked whales were not observed (Rone et al. 2013).

Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that if beaked whales are exposed to sonar or other active acoustic sources they may startle, break off feeding dives (see Defence Science and Technology Laboratory 2007), and avoid the area of the sound source to levels of 157 dB re 1 μ Pa or below (McCarthy et al. 2011). In research done at the Navy's instrumented tracking range in the Bahamas, animals leave the immediate area of the anti-submarine warfare training exercise, but return within a few days after the event ends (Claridge and Durban 2009, McCarthy et al. 2011, Moretti et al. 2009, Tyack et al. 2011). Passive acoustic monitoring of a training event at the Navy's instrumented range in Hawaii was undertaken during a Submarine Commander Course involving three surface ships and a submarine using mid-frequency sonar over the span of the multiple-day event. Manzano-Roth et al. (2013) determined that beaked whales (tentatively identified as Blainville's beaked whales) continued to make foraging dives at estimated distances of 13 to 52 km from active mid-frequency sonar, but that the animals shifted to the southern edge of the range with differences in the dive vocal period duration and dive rate. De Ruiter et al. (2013a) presented results from two Cuvier's beaked whales that were tagged and exposed to simulated MFA sonar during the 2010 and 2011 field seasons of the Southern California behavioral response study (note that preliminary results from a similar behavioral response study in Southern California waters have been presented for the 2010–2011 field season [Southall 2011]). The 2011 tagged whales were also incidentally exposed to MFA sonar from a distant naval exercise. Received levels from the MFA sonar signals from the controlled and incidental exposures were calculated as 84–144 and 78–106 dB re 1 μ Pa rms, respectively. Both whales showed responses to the controlled exposures, ranging from initial orientation changes to avoidance responses characterized by energetic fluking and swimming away from the source. However, the authors did not detect similar responses to incidental exposure from distant naval sonar exercises at comparable received levels, indicating that context of the exposures (e.g., source proximity, controlled source ramp-up) may have been a significant factor. Cuvier's beaked whale responses suggested particular sensitivity to sound exposure as consistent with results for Blainville's beaked whale. Based on these findings, behavioral reactions seem likely in most cases if beaked whales are exposed to anti-submarine sonar within a few tens of kilometers (Section 3.8.3.3.1, Impacts from Sonar and Other Active Acoustic Sources), especially for prolonged periods (a few hours or more) since research indicates beaked whales have been shown to will leave an area where anthropogenic sound is present (Tyack et al. 2011; De Ruiter et al. 2013a; Manzano-Roth et al. 2013).

The concern with beaked whales and an avoidance response is whether that displacement is likely to have long-term consequences for an animal or populations. Research involving tagged Cuvier's beaked whales in the SOCAL Range Complex reported on by Falcone and Schorr (2012, 2014) has documented movements in excess of hundreds of kilometers by some those animals. Schorr et al. (2014) reported the results for eight tagged Cuvier's beaked whales from the same area. Five of these eight whales made journeys of approximately 250 km from their tag deployment location and one of these five made an extra-regional excursion over 450 km south to Mexico and back again. Given that some beaked whales may routinely move hundreds of kilometers as part of their normal pattern, temporarily leaving an area to avoid sonar or other anthropogenic activity may have little if any cost to such an animal. Photo identification studies in the SOCAL Range Complex have identified approximately 100 individual Cuvier's beaked whales with 40 percent having been seen in one or more prior years, with re-sightings up to 7 years apart (Falcone and Schorr 2014). These results indicate long-term residency by beaked whales in an intensively used Navy training and testing area where sonar use is common and has been occurring

for decades. These results suggest inconsequential effects or a lack of long-term consequences resulting from exposure to Navy training activities.

Moore and Barlow (2013) noted a decline in beaked whales in a broad area of the Pacific Ocean within the EEZ. Interestingly, however, in the small portion of the EEZ overlapping the Navy's SOCAL Range Complex, long-term residency by individual Cuvier's beaked whales and higher densities suggest that the proposed decline noted elsewhere is not apparent where the Navy has been intensively training and testing with sonar and other systems for decades. Navy sonar training and testing is not conducted along a large part of the U.S. West Coast from which Moore and Barlow (2013) drew their survey data. In Southern California, based on a series of surveys from 2006 to 2008 and a high number encounter rate, Falcone et al. (2009) suggested the ocean basin west of San Clemente Island may be an important region for Cuvier's beaked whales given the number of animals encountered there. Follow-up research (Falcone and Schorr 2012, 2014) in this same location suggests that Cuvier's beaked whales may have population sub-units with higher than expected residency, particularly in Navy's instrumented SOCAL Anti-Submarine Warfare Range. Encounters with multiple groups of Cuvier's and Baird's beaked whales indicated not only that they were prevalent on the range where Navy routinely trains and tests, but also that they were potentially present in much higher densities than had been reported for anywhere along the U.S. west coast (Falcone et al. 2009, Falcone and Schorr 2012). This finding is also consistent with concurrent results from passive acoustic monitoring that estimated regional Cuvier's beaked whale densities were higher than indicated by NMFS's broad scale visual surveys for the U.S. west coast (Hildebrand and McDonald 2009).

Moore and Barlow (2013) suggest that one reason for the decline in beaked whales from Canada to Mexico may be as a result of anthropogenic sound, including the use of sonar by the U.S. Navy in the fraction of the U.S. Pacific coast overlapped by the SOCAL Range Complex. Moore and Barlow (2013) recognized the inconsistency between their hypothesis and the abundance trends in the region of SOCAL Range Complex, stating, "High densities are not obviously consistent with a hypothesis that declines are due to military sonar, but they do not refute the possibility that declines have occurred in these areas (i.e., that densities were previously even higher)." While it is possible that the high densities of beaked whale currently inhabiting the Navy's range were even higher before the Navy began training with sonar, there is no data available to test that hypothesis. Although Moore and Barlow (2013) have noted a decline in the overall beaked whale population along the Pacific coast, in the small fraction of that area where the Navy has been training and testing with sonar and other systems for decades (the Navy's SOCAL Range Complex), higher densities and long-term residency by individual Cuvier's beaked whales suggest that the decline noted elsewhere is not apparent where Navy sonar use is most intense. Navy sonar training and testing is not conducted along a large part of the U.S. West Coast from which Moore and Barlow (2013) drew their survey data. In Southern California, based on a series of surveys from 2006 to 2008 and a high number encounter rate, Falcone et al. (2009) suggested the ocean basin west of San Clemente Island may be an important region for Cuvier's beaked whales given the number of animals encountered there.

For over three decades, the ocean west of San Clemente Island has been the location of the Navy's instrumented training range and is one of the most intensively used training and testing areas in the Pacific. Research has documented the presence and long-term residence of Cuvier's beaked whales for the ocean basin west of San Clemente Island (Falcone et al. 2009, Falcone and Schorr 2012, 2014) and results from passive acoustic monitoring estimated regional Cuvier's beaked whale densities were higher than indicated by the NMFS's broad scale visual surveys for the U.S. west coast (Hildebrand and McDonald 2009). Based on these findings, it is clear that the Navy's long-term ongoing use of sonar and

other active acoustic sources has not precluded beaked whales from also continuing to inhabit those areas. In summary, based on the best available science, the Navy believes that beaked whales that exhibit a behavioral reaction due to sonar and other active acoustic training activities would generally not have long-term consequences for individuals or populations. Neither NMFS nor the Navy anticipates that marine mammal strandings or mortality will result from the operation of sonar or other acoustic sources during Navy exercises within the TMAA. Additionally, through the MMPA process (which allows for adaptive management), NMFS and the Navy will determine the appropriate way to proceed in the event that a causal relationship were to be found between Navy activities and a future stranding involving beaked whale or other marine mammal species.

There are two TTS exposures from sonar and other active acoustic sources predicted for Cuvier's beaked whales (no TTS are predicted for the other two beaked whale species (Baird's and Stejneger's) in the Study Area. For the most powerful surface ship sonar (MF1) proposed for use in the Study Area, the predicted TTS exposures for beaked whales (a MF cetacean) would have to occur within approximately 100 yd. (100 m) of a ship's bow or well within the established mitigation zone (see Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring, for discussion of the mitigation zones). It was not, however, assumed that Cuvier's beaked whales would be detected and model predicted TTS exposures were not reduced even though implemented mitigation may be effective in reducing model predicted TTS exposures. Given that beaked whales have been documented to leave the area where sonar use or other anthropogenic disturbance is occurring (Claridge and Durban 2009; De Ruiter et al. 2013a; McCarthy et al. 2011; Moretti et al. 2009; Tyack et al. 2011; Manzano-Roth et al. 2013), it is likely that Cuvier's beaked whale would avoid the area before coming within range of a TTS exposure. As noted above, research from the intensively used the SOCAL Range Complex indicates year-round prolonged use of the Navy's training and testing area by Cuvier's and Baird's beaked whales (Falcone et al. 2009; Falcone and Schorr 2012, 2014; Hildebrand and McDonald 2009). Research efforts involving tagging of Cuvier's beaked whales (Falcone and Schorr 2014; Schorr et al. 2014) have documented movements in excess of hundreds of kilometers as part of their normal pattern of movement, suggesting that a temporary movement to avoid the vicinity of sonar use or other anthropogenic disturbance may have little if any cost to such an animal. Costs and long-term consequences to the individual and population as a result of a beaked whale behaviorally reacting to sonar and other active acoustic sources are not expected. Costs and long-term consequences to the individual and population as a result of a beaked whale receiving a TTS is the same as presented above in the general discussion for odontocetes. Population-level consequences are not expected.

3.8.3.3.4.3 Dall's Porpoise

Dall's porpoise are classified as high-frequency cetaceans (Section 3.8.2.3.1, High-Frequency Cetaceans) and are part of the Alaska stock. Dall's porpoises were most often visually detected during the GOALS II survey (Rone et al. 2013) in pods of 2 or more individuals, with group sizes ranging from 1 to 25 individuals (the average group size was 2.69). Survey observations by Rone et al. (2009) recorded 10 sightings of 59 Dall's porpoise with an average group size of 5.90 and thus illustrating the variability possible in group sizes between the two survey efforts. Acoustic modeling predicts that Dall's porpoise could be exposed to sonar and other active acoustic sources that may result in 1 PTS, 6,967 TTS, and 1,099 behavioral reactions. Costs and long-term consequences to the individual and population as a result of a Dall's porpoise receiving a PTS or TTS is the same as presented above in the general discussion for odontocetes. Population-level consequences are not expected.

3.8.3.3.4.4 Killer Whale

Killer whales are classified as mid-frequency cetaceans (Section 3.8.2.3.2, Mid-Frequency Cetaceans). Killer whales were visually detected during the GOALS II survey (Rone et al. 2013) approximately 90 percent of the time in pods of 2 or more individuals, with group sizes ranging from 1 to 45 individuals (the average group size was 6.57). Acoustic modeling predicts that killer whales (see Table 3.8-16 for the details of exposure to the four stocks of killer whales in the Study Area) could be exposed to sound that may result in 16 TTS and 363 behavioral reactions annually. The acoustic modeling and post-modeling analyses predict there would be no exposures to killer whale from sonar and other active acoustic sources resulting in PTS, due to the short range from the source required for PTS to occur (see discussion in Section 3.8.3.3.1.1, Range to Effects).

Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that if killer whales are exposed to sonar or other active acoustic sources they may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Killer whales may not react at all until the sound source is approaching within a few hundred meters to within a few kilometers depending on the environmental conditions and species. Killer whales that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, change their behaviors or vocalizations, avoid the sound source by swimming away or diving, or be attracted to the sound source. Research has demonstrated that Alaska Resident killer whales may routinely move over long large distances (Andrews and Matkin 2014, Fearnbach et al. 2013). In a similar documented long-distance movement, an Eastern North Pacific Offshore stock killer whale tagged off San Clemente Island, California, moved (over a period of 147 days) to waters off northern Mexico, then north to Cook Inlet, Alaska, and finally (when the tag ceased transmitting) to coastal waters off Southeast Alaska (Falcone and Schorr 2014). Given these findings, temporary displacement due to avoidance of training activities are therefore unlikely to have biological significance to individual animals. Long-term consequences to individual killer whales or populations are not likely due to exposure to sonar or other active acoustic sources.

Costs and long-term consequences to the individual and population as a result of killer whale receiving an exposure resulting in TTS are the same as presented above in the general discussion for odontocetes. Population-level consequences are not expected.

3.8.3.3.4.5 Pacific White-Sided Dolphin

Pacific white-sided dolphin are classified as mid-frequency cetaceans (Section 3.8.2.3.2, Mid-Frequency Cetaceans). Pacific white-sided dolphins were not detected during the Rone et al. (2013) survey in the Study Area. Acoustic impact modeling predicts that Pacific white-sided dolphin (Table 3.8-16) could be exposed to sound that may result in 42 TTS and 939 behavioral reactions. The acoustic modeling and post-modeling analyses predict there would be no exposure to Pacific white-sided dolphin from sonar and other active acoustic sources resulting in PTS, due to the short range from the source required for PTS to occur (see discussion in Section 3.8.3.3.1.1, Range to Effects).

Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that if delphinids such as the Pacific white-sided dolphin are exposed to sonar or other active acoustic sources they may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Delphinids may not react at all until the sound source is approaching within a few hundred meters to within a few kilometers depending on the environmental conditions and species. Delphinids that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, change their behaviors or vocalizations, avoid the

sound source by swimming away or diving, or be attracted to the sound source. Long-term consequences to individual delphinids or populations are not likely due to exposure to sonar or other active acoustic sources.

Costs and long-term consequences to the individual and population as a result of Pacific white-sided dolphin receiving an exposure resulting in TTS are the same as presented above in the general discussion for odontocetes. Population-level consequences are not expected.

3.8.3.3.4.6 Pinniped

Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that pinnipeds in the water are tolerant of anthropogenic noise and activity. Evidence from areas where the Navy extensively trains and tests provides some indication of the possible consequences resulting from those proposed activities. In the confined waters of Washington State's Hood Canal where the Navy has been training and intensively testing for decades and harbor seals are present year-round, the population level has remained stable suggesting the area's carrying capacity may have been reached (Jeffries et al. 2003). In a similar manner, the beaches and shallow water areas within the PMRF at Kauai (in the main Hawaiian Islands) continue to be an important haulout and nursing area for endangered Hawaiian Monk Seals. While there has been a decline in the population of Hawaiian monk seals in the northwestern Hawaiian Islands, in the main Hawaiian Islands the numbers have continued to increase (Littnan 2011). If seals are exposed to sonar or other active acoustic sources they may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Seals may not react at all until the sound source is approaching within a few hundred meters and then may alert, ignore the stimulus, change their behaviors, or avoid the immediate area by swimming away or diving. Biologically meaningful behavioral reactions would not be expected in most cases and long-term consequences for individuals or pinniped populations are unlikely.

Recovery from a hearing threshold shift (i.e., TTS; temporary partial loss of hearing sensitivity) can take a few minutes to a few days depending on the severity of the initial shift. More severe shifts may not fully recover and thus would be considered PTS. Threshold shifts do not necessarily affect all hearing frequencies equally, so threshold shifts may not necessarily interfere with an animal's ability to hear biologically relevant sounds. As discussed previously in this section, it is uncertain whether some permanent loss of hearing sensitivity over a part of a marine mammal's hearing range would have long-term consequences for that individual given that natural hearing loss occurs in marine mammals as a result of disease, parasitic infestations, and age-related impairment (Ketten 2012).

Phocids (Harbor Seal, Northern Elephant Seal, and Ribbon Seal)

Harbor seal, northern elephant seal, and ribbon seal are the species of phocid pinnipeds that may be present within the Study Area. Elephant seals were visually identified 16 times at-sea during the GOALS II survey (Rone et al. 2013) as single individuals and no other phocids were encountered.

There are six stocks of Harbor seal that may be present in the general Gulf of Alaska area although migrating harbor seals generally use of only nearshore pelagic areas based on an analysis of the findings in Alaska from Womble and Gende (2013). Modeled effects for harbor seal were apportioned based on the ratio of abundance for each stock as provided in the Alaska Stock Assessment Report (Allen and Angliss 2013). Northern elephant seal are the California breeding stock and Ribbon seal are the Alaska Stock.

Predicted effects to phocids are from anti-submarine warfare events involving surface ships, submarines, and aircraft during the Carrier Strike Group exercise. As discussed in Section 3.8.3.3.1 (Impacts from Sonar and Other Active Acoustic Sources) ranges to TTS for hull-mounted sonar (e.g., sonar Bin MF1; SQS-53) can be on the order of a several kilometers for phocid seals (see discussion in Section 3.8.3.3.1.1, Range to Effects). Some behavioral effects could hypothetically take place at distances exceeding 54 mi. (87 km), although biologically meaningful behavioral effects are much more likely at higher received levels within a few kilometers of the sound source. For behavioral exposures, long-term consequences would not be expected. Costs and long-term consequences to the individual and population as a result of a phocid receiving a TTS is the same as presented above under the general discussion for pinniped. Population-level consequences are not expected.

Acoustic modeling predicts phocids could be exposed to sound that may result in 22 TTS and 102 behavioral reactions (see Table 3.8-16 for details regarding the species and six harbor seal stocks). The majority of all exposures (approximately 98 percent) are attributed to northern elephant seal. Exposures to harbor seals (two total) are predicted based on animals being at sea in deep water such as is present in the TMAA. Individual ribbon seal may be present in the Study Area but they are expected to be rare in occurrence. Based on that rare occurrence, ribbon seal are unlikely to be exposed to sonar or other active acoustic sources associated with training activities, which would exceed the current impact thresholds.

Otariids (Sea Lion and Fur Seal)

Northern fur seal, California sea lion, and Steller sea lion comprise the otariid species of pinniped in the Study Area. Otariids may be exposed to sonar or other active acoustic stressors associated with anti-submarine warfare events involving surface ships, submarines, and aircraft during the Carrier Strike Group exercise, which generally take place in deep ocean areas away from the shelf and coastal margins. Olesiuk reported that evidence from various sources indicates that juvenile and non-breeding northern fur seal are virtually ubiquitous throughout the Northeastern Pacific Ocean, albeit in densities lower than at the coastal margins (Olesiuk 2012). It is likely that Steller sea lion and the rare California sea lion, which share haulout locations with them in the Gulf of Alaska, are generally foraging in the vicinity to their haulouts and will therefore be concentrated outside the Study Area. Northern fur seals were visually detected at-sea during the GOALS II survey (Rone et al. 2013) on 78 occasions, and on 5 of those occasions in pairs. California sea lion and Steller sea lion were not identified during the GOALS II survey (Rone et al. 2013). Acoustic modeling predicts otariids could be exposed to sound that may result in 1,336 behavioral reactions (see Table 3.8-16 for details). As presented above under the general discussion for pinnipeds, behavioral exposures otariid are not expected to result in long-term consequences to individuals or populations.

Steller Sea Lion (Endangered Species Act-Listed Threatened Western Distinct Population Segment and the Recovered Eastern Distinct Population Segment)

Acoustic modeling predicts that the Western stock of Steller sea lion (also considered the Western DPS under the ESA) could be exposed to sound from sonar and other active acoustic sources that may result in 286 behavioral reactions. Acoustic modeling predicts that the Eastern stock of Steller sea lion could be exposed to sound from sonar and other active acoustic sources that may result in 335 behavioral reactions. As discussed in Section 3.8.3.3.1 (Impacts from Sonar and Other Active Acoustic Sources), ranges to some behavioral impacts could take place at distances exceeding 100 km (62 mi.), although biologically meaningful behavioral effects are much more likely at higher received levels within a few kilometers of the sound source. Biologically meaningful behavioral reactions would not be expected and long-term consequences for individuals or populations are unlikely. Pursuant to the ESA, training

activities in the Study Area may affect and are likely to adversely affect the ESA-listed Western stock of Steller sea lion. In the Alaska region, critical habitat has been designated for Steller sea lions in the Aleutian Islands and Western Alaska. Steller sea lion critical habitat is not present within the Study Area.

3.8.3.3.4.7 Mustelid (Northern Sea Otter)

Because sea otter are rare in waters where depths exceed 35 m (115 ft.), it is extremely unlikely that sea otters would be present in proximity to most training taking place in the TMAA where the water depth greatly exceeds a sea otter's preferred habitat. Sea otters seldom range more than approximately 1 nm from shore, although some individuals, particularly juvenile males, may travel farther offshore (Riedman and Estes 1990; Ralls et al. 1995, 1996; U.S. Fish and Wildlife Service 2003). As a result, sea otter may on rare occasions be present in the Study Area. Acoustic modeling for sea otter was not undertaken given almost all sea otter should be far from where activities involving sonar and other active acoustic sources are proposed to occur, they inhabit complex shallow water environments where acoustic modeling is very imprecise and therefore not representative of actual likely impacts, and sea otter spend little time underwater thus very much limiting the potential for exposure to underwater sound in any case. The unlikely potential for sea otter to hear underwater sound would especially be the case for wandering sea otter in the TMAA since the average depth within the Study Area greatly exceeds the foraging depth for sea otter, therefore, they would generally not be exposed to the sound field from distant sources. Ghoul and Reichmuth (2013) have shown that sea otters are not especially well adapted for hearing underwater, which suggests that the function of this sense has been less important in their survival and evolution than in comparison to pinniped. Finally, USFWS has stated that they had no evidence that defense-related activities have had any adverse effects on the well-monitored experimental population of southern sea otters at San Nicolas Island (California) or in the SOCAL Range Complex (U.S. Fish and Wildlife Service 2011). Given these factors, long-term consequences for individuals or the population would not be expected. Pursuant to the ESA, training activities in the Study Area may affect and are not likely to adversely affect the ESA-listed Southwest Alaska stock of Northern sea otter. In the Alaska region, critical habitat has been designated for Northern sea otters, but those nearshore areas are not present within the Study Area.

3.8.3.3.4.8 Conclusion

Training activities under Alternative 1 include the use of sonar and other active acoustic sources as described in Table 2.3-1. These activities may result in inadvertent exposure of marine mammals in the Study Area to underwater sound.

Pursuant to the MMPA, the use of sonar and other acoustic sources during training activities under Alternative 1:

- *May expose marine mammals up to 18,195 times annually to sound levels that would be considered Level B harassment, as defined by the MMPA*
- *May expose a Dall's porpoise 1 time annually to sound levels that would be considered Level A harassment, as defined by the MMPA*

Pursuant to the ESA, the use of sonar and other acoustic sources during training activities as described under Alternative 1:

- *May affect, and is likely to adversely affect, the North Pacific right whale, humpback whale, blue whale, fin whale, sei whale, sperm whale, and the Western Distinct Population Segment of Steller sea lion*
- *May affect, and is not likely to adversely affect Western North Pacific gray whale, and the Southwest Alaska stock of Northern sea otter*
- *Would have no effect on North Pacific right whale, Steller sea lion, or Northern sea otter critical habitat*

3.8.3.3.5 Alternative 2

Activities Involving Sonar and Other Active Acoustic Sources are described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.3-1, and Section 3.0.5.2.1.1 (Acoustic Stressors). Activities could occur throughout the TMAA but generally would not occur near the boundaries of the TMAA.

The predicted annual effects to marine mammals for activities involving use of sonar and other active acoustic sources are presented in Table 3.8-17. Annual totals presented in the table are the summation of all annual events occurring in a 12-month period. It is important to note that exposure numbers presented in Table 3.8-17 are the total number of exposures and not necessarily the number of separate individual marine mammals exposed. As discussed in Section 3.8.3.1.5 (Behavioral Responses), an animal could be predicted to receive more than one exposure over the course of the two 21-day exercise periods proposed to occur annually. The acoustic modeling and post-modeling analyses predict 36,411 marine mammal exposures¹⁶ to sonar and other active acoustic sources resulting in Level B harassment and 3 exposures¹⁷ resulting in Level A as defined under the MMPA for military training activities.

¹⁶ This is the combined summation of all non-TTS and TTS exposures (behavioral effects) for all species and stocks in the TMAA for an annual total (based on a 12-month period).

¹⁷ This is the combined summation of all PTS exposures for all species and stocks in the TMAA for an annual total (based on a 12-month period).

Table 3.8-17: Annual Predicted Effects to Marine Mammals from Use of Sonar and Other Active Acoustic Sources under Alternative 2

Species	Stock	Behavioral	TTS	PTS
North Pacific right whale	Eastern North Pacific	5	2	0
Humpback whale	Western North Pacific	1	0	0
	Central North Pacific	63	19	0
	California, Washington, and Oregon	43	13	0
Blue whale	Eastern North Pacific	76	19	0
	Central North Pacific	0	0	0
Fin whale	Northeast Pacific	1,882	700	0
Sei whale	Eastern North Pacific	10	3	0
Minke whale	Alaska	70	17	0
Gray whale	Eastern North Pacific	0	0	0
	Western North Pacific	0	0	0
Sperm whale	North Pacific	196	1	0
Killer whale	Alaskan Resident	539	25	0
	Eastern North Pacific Offshore	51	2	0
	AT1 Transient	1	0	0
	GOA, Aleutian Island, and Bering Sea Transient	138	6	0
Pacific white-sided dolphin	North Pacific	1,878	85	0
Harbor porpoise	Gulf of Alaska	5,484	0	0
	Southeast Alaska	1,926	0	0
Dall's porpoise	Alaska	2,198	13,935	3
Cuvier's beaked whale	Alaska	2,539	5	0
Baird's beaked whale	Alaska	401	0	0
Stejneger's beaked whale	Alaska	1,153	0	0
Steller sea lion	Eastern U.S.	671	0	0
	Western U.S.	572	0	0
California sea lion	U.S.	5	0	0
Northern fur seal	Eastern Pacific-Alaska	1,427	1	0
Northern elephant seal	California Breeding	201	44	0
Harbor Seal	North Kodiak	1	0	0
	South Kodiak	1	0	0
	Prince William Sound	1	1	0
	Glacier Bay/Icy Strait	0	0	0
	Sitka/Chatham	0	0	0
	Dixon/Cape Decision	0	0	0
Ribbon seal	Alaska	0	0	0
Northern sea otter	Southeast Alaska	0	0	0
	Southcentral Alaska	0	0	0
	Southwest Alaska	0	0	0
Sub-Total		21,533	14,878	3
MMPA Totals		Level B		Level A
		36,411		3

As described in Section 3.8.3.1.6.1 (Marine Species Density Data), in some cases (humpback whales, blue whale, gray whale, transient killer whale, harbor porpoise, Steller sea lion, and harbor seal) the density of marine mammals can be calculated for use in the NAEMO analysis; however, the number of whales from each stock contributing to that species density is unknown. To provide the number of effects by species and stock, the total modeled effects to the species were apportioned to each stock using derived ratios. These species/stock ratios were based on the relative abundances for each stock as provided in the applicable SARs (Allen and Angliss 2013, Carretta et al. 2013a). This method of apportionment is consistent with the Navy's approach in previous documents (U.S. Department of the Navy 2011a, 2013d) and as developed in consultation with NMFS as a cooperating agency; see Section 3.8.3.1.6.1 (Marine Species Density Data) regarding details on this approach for each applicable species.

Predicted acoustic effects to marine mammals from training activities from sonar and other active sound sources are, with the exception of two exposures from torpedo use during a Sinking Exercise, all from anti-submarine warfare events involving multiple platforms and sensors operating in a coordinated manner. As discussed in Section 3.8.3.3.1 (Impacts from Sonar and Other Active Acoustic Sources), ranges to TTS for hull-mounted sonar (e.g., sonar Bin MF1; SQS-53 anti-submarine warfare hull-mounted sonar) can be on the order of several kilometers, whereas some behavioral effects could take place at distances exceeding 93 mi. (150 km), although biologically meaningful behavioral effects are much more likely at higher received levels within a few kilometers of the sound source.

All effects to marine mammals from sonar and other active acoustic sources are associated with the activities conducted during a Carrier Strike Group exercise; see Table 2.3-1). The exercise is a 21-day event composed of multiple, dispersed yet coordinated activities involving multiple platforms (e.g., ships, planes, helicopters, and submarines) that often require movement across or use of large portions of the Study Area. Some animals may be exposed to this activity multiple times over the course of a few days and leave the area although these activities do not use the same locations day-after-day during multi-day activities. Therefore, displaced animals could return after the exercise moves away, allowing the animal to recover from any energy expenditure or missed resources.

For shorter term exposures or those from distant sources, animals may stop vocalizing, break off feeding dives, or, alternatively, ignore the acoustic stimulus, especially if it is located more than a few kilometers away (see Section 3.8.3.1.2.6, Behavioral Reactions, for discussion of research and observations on the behavioral reactions of marine mammals to sonar and other active acoustic sources). A few behavioral reactions per year, even from a single individual, are unlikely to produce long-term consequences for that individual or the population. Furthermore, mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) would further reduce the predicted impacts since not all mitigations are accounted for in the adjustments to the acoustic effects modeling numbers.

3.8.3.3.5.1 Mysticetes

Predicted acoustic effects to mysticetes during the Carrier Strike Group exercise are from anti-submarine warfare events involving surface ships, aircraft, and submarines. As discussed in Section 3.8.3.3.1 (Impacts from Sonar and Other Active Acoustic Sources), ranges to TTS for hull-mounted sonar (e.g., sonar Bin MF1; SQS-53 anti-submarine warfare hull-mounted sonar) can be on the order of several thousand yards (kilometers); see Section 3.8.3.3.1.1 (Range to Effects) and Table 3.8-11 for details. If there was no background noise (such as that from vessel traffic, breaking waves, or other vocalizing marine mammals) masking the active ping occurring approximately every 50 seconds, the ping could reach and possibly be heard underwater at distances exceeding approximately 54 mi. (87 km), although biologically meaningful behavioral effects are much more likely at higher received levels within a few

kilometers of the sound source. The low received level (approximately 120 dB SPL) from the sonar at a distance exceeding approximately 54 mi. (87 km) is modeled as having some behavioral effects.

Research by Risch et al. (2012) found that humpback whale vocalizations were reduced concurrent with pulses at low received levels from a low frequency source located approximately 100 mi. (161 km) away. None of the sources proposed for use in this Supplemental EIS/OEIS are comparable to the low frequency source recorded by Risch et al. (2012). Those findings do, however, validate use of the Behavioral Response Function's low (120 dB SPL received level) threshold as criteria for MMPA Level B harassment for a percent of the population exposed to that level of sound.

As mentioned previously in Section 3.8.3.1.2.6 (Behavioral Reactions), Melcón et al. (2012) documented that blue whales decreased the proportion of time spent producing certain types of calls when mid-frequency simulated sonar was present. Changes in vocal response by marine mammals have been documented elsewhere (Noren et al. 2009, Potter et al. 2007), while blue whale feeding/social calls were found to increase when seismic exploration was underway (Di Iorio and Clark 2010), indicative of a potentially compensatory response to the increased noise level. Although long-term implications of disruption in call production to blue whale foraging and other behaviors are currently not well understood, sonar usage in the Gulf of Alaska (fathometers, fish-finders, research sonar, and Navy mid-frequency sonar during annual training) in narrow bands of the mid-frequency and high frequency spectrums is not likely to have long-term impacts on marine mammals believed to predominately use the low frequency sound.

Additionally in Section 3.8.3.1.2.6 (Behavioral Reactions), Goldbogen et al. (2013) reported on the results of an ongoing Navy-funded behavioral response study in the waters of Southern California.¹⁸ Goldbogen et al. (2013) suggested that "frequent exposure to mid-frequency anthropogenic sounds may pose significant risks to the recovery rates of endangered blue whale populations." However, research along the U.S. west coast and Baja California reported by Calambokidis et al. (2009b) based on mark-recapture estimates "indicated a significant upward trend in abundance of blue whales" at a rate of increase just under 3 percent per year for the portion of the blue whale population in the Pacific that includes Southern California as part of its range. The Eastern North Pacific stock (population), which is occasionally present in Southern California, is known to migrate from the northern Gulf of Alaska to the eastern tropical Pacific at least as far south as the Costa Rica Dome and has been increasingly found feeding to the north and south of the U.S. west coast during summer and fall (Carretta et al. 2014). Given this population's vast range and absent discussion of any other documented impacts, such as commercial ship strikes (Berman-Kowalewski et al. 2010), the suggestion by Goldbogen et al. (2013) that since the end of commercial whaling, sonar use (in the fraction of time and area represented by Navy's training and testing in the SOCAL Range Complex) may be of significant risk to the blue whale's recovery in the Pacific is speculative at this stage. Furthermore, the suggestion is contradicted by the upward trend in abundance and counts of blue whales (Berman-Kowalewski et al. 2010, Calambokidis et al. 2009b) in the location discussed by Goldbogen et al. (2013) and where sonar use has been occurring for decades. Additionally, while there has not been evidence to suggest an increase in the Eastern North Pacific blue whale population, data provided by Monnahan et al. (2014) indicate that population may have recovered near to its estimated pre-whaling size.

¹⁸ Navy-funded Behavioral Response Study (BRS) investigations have been ongoing since 2007. The Navy is continuing funding the BRS research which has, for the first time in Southern California in fall 2013, exposed marine mammals to actual U.S. Navy mid-frequency sonar. The results from that most recent fieldwork are pending.

Given the documented environmental variability along the U.S. west coast and lack of data needed to make a complete assessment of the blue whale population, there can be no definitive statements regarding the recovery of the blue whale population in the Pacific or inferences then drawn based on a trend in the species recovery in the Pacific from sightings along the U.S. west coast. It is, however, important to note that for the blue whale population along the U.S. west coast (which includes Southern California, where the Navy has been training and testing for decades) there has been a significant upward trend in abundance (Calambokidis et al. 2009b) despite an increasingly found likely redistribution beyond that area (Carretta et al. 2014).

To summarize, research and observations show that if mysticetes are exposed to sonar or other active acoustic sources they may react in a number of ways depending on the characteristics of the sound source, their experience with the sound source, and whether they are migrating or on seasonal grounds (i.e., breeding or feeding). Reactions may include changes in vocalization, alerting; breaking off feeding dives and surfacing, diving or swimming away, or no response at all.

Animals that do experience TTS may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations until their hearing recovers and is therefore as a condition potentially affecting an animal's behavior. Recovery from a threshold shift (i.e., TTS; temporary partial loss of hearing sensitivity) can take a few minutes to a few days depending on the severity of the initial shift. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal's ability to hear biologically relevant sounds. For exposures resulting in TTS, long-term consequences for individuals or populations of mysticetes would not be expected. This assessment of long-term consequences is based on findings from ocean areas where the Navy has been intensively training and testing with sonar and other active acoustic sources for decades. While there are many factors such as the end of large-scale commercial whaling complicating any analysis, there is no data suggesting any long-term consequences to mysticetes from exposure to sonar and other active acoustic sources. On the contrary, there are findings suggesting mysticete populations are increasing in the two primary locations (Southern California and Hawaii) where the Navy's most intensively used range complexes are located. These findings include: (1) Calambokidis et al. (2009b) indicating a significant upward trend in abundance of for blue whales in Southern California; (2) the recovery of gray whales that migrate through the Navy's SOCAL Range Complex twice a year; (3) work by Moore and Barlow (2011) indicating evidence of increasing fin whale abundance in the California Current area, which includes the SOCAL Range Complex; (4) the range expansion and increasing presence of Bryde's whales south of Point Conception in Southern California (Kerosky et al. 2012); and (5) the ocean area contained within the Hawaii Range Complex continuing to function as a critical breeding, calving, and nursing area to the point at which the overall humpback whale population in the North Pacific is now greater than some prior estimates of pre-whaling abundance (Barlow et al. 2011).

As presented in detail in Section 3.8.3.3.4.1 (Mysticetes) for Alternative 1, review of the NMFS-identified feeding and migration areas showed there is only minimal spatial overlap with the Navy TMAA and the North Pacific right whale feeding area southeast of Kodiak Island and minimal overlap with the edge of the gray whale migration area offshore of Kenai Peninsula (Ferguson et al. 2015b). Those areas of overlap at the corners of the TMAA are very unlikely to have any Navy training activity. Therefore, it is very unlikely there would be an effect to feeding or migrating activities if right whales or gray whales were present. Additionally, appropriate standard operating procedures and mitigation measures (as detailed in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) would be implemented for any detected marine mammals and thus further reduce the potential for the feeding or migration activities to be affected.

North Pacific Right Whales (Endangered Species Act-Listed)

North Pacific right whales may be exposed to sonar or other active acoustic stressors that may result in two TTS and five behavioral reactions per year. These seven predicted behavioral effects could be to the same animal on subsequent days, or be the result of exposures to two or more animals. As presented above for mysticetes in general, long-term consequences for individuals or the population would not be expected. Pursuant to the ESA, training activities in the Study Area may affect and are likely to adversely affect this species. There is no designated right whale critical habitat in the Study Area.

Blue Whales (Endangered Species Act-Listed)

Blue whales were visually detected five times during the GOALS II survey (Rone et al. 2013), both as single individuals and in pairs. Blue whales should be readily detectable; however, there was no adjustment to the model predicted impacts due to implemented mitigation or animal avoidance. Blue whales may be exposed to sonar or other active acoustic stressors that may result in 19 TTS and 76 behavioral reactions per year. For both stocks and as presented above for mysticetes in general, long-term consequences for individuals or the population would not be expected. Pursuant to the ESA, training activities in the Study Area may affect and are likely to adversely affect this species.

Humpback Whales (Endangered Species Act-Listed)

Humpback whales were visually detected during the GOALS II survey (Rone et al. 2013) and were typically in groups of two or more animals. Group sizes ranged from 1 to 15 individuals, and the average group size was 3.12. Humpback whales should be readily detectable; however, there was no adjustment to the model predicted impacts due to implemented mitigation or animal avoidance. Humpback whales may be exposed to sonar or other active acoustic stressors that may result in 34 TTS and 108 behavioral reactions per year. For the stocks and as presented above for mysticetes in general, long-term consequences for individuals or the population would not be expected. Pursuant to the ESA, training activities in the Study Area may affect and are likely to adversely affect this species.

Sei Whales (Endangered Species Act-Listed)

Sei whales may be exposed to sonar or other active acoustic stressors that may result in 3 TTS and 11 behavioral reactions per year. As presented above for mysticetes in general, long-term consequences for individuals or the population would not be expected. Pursuant to the ESA, training activities in the Study Area may affect and are likely to adversely affect this species.

Fin Whales (Endangered Species Act-Listed)

Fin whales were visually detected during the GOALS II survey (Rone et al. 2013) approximately 54 percent of the time as single individuals and 46 percent in groups of two or more. Group sizes ranged from 1 to 13 individuals (the average group size was 1.96). Goldbogen et al. (2006) found that fin whales engaged in lunge feeding at depth had dive durations that averaged approximately 7 minutes; therefore, they should be available at the surface for detection by vessels, helicopters, and aircraft participating in training. Although fin whales should be readily detectable, however, there was no adjustment to the model-predicted impacts due to implemented mitigation or animal avoidance. Fin whales may be exposed to sonar or other active acoustic stressors that may result in 700 TTS and 1,882 behavioral reactions per year. As presented above for mysticetes in general, long-term consequences for individuals or the population would not be expected. Pursuant to the ESA, training activities in the Study Area may affect and are likely to adversely affect this species.

Gray Whales, Eastern North Pacific Stock and Endangered Species Act-Listed Western North Pacific Stock

No gray whales were detected in the TMAA Study Area during the GOALS II survey (Rone et al. 2013). Acoustic modeling indicates that gray whales would not be exposed to sonar or other active acoustic sources associated with training activities, which would exceed the current impact thresholds. Gray whales of the Western North Pacific stock may migrate through the Study Area although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur. Since gray whales of the Western North Pacific stock could potentially be present in the Study Area, they may be exposed to low levels of sound or energy. Pursuant to the ESA, training activities in the Study Area may affect and are not likely to adversely affect this species.

Minke Whales

Minke whales were visually detected during the GOALS II survey (Rone et al. 2013) on three occasions in groups of one, two, and three individuals. There was no adjustment to the model predicted impacts due to implemented mitigation or animal avoidance. Minke whales may be exposed to sonar or other active acoustic stressors that may result in 18 TTS and 70 behavioral reactions per year. As presented above for mysticetes in general, long-term consequences for individuals or the population would not be expected.

3.8.3.3.5.2 Odontocetes

Predicted impacts to odontocetes from training activities under Alternative 2 from sonar and other active acoustic sources during the Carrier Strike Group exercise are, with the exception of two exposures from torpedo use during a Sinking Exercise, all from anti-submarine warfare events involving surface ships and hull-mounted sonar. As discussed in Section 3.8.3.3.1.1 (Range to Effects), for mid-frequency odontocetes (cetaceans constituting the majority of marine mammals present), ranges to TTS for hull-mounted sonar (e.g., sonar Bin MF1; SQS-53 anti-submarine warfare hull-mounted sonar) is within a maximum of approximately 200 yd. (200 m) for a single ping. For high-frequency cetaceans (i.e., Dall's porpoise and harbor porpoise), ranges to TTS for multiple pings can stretch to distances of over 5 mi. (8 km). If there was no background noise (such as that from vessel traffic, breaking waves, or other vocalizing marine mammals) masking the active ping occurring approximately every 50 seconds, the most powerful surface ship hull-mounted sonar could, under rather optimal conditions, reach and possibly be heard underwater at distances exceeding approximately 107 mi. (172 km). The low received level (approximately 120 dB SPL) at that distance is modeled as having some behavioral effects possible, although biologically meaningful behavioral effects are much more likely at higher received levels within a few kilometers of the sound source. Modeling predicts behavioral effects at long distance and low received levels but does not take into account background ambient noise levels or other competing biological sounds, which may mask sound from distant Navy sources. D'Spain and Batchelor (2006) measured a source spectral density of 105–120 dB re 1 $\mu\text{Pa}^2/\text{Hz}$ at 1 m (in the mid-frequency range) and calculated an estimated source level of 135–150 dB re 1 μPa at 1 m from various biologics (fish and marine mammals) contributing to those underwater ambient sound levels recorded to the southeast of San Clemente Island off San Diego, California.

Although involving species that are not present in the GOA Study Area, controlled exposure experiments in 2007 and 2008 in the Bahamas recorded responses of false killer whales, short-finned pilot whales, and melon-headed whales to simulated MFA sonar (De Ruiter et al. 2013b). The responses to exposures between species were variable. After hearing each MFA signal, false killer whales were found to “increase their whistle production rate and made more-MFA-like whistles” (De Ruiter et al. 2013b). In contrast, melon-headed whales had “minor transient silencing” after each MFA signal, while pilot whales had no apparent response.

Pilot whales or false killer whales in the Bahamas showed an avoidance response to controlled exposure playbacks (Southall et al. 2009a). Consistent with the findings of other previous research (see, for example, Southall et al. 2007; De Ruiter et al. 2013b) found the responses were variable by species and with the context of the sound exposure. The assumption is that odontocete species in general, including those in the GOA Study Area, would have similar variable responses.

Activities involving anti-submarine warfare training in a Carrier Strike Group exercise involve multiple participants and activities associated with the event. More sensitive species of odontocetes such as beaked whales, Dall's porpoises, and harbor porpoise may avoid the area for the duration of the event (see Section 3.8.3.1.2.6, Behavioral Reactions, for a discussion of these species observed reactions sonar and other active acoustic sources). After the event ends, displaced animals would likely return to the area within a few days as seen in the Bahamas study with Blainville's beaked whales (Tyack et al. 2011). This would allow the animal to recover from any energy expenditure or missed resources, reducing the likelihood of long-term consequences for the individual or population.

Animals that do experience TTS may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations until their hearing recovers. Recovery from a threshold shift (i.e., TTS; temporary partial loss of hearing sensitivity) can take a few minutes to a few days depending on the severity of the initial shift. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal's ability to hear biologically relevant sounds. For exposures resulting in TTS, long-term consequences for individuals or populations would not be expected.

There are three PTS exposures predicted annually for Dall's porpoises. For PTS, it is uncertain whether some permanent loss of hearing sensitivity over a part of a marine mammal's hearing range would have long-term consequences for that individual, given that natural hearing loss occurs in marine mammals as a result of disease, parasitic infestations, and age-related impairment (Ketten 2012). Furthermore, likely avoidance of intense activity and sound coupled with mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) would further reduce the potential for PTS exposures to occur. Considering these factors, long-term consequences for individuals or populations would not be expected.

Sperm Whales (Endangered Species Act-Listed)

Sperm whales were visually detected during the GOALS II survey (Rone et al. 2013) as single individuals or approximately 10 percent of the time in pairs. There was no adjustment to the model predicted impacts due to implemented mitigation or animal avoidance. Sperm whales (classified as mid-frequency cetaceans [Section 3.8.2.3.2, Mid-Frequency Cetaceans]) may be exposed to sonar or other active acoustic stressors associated with training activities that may result in 1 TTS and 196 behavioral reactions per year.

Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that if sperm whales are exposed to sonar or other active acoustic sources they may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Sperm whales have shown resilience to acoustic and human disturbance, although they may react to sound sources and activities within a few kilometers. Sperm whales that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, avoid the area by swimming away or diving, or display aggressive behavior. Straley et al. (2014) reported on findings from satellite tags attached to 10 sperm whales in the Gulf of Alaska. The tags demonstrated

that at least three of these animals went as far south as waters off Mexico. This suggests that potential behavioral disturbances resulting in avoidance of Navy events or acoustic sources is unlikely to have any meaningful consequences for animals that cover such distances. As presented above for odontocetes in general, long-term consequences for sperm whale individuals or populations would not be expected. Pursuant to the ESA, training activities involving the use of sonar and other active acoustic sources in the Study Area may affect and are likely to adversely affect this species.

Harbor Porpoises

Harbor porpoises were visually detected eight times during the GOALS II survey (Rone et al. 2013) as single individuals or in pairs (approximately 38 percent of the time). Harbor porpoises may be exposed to sonar or other active acoustic stressors associated with training activities that may result in 5,484 behavioral reactions involving the Gulf of Alaska stock and 1,926 behavioral reactions involving the Southeast Alaska stock.

Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) of harbor porpoises show that this small species is very wary of human activity and will avoid anthropogenic sound sources in many situations at levels down to 120 dB re 1 μ Pa. This level was determined by observing harbor porpoise reactions to acoustic deterrent and harassment devices used to drive away animals from around fishing nets and aquaculture facilities. Avoidance distances typically were about 1 km or more, but it is unknown if animals would react similarly if the sound source were at a distance of tens or hundreds of kilometers. The behavioral response function is not used to estimate behavioral responses by harbor porpoises; rather, a single threshold is used. Because of this very low behavioral threshold (120 dB re 1 μ Pa), harbor porpoises at distances exceeding approximately 100 nm would in some cases be predicted to have a behavioral reaction in this acoustic analysis. It is not known whether animals would actually react to sound sources at these ranges, regardless of the received sound level. Harbor porpoises may startle and leave the immediate area of the anti-submarine warfare training exercise but return within a few days after the cessation of the event. Behavioral reactions seem more likely than with most other odontocetes. Since these species are typically found in nearshore and inshore habitats, they should generally not be present in the TMAA. Animals that do exhibit a behavioral reaction would likely recover from any incurred costs, reducing the likelihood of long-term consequences for the individual or population.

There are no PTS or TTS exposures predicted for harbor porpoises.

Beaked Whales

Beaked whales (Baird's, Cuvier's, and Stejneger's beaked whales) may be exposed to sonar or other active acoustic stressors that may result in 5 TTS and 4,093 behavioral reactions annually (see Table 3.8-16 for details regarding predicted exposures for each species). Baird's beaked whales were visually detected during the GOALS II survey (Rone et al. 2013) in groups of 2 or more individuals (the average group size was 8.29), with group sizes ranging from 2 to 16 individuals. Only a single Cuvier's beaked whale was visually detected during the GOALS II survey; Stejneger's beaked whales were not observed (Rone et al. 2013).

Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that if beaked whales are exposed to sonar or other active acoustic sources they may startle, break off feeding dives (see Defence Science and Technology Laboratory 2007), and avoid the area of the sound source to levels of 157 dB re 1 μ Pa or below (McCarthy et al. 2011). In research done at the Navy's instrumented tracking range in the Bahamas, animals leave the immediate area of the anti-submarine warfare training exercise, but return

within a few days after the event ends (Claridge and Durban 2009, McCarthy et al. 2011, Moretti et al. 2009, Tyack et al. 2011). Passive acoustic monitoring of a training event at the Navy's instrumented range in Hawaii was undertaken during a Submarine Commander Course involving three surface ships and a submarine using mid-frequency sonar over the span of the multiple-day event. Manzano-Roth et al. (2013) determined that beaked whales (tentatively identified as Blainville's beaked whales) continued to make foraging dives at estimated distances of 13 to 52 km from active mid-frequency sonar, but that the animals shifted to the southern edge of the range with differences in the dive vocal period duration and dive rate. De Ruiter et al. (2013a) presented results from two Cuvier's beaked whales that were tagged and exposed to simulated MFA sonar during the 2010 and 2011 field seasons of the Southern California behavioral response study (note that preliminary results from the same behavioral response study in Southern California waters have been presented for the 2010–2011 field season [Southall 2011]). One of the 2011 tagged whales was also incidentally exposed to MFA sonar from a distant naval exercise. Received levels from the MFA sonar signals from the controlled and incidental exposures were calculated as 84–144 and 78–106 dB re 1 μ Pa rms, respectively. Both tagged whales showed responses to the controlled exposures, ranging from initial orientation changes to avoidance responses characterized by energetic fluking and swimming away from the source. However, the authors did not detect similar responses to incidental exposure from distant naval sonar exercises at comparable received levels, indicating that context of the exposures (e.g., source proximity, controlled source ramp-up) may have been a significant factor. Cuvier's beaked whale responses suggested particular sensitivity to sound exposure as consistent with results for Blainville's beaked whale. Based on these findings, behavioral reactions seem likely in most cases if beaked whales are exposed to anti-submarine sonar within a few tens of kilometers (Section 3.8.3.3.1, Impacts from Sonar and Other Active Acoustic Sources), especially for prolonged periods (a few hours or more) since research indicates beaked whales have been shown to leave an area where anthropogenic sound is present (Tyack et al. 2011; Manzano-Roth et al. 2013).

The concern with beaked whales and an avoidance response is whether that displacement is likely to have long-term consequences for an animal or populations. Research involving three tagged Cuvier's beaked whales in the SOCAL Range Complex reported on by Falcone and Schorr (2012, 2014) has documented movements in excess of hundreds of kilometers by some of those animals. Schorr et al. (2014) reported the results for an additional eight tagged Cuvier's beaked whale in the same area. Five of these eight whales made journeys of approximately 250 km from their tag deployment location and one of these five made an extra-regional excursion over 450 km south to Mexico and back again. Given that some beaked whales may routinely move hundreds of kilometers as part of their normal pattern, temporarily leaving an area to avoid sonar or other anthropogenic activity may have little if any cost to such an animal. Photo identification studies in the SOCAL Range Complex have identified approximately 100 individual Cuvier's beaked whales, with 40 percent having been seen in one or more prior years, with re-sightings up to 7 years apart (Falcone and Schorr 2014). These results indicate long-term residency by beaked whales in an intensively used Navy training and testing area where sonar use is common and has been occurring for decades. These results suggest inconsequential effects or a lack of long-term consequences resulting from exposure to Navy training activities.

Moore and Barlow (2013) noted a decline in beaked whales in a broad area of the Pacific Ocean within the U.S. EEZ. Interestingly, however, in the small portion of the EEZ overlapping the Navy's SOCAL Range Complex, long-term residency by individual Cuvier's beaked whales and higher densities provide indications that the proposed decline noted elsewhere is not apparent where the Navy has been intensively training and testing with sonar and other systems for decades. In Southern California, based on a series of surveys from 2006 to 2008 and a high number encounter rate, Falcone et al. (2009)

proposed that their observations suggested the ocean basin west of San Clemente Island may be an important region for Cuvier's beaked whales given the number of animals encountered there (see also Hildebrand and McDonald 2009). Follow-up research (Falcone and Schorr 2012; 2014) in this same location suggests that Cuvier's beaked whales may have population sub-units with higher than expected residency in Navy's instrumented SOCAL Anti-Submarine Warfare Range in particular. Encounters with multiple groups of Cuvier's and Baird's beaked whales indicated not only that they were prevalent on the range where Navy routinely trains and tests, but also that they were potentially present in much higher densities than had been reported for anywhere along the U.S. west coast (Falcone et al. 2009, Falcone and Schorr 2012, 2014). This finding is also consistent with concurrent results from passive acoustic monitoring that estimated regional Cuvier's beaked whale densities were higher than indicated by NMFS's broad scale visual surveys for the U.S. west coast (Hildebrand and McDonald 2009).

Moore and Barlow (2013) suggest that one reason for the decline in beaked whales from Canada to Mexico may be as a result of anthropogenic sound, including the use of sonar by the U.S. Navy in the fraction of the U.S. Pacific coast overlapped by the SOCAL Range Complex. Moore and Barlow (2013) recognized the inconsistency between their hypothesis and the abundance trends in the region of SOCAL Range Complex stating, "High densities are not obviously consistent with a hypothesis that declines are due to military sonar, but they do not refute the possibility that declines have occurred in these areas (i.e., that densities were previously even higher)." While it is possible that the high densities of beaked whale currently inhabiting the Navy's range were even higher before the Navy began training with sonar, there is no data available to test that hypothesis. Although Moore and Barlow (2013) have noted a decline in the overall beaked whale population along the Pacific coast, in the small fraction of that area where the Navy has been training and testing with sonar and other systems for decades (the Navy's SOCAL Range Complex), higher densities and long-term residency by individual Cuvier's beaked whales suggest that the decline noted elsewhere is not apparent where Navy sonar use is most intense. Navy sonar training and testing is not conducted along a large part of the U.S. West Coast from which Moore and Barlow (2013) drew their survey data. In Southern California, based on a series of surveys from 2006 to 2008 and a high number encounter rate, Falcone et al. (2009) suggested the ocean basin west of San Clemente Island may be an important region for Cuvier's beaked whales given the number of animals encountered there.

In summary, based on the best available science, the Navy believes that beaked whales that exhibit a behavioral reaction due to sonar and other active acoustic training activities would generally not have long-term consequences for individuals or populations. Neither NMFS nor the Navy anticipates that marine mammal strandings or mortality will result from the operation of sonar or other acoustic sources during Navy exercises within the TMAA. Additionally, through the MMPA process (which allows for adaptive management), NMFS and the Navy will determine the appropriate way to proceed in the event that a causal relationship were to be found between Navy activities and a future stranding involving beaked whale or other marine mammal species.

There are 5 TTS exposures from sonar and other active acoustic sources predicted for Cuvier's beaked whales (no TTS are predicted for the other two beaked whale species [Baird's and Stejneger's] in the Study Area. For the most powerful surface ship sonar (MF1) proposed for use in the Study Area, the predicted TTS exposures for beaked whales (a MF cetacean) would have to occur within approximately 100 yd. (100 m) of a ship's bow or well within the established mitigation zone (see Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring, for discussion of the mitigation zones). It was not, however, assumed that Cuvier's beaked whales would be detected and model predicted TTS exposures were not reduced even though implemented mitigation may be effective in reducing model predicted

TTS exposures. Given that beaked whales have been documented to leave the area where sonar use or other anthropogenic disturbance is occurring (Claridge and Durban 2009; De Ruiter et al. 2013a; McCarthy et al. 2011; Moretti et al. 2009; Tyack et al. 2011; Manzano-Roth et al. 2013), it is likely that Cuvier's beaked whale would avoid the area before coming within range of a TTS exposure. As noted above, research from the intensively used SOCAL Range Complex indicates year-round prolonged use of the Navy's training and testing area by Cuvier's and Baird's beaked whales (Falcone et al. 2009, Falcone and Schorr 2012, 2014; Hildebrand and McDonald 2009). Research efforts involving tagging of Cuvier's beaked whales (Falcone and Schorr 2014) has documented movements in excess of hundreds of kilometers as part of their normal pattern of movement, suggesting that a temporary movement to avoid the vicinity of sonar use or other anthropogenic disturbance may have little if any cost to such an animal. Costs and long-term consequences to the individual and population as a result of a beaked whale behaviorally reacting to sonar and other active acoustic sources are not expected. Costs and long-term consequences to the individual and population as a result of a beaked whale receiving a TTS is the same as presented above in the general discussion for odontocetes. Population-level consequences are not expected.

3.8.3.3.5.3 Dall's Porpoise

Dall's porpoise are classified as high-frequency cetaceans (Section 3.8.2.3.1, High-Frequency Cetaceans) and are part of the Alaska stock. Dall's porpoises were most often visually detected during the GOALS II survey (Rone et al. 2013) in pods of 2 or more individuals, with group sizes ranging from 1 to 25 individuals (the average group size was 2.69). Survey observations by Rone et al. (2009) recorded 10 sightings of 59 Dall's porpoise with an average group size of 5.90 and thus illustrated the variability possible in group sizes between the two survey efforts. Acoustic modeling predicts that Dall's porpoise could be exposed to sonar and other active acoustic sources that may result in 3 PTS, 13,935 TTS, and 2,198 behavioral reactions. Costs and long-term consequences to the individual and population as a result of a Dall's porpoise receiving a PTS or TTS is the same as presented above in the general discussion for odontocetes. Population-level consequences are not expected.

3.8.3.3.5.4 Killer Whale

Killer whales are classified as mid-frequency cetaceans (Section 3.8.2.3.2, Mid-Frequency Cetaceans). Killer whales were visually detected during the GOALS II survey (Rone et al. 2013) approximately 90 percent of the time in pods of 2 or more individuals, with group sizes ranging from 1 to 45 individuals (the average group size was 6.57). Acoustic modeling predicts that killer whales (see Table 3.8-16 for the details of exposure to the four stocks of killer whales in the Study Area) could be exposed to sound that may result in 33 TTS and 729 behavioral reactions annually. The acoustic modeling and post-modeling analyses predict there would be no exposures to killer whale from sonar and other active acoustic sources resulting in PTS, due to the short range from the source required for PTS to occur (see discussion in Section 3.8.3.3.1.1, Range to Effects).

Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that if killer whales are exposed to sonar or other active acoustic sources they may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Killer whales may not react at all until the sound source is approaching within a few hundred meters to within a few kilometers depending on the environmental conditions and species. Killer whales that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, change their behaviors or vocalizations, avoid the sound source by swimming away or diving, or be attracted to the sound source. Research has demonstrated that Alaska Resident killer whales may routinely move over long large distances (Andrews and Matkin 2014, Fearnbach et al. 2013).

In a similar documented long distance movement, an Eastern North Pacific Offshore stock killer whale tagged off San Clemente Island, California moved (over a period of 147 days) to waters off northern Mexico, then north to Cook Inlet, Alaska, and finally (when the tag ceased transmitting) to coastal waters off Southeast Alaska (Falcone and Schorr 2014). Given these findings, temporary displacement due to avoidance of training activities are therefore unlikely to have biological significance to individual animals. Long-term consequences to individual killer whales or populations are not likely due to exposure to sonar or other active acoustic sources.

Costs and long-term consequences to the individual and population as a result of a killer whale receiving an exposure resulting in TTS are the same as presented above in the general discussion for odontocetes. Population-level consequences are not expected.

3.8.3.3.5.5 Pacific White-Sided Dolphin

Pacific white-sided dolphin are classified as mid-frequency cetaceans (Section 3.8.2.3.2, Mid-Frequency Cetaceans). Pacific white-sided dolphins were not detected during the Rone et al. (2013) survey in the Study Area. Acoustic impact modeling predicts that Pacific white-sided dolphin (Table 3.8-16) could be exposed to sound that may result in 65 TTS and 1,878 behavioral reactions. The acoustic modeling and post-modeling analyses predict there would be no exposure to Pacific white-sided dolphin from sonar and other active acoustic sources resulting in PTS, due to the short range from the source required for PTS to occur (see discussion in Section 3.8.3.3.1.1, Range to Effects).

Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that if delphinids such as the Pacific white-sided dolphin are exposed to sonar or other active acoustic sources they may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Delphinids may not react at all until the sound source is approaching within a few hundred meters to within a few kilometers depending on the environmental conditions and species. Delphinids that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, change their behaviors or vocalizations, avoid the sound source by swimming away or diving, or be attracted to the sound source. Long-term consequences to individual delphinids or populations are not likely due to exposure to sonar or other active acoustic sources.

Costs and long-term consequences to the individual and population as a result of Pacific white-sided dolphin receiving an exposure resulting in TTS are the same as presented above in the general discussion for odontocetes. Population-level consequences are not expected.

3.8.3.3.5.6 Pinniped

Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that pinnipeds in the water are tolerant of anthropogenic noise and activity. Evidence from areas where Navy extensively trains and tests provides some indication of the possible consequences resulting from those proposed activities. In the confined waters of Washington State's Hood Canal where the Navy has been training and intensively testing for decades and harbor seals are present year-round, the population level has remained stable suggesting the area's carrying capacity may have been reached (Jeffries et al. 2003). In a similar manner, the beaches and shallow water areas within the PMRF at Kauai (in the main Hawaiian Islands) continue to be an important haulout and nursing area for endangered Hawaiian Monk Seals. While there has been a decline in the population of Hawaiian monk seals in the northwestern Hawaiian Islands, in the main Hawaiian Islands the numbers have continued to increase (Littnan 2011). If seals are exposed to sonar or other active acoustic sources they may react in a number of ways depending on their

experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Seals may not react at all until the sound source is approaching within a few hundred meters and then may alert, ignore the stimulus, change their behaviors, or avoid the immediate area by swimming away or diving. Biologically meaningful behavioral reactions would not be expected in most cases and long-term consequences for individuals or pinniped populations are unlikely.

Recovery from a hearing threshold shift (i.e., TTS; temporary partial loss of hearing sensitivity) can take a few minutes to a few days depending on the severity of the initial shift. More severe shifts may not fully recover and thus would be considered PTS. Threshold shifts do not necessarily affect all hearing frequencies equally, so threshold shifts may not necessarily interfere with an animal's ability to hear biologically relevant sounds. As discussed previously in this section, it is uncertain whether some permanent loss of hearing sensitivity over a part of a marine mammal's hearing range would have long-term consequences for that individual given that natural hearing loss occurs in marine mammals as a result of disease, parasitic infestations, and age-related impairment (Ketten 2012).

Phocids (Harbor Seal, Northern Elephant Seal, and Ribbon Seal)

Harbor seal, northern elephant seal, and ribbon seal are the species of phocid pinnipeds that may be present within the Study Area. Elephant seals were visually identified 16 times at-sea during the GOALS II survey (Rone et al. 2013) as single individuals and no other phocids were encountered.

There are six stocks of Harbor seal that may be present in the general Gulf of Alaska area although migrating harbor seals generally use of only nearshore pelagic areas based on an analysis of the findings in Alaska from Womble and Gende (2013). Modeled effects for harbor seal were apportioned based on the ratio of abundance for each stock as provided in the Alaska Stock Assessment Report (Allen and Angliss 2013). Northern elephant seal are the California breeding stock and Ribbon seal are the Alaska Stock.

Predicted effects to phocids are from anti-submarine warfare events involving surface ships, submarines, and aircraft during the Carrier Strike Group exercise. As discussed in Section 3.8.3.3.1 (Impacts from Sonar and Other Active Acoustic Sources), ranges to TTS for hull-mounted sonar (e.g., sonar Bin MF1; SQS-53) can be on the order of a several kilometers for phocid seals (see discussion in Section 3.8.3.3.1.1, Range to Effects). Some behavioral effects could hypothetically take place at distances exceeding 54 mi. (87 km), although biologically meaningful behavioral effects are much more likely at higher received levels within a few kilometers of the sound source. For behavioral exposures, long-term consequences would not be expected. Costs and long-term consequences to the individual and population as a result of a phocid receiving a TTS is the same as presented above under the general discussion for pinniped. Population-level consequences are not expected.

Acoustic modeling predicts phocids could be exposed to sound that may result in 45 TTS and 204 behavioral reactions (see Table 3.8-16 for details regarding the species and six harbor seal stocks). The majority of all exposures (approximately 98 percent) are attributed to northern elephant seal. Exposures to harbor seals (four total) are predicted based on animals being at sea in deep water such as is present in the TMAA. Individual ribbon seal may be present in the Study Area but they are expected to be rare in occurrence. Based on that rare occurrence, ribbon seal are unlikely to be exposed to sonar or other active acoustic sources associated with training activities, which would exceed the current impact thresholds.

Otariids (Sea Lion and Fur Seal)

Northern fur seal, California sea lion, and Steller sea lion comprise the otariid species of pinniped in the Study Area. Otariids may be exposed to sonar or other active acoustic stressors associated with anti-submarine warfare events involving surface ships, submarines, and aircraft during the Carrier Strike Group exercise, which generally take place in deep ocean areas away from the shelf and coastal margins. Olesiuk reported that evidence from various sources indicates that juvenile and non-breeding northern fur seal are virtually ubiquitous throughout the Northeastern Pacific Ocean, albeit in densities lower than at the coastal margins (Olesiuk 2012). It is likely that Steller sea lion and the rare California sea lion, which share haulout locations with them in the Gulf of Alaska, are generally foraging in the vicinity to their haulouts and will therefore be concentrated outside the Study Area. Northern fur seals were visually detected at-sea during the GOALS II survey (Rone et al. 2013) on 78 occasions and on five of those occasions in pairs. California sea lion and Steller sea lion were not identified during the GOALS II survey (Rone et al. 2013). Acoustic modeling predicts otariids could be exposed during the Carrier Strike Group exercise to sound that may result in 1 TTS and 2,675 behavioral reactions (see Table 3.8-16 for details).

For behavioral exposures otariid, long-term consequences would not be expected. Costs and long-term consequences to the individual and population as a result of a northern fur seal receiving a TTS exposure is the same as presented above under the general discussion for pinnipeds. Population-level consequences are not expected.

Steller Sea Lion (Endangered Species Act-Listed Threatened Western Distinct Population Segment and the Recovered Eastern Distinct Population Segment)

Acoustic modeling predicts that the Western stock of Steller sea lion (also considered the Western DPS under the ESA) could be exposed to sound from sonar and other active acoustic sources that may result in 572 behavioral reactions. Acoustic modeling predicts that the Eastern stock of Steller sea lion could be exposed to sound from sonar and other active acoustic sources that may result in 671 behavioral reactions. As discussed in Section 3.8.3.3.1 (Impacts from Sonar and Other Active Acoustic Sources) ranges to some behavioral impacts could take place at distances exceeding 100 km (62 mi.), although biologically meaningful behavioral effects are much more likely at higher received levels within a few kilometers of the sound source. Biologically meaningful behavioral reactions would not be expected and long-term consequences for individuals or populations are unlikely. Pursuant to the ESA, training activities in the Study Area may affect and are likely to adversely affect the ESA-listed Western stock of Steller sea lion. In the Alaska region, critical habitat has been designated for Steller sea lions in the Aleutian Islands and Western Alaska. Steller sea lion critical habitat is not present within the Study Area.

3.8.3.3.5.7 Mustelid (Northern Sea Otter)

Because sea otter are rare in waters where depths exceed 35 m (115 ft.), it is extremely unlikely that sea otters would be present in proximity to most training taking place in the TMAA where the water depth greatly exceeds a sea otter's preferred habitat. Sea otters seldom range more than approximately 1 nm from shore, although some individuals, particularly juvenile males, may travel farther offshore (Ralls et al. 1995, 1996; Riedman and Estes 1990; U.S. Fish and Wildlife Service 2003). As a result, sea otter may on rare occasions be present in the Study Area. Acoustic modeling for sea otter was not undertaken given almost all sea otter should be far from where activities involving sonar and other active acoustic sources are proposed to occur, they inhabit complex shallow water environments where acoustic modeling is very imprecise and therefore not representative of actual likely impacts, and sea otter spend little time underwater thus very much limiting the potential for exposure to underwater sound in any case. The unlikely potential for sea otter to hear underwater sound would especially be the case for

wandering sea otter in the TMAA since the average depth within the Study Area greatly exceeds the foraging depth for sea otter; therefore, they would generally not be exposed to the sound field from distant sources given their nearshore shallow water habitat. Ghaul and Reichmuth (2013) have shown that sea otters are not especially well adapted for hearing underwater, which suggests that the function of this sense has been less important in their survival and evolution than in comparison to pinniped. Finally, USFWS has stated that they had no evidence that defense-related activities have had any adverse effects on the well-monitored experimental population of southern sea otters at San Nicolas Island or in the SOCAL Range Complex (U.S. Fish and Wildlife Service 2011). Pursuant to the ESA, training activities in the Study Area may affect and are not likely to adversely affect the ESA-listed Southwest Alaska stock of Northern sea otter. In the Alaska region, critical habitat has been designated for Northern sea otters, but those nearshore areas are not present within the Study Area. Given these factors, long-term consequences for individuals or the population would not be expected.

3.8.3.3.5.8 Conclusion

Training activities under Alternative 2 include the use of sonar and other active acoustic sources as described in Table 2.3-1. These activities may result in inadvertent exposure of marine mammals in the Study Area to underwater sound.

Pursuant to the MMPA, the use of sonar and other acoustic sources during training activities under Alternative 2:

- *May expose marine mammals up to 36,411 times annually to sound levels that would be considered Level B harassment, as defined by the MMPA*
- *May expose Dall's porpoises up to 3 times annually to sound levels that would be considered Level A harassment, as defined by the MMPA*

Pursuant to the ESA, the use of sonar and other acoustic sources during training activities as described under Alternative 2:

- *May affect, and is likely to adversely affect, the North Pacific right whale, humpback whale, blue whale, fin whale, sei whale, sperm whale, and the Western Distinct Population Segment of Steller sea lion*
- *May affect, and is not likely to adversely affect Western North Pacific gray whale, and the Southwest Alaska stock of Northern sea otter*
- *Would have no effect on North Pacific right whale, Steller sea lion, or Northern sea otter critical habitat*

3.8.3.3.6 Impacts from Explosives

Marine mammals could be exposed to energy and sound from underwater explosions associated with proposed activities as described in Chapter 2 (Description of Proposed Action and Alternatives). Predicted impacts on marine mammals from at-sea explosions are based on a modeling approach that considers many factors. The inputs for the models consider the net explosive weight, the properties of detonations underwater, and environmental factors such as depth of the explosion, overall water depth, water temperature, and bottom type. The net explosive weight accounts for the mass and type of explosive material. Energy from an explosion is capable of causing mortality, injury to the lungs or gastrointestinal tract, hearing loss, or a behavioral response depending on the level of exposure.

Section 3.8.3.1.2.1 (Direct Injury) presents a review of observations and experiments involving marine mammals and reactions to impulsive sounds and underwater detonations. Energy from explosions is capable of causing mortality, direct injury, hearing loss, or a behavioral response depending on the level of exposure. The death of an animal will, of course, eliminate future reproductive potential and cause a long-term consequence for the individual that must then be considered for potential long-term consequences for the population. Exposures that result in long-term injuries such as PTS may limit an animal's ability to find food, communicate with other animals, or interpret the surrounding environment. Impairment of these abilities can decrease an individual's chance of survival or impact its ability to successfully reproduce. TTS can also impair an animal's abilities, but the individual may recover quickly with little biologically meaningful effect. Behavioral responses can include shorter surfacings, shorter dives, fewer blows (breaths) per surfacing, longer intervals between blows, ceasing or increasing vocalizations, shortening or lengthening vocalizations, and changing frequency or intensity of vocalizations (National Research Council 2005). However, it is not clear how these responses relate to long-term consequences for the individual or population (National Research Council 2005).

Explosions in the ocean or near the water surface can introduce loud, impulsive, broadband sounds into the marine environment. These sounds are likely within the audible range of most cetaceans, but the duration of individual sounds is very short. The direct sound from explosions used during training activities last less than a second, and most events involve the use of only one or a few explosions. Furthermore, events are dispersed in time and throughout the Study Area. These factors reduce the likelihood of these sources causing substantial auditory masking in marine mammals.

3.8.3.3.6.1 Range to Effects

The following section provides the range (distance) over which specific physiological or behavioral effects are expected to occur based on the explosive criteria (Section 3.8.3.1.4, Thresholds and Criteria for Predicting Acoustic and Explosive Impacts on Marine Mammals) and the explosive propagation calculations from the NAEMO (Section 3.8.3.1.6.3). The range to effects is important information in estimating the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher-level effects, especially physiological effects such as injury and mortality.

Figure 3.8-17 through Figure 3.8-20 show the range to slight lung injury and mortality for five representative animals of different masses for 0.5–1,000 lb. net explosive weight detonations (Bins E2, E5, E9, and E12). Modeled ranges for onset slight lung injury and onset mortality are based on the smallest calf/pup weight in each category and therefore represents a conservative estimate (i.e., longer ranges) since populations contain many animals larger than calves/pups and are therefore less susceptible to injurious effects. Animals within these water volumes would be expected to receive minor injuries at the outer ranges, increasing to more substantial injuries, and finally mortality as an animal approaches the detonation point.

It is also important to note that the Navy's modeling uses onset mortality criteria based on receipt of impulse energy, where only 1 percent of the animals exposed would not survive the injuries received. All animals within the range to onset mortality are quantified as mortalities, although many animals would actually recover from or otherwise survive the injury that is the basis of the mortality criteria.

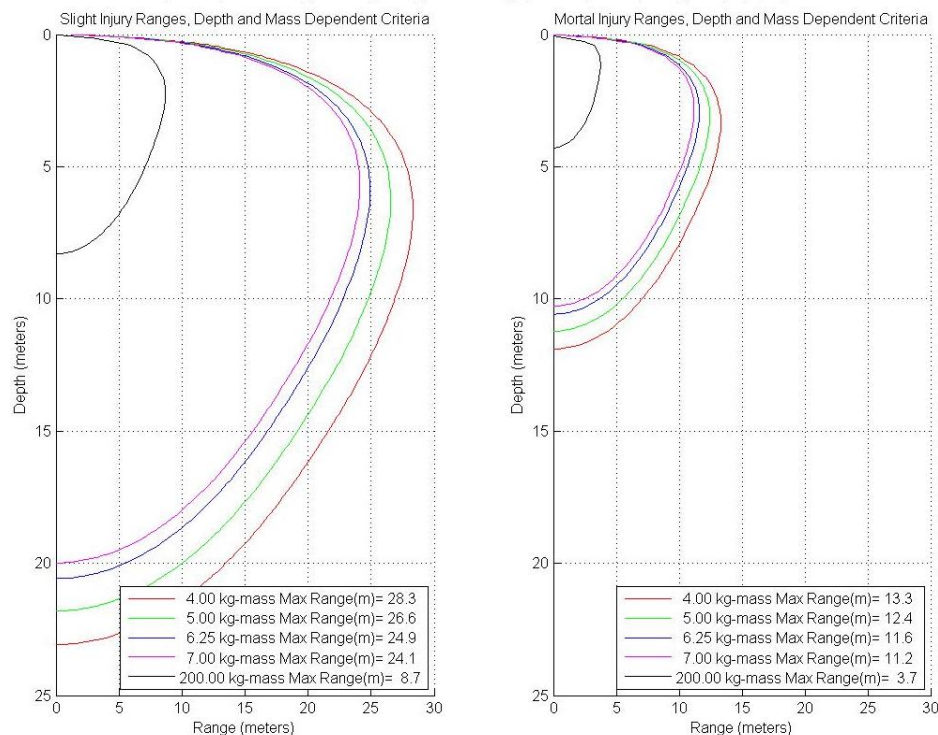


Figure 3.8-17: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses for a 0.5-Pound Net Explosive Weight Charge (Bin E2) Detonated at 1-Meter Depth

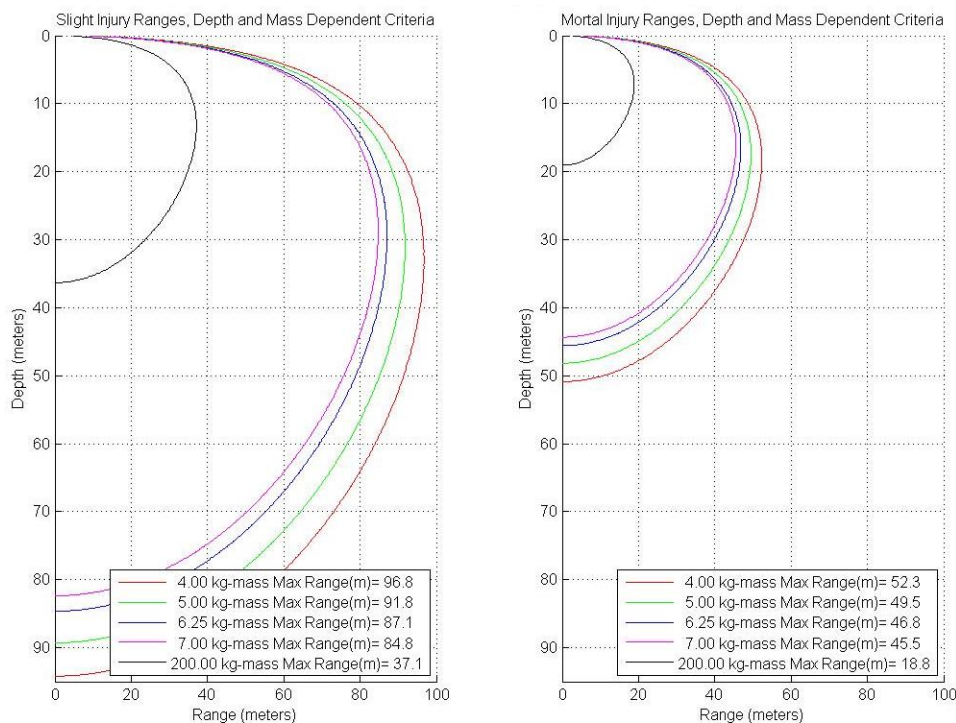


Figure 3.8-18: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses for a 10-Pound Net Explosive Weight Charge (Bin E5) Detonated at 1-Meter Depth

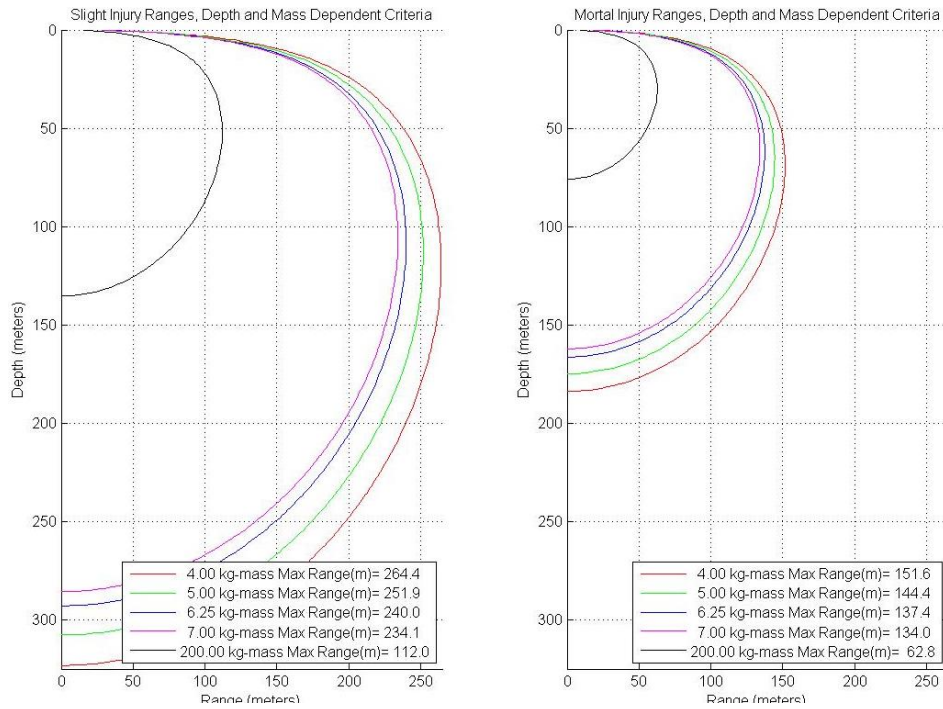


Figure 3.8-19: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses for a 250-Pound Net Explosive Weight Charge (Bin E9) Detonated at 1-Meter Depth

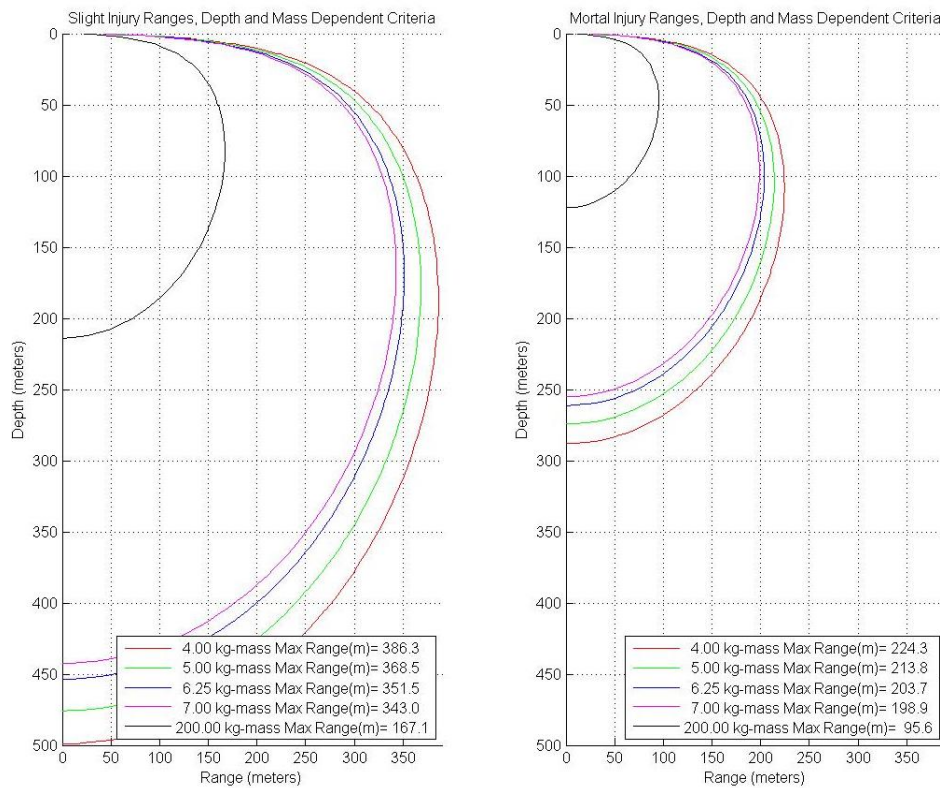


Figure 3.8-20: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses for a 1,000-Pound Net Explosive Weight Charge (Bin E12) Detonated at 1-Meter Depth

Table 3.8-18 shows the average approximate ranges to the potential effect based on the thresholds described in Section 3.8.3.1.4 (Thresholds and Criteria for Predicting Acoustic and Explosive Impacts on Marine Mammals). Similar to slight lung injury and mortality ranges discussed above, behavioral, TTS, and PTS ranges also represent conservative estimates (i.e., longer ranges) based on assuming all impulses are 1 second in duration. In fact, most impulses are much less than 1 second and therefore contain less energy than what is being used to produce the estimated ranges below.

Table 3.8-18: Average Approximate Range to Effects from Explosions for Marine Mammals within the Study Area

Hearing Group Criteria/Predicted Impact	Average Approximate Range (meters) to Effects for Sample Explosive Bins				
	Bin E5 (> 5–10 lb. NEW)	Bin E7 (> 20–60 lb. NEW)	Bin E9 (> 100–250 lb. NEW)	Bin E10 (> 250–500 lb. NEW)	Bin E12 (> 650–1,000 lb. NEW)
Low-frequency Cetaceans					
Onset Mortality	20	80	65	80	95
Onset Slight Lung Injury	40	165	110	135	165
Onset Slight GI Tract Injury	80	150	145	180	250
PTS	170	370	255	305	485
TTS	445	860	515	690	1,760
Behavioral Response	525	1,290	710	905	2,655
Mid-frequency Cetaceans					
Onset Mortality	45	205	135	165	200
Onset Slight Lung Injury	85	390	235	285	345
Onset Slight GI Tract Injury	80	150	145	180	250
PTS	70	160	170	205	265
TTS	215	480	355	435	720
Behavioral Response	285	640	455	555	970
High-Frequency Cetaceans					
Onset Mortality	50	225	145	175	215
Onset Slight Lung Injury	90	425	250	305	370
Onset Slight GI Tract Injury	80	150	145	180	250
PTS	375	710	470	570	855
TTS	705	4,125	810	945	2,415
Behavioral Response	930	5,030	2,010	4,965	5,705
Otariidae and Mustelidae					
Onset Mortality	65	285	175	215	260
Onset Slight Lung Injury	115	530	307	370	450
Onset Slight GI Tract Injury	8	150	145	180	250
PTS	50	30	50	85	150
TTS	85	210	220	260	400
Behavioral Response	145	305	300	350	530
Phocinea					
Onset Mortality	50	240	150	185	225
Onset Slight Lung Injury	100	445	265	320	385
Onset Slight GI Tract Injury	80	150	145	180	250
PTS	180	410	340	445	680
TTS	500	1,215	665	815	1,350
Behavioral Response	600	1,575	815	950	1,685

3.8.3.3.6.2 Avoidance Behavior and Mitigation Measures as Applied to Explosions

As discussed above, within the NAEMO, animats (virtual animals) do not move horizontally or react in any way to avoid sound at any level. In reality, various researchers have demonstrated that cetaceans can perceive the location and movement of a sound source (e.g., vessel, seismic source, etc.) relative to their own location and react with responsive movement away from the source, often at distances of a kilometer or more (Au and Perryman 1982, Jansen et al. 2010, Richardson et al. 1995, Tyack et al. 2011, Watkins 1986, Wursig et al. 1998). Section 3.8.3.1.2 (Analysis Background and Framework) reviews research and observations of marine mammals' reactions to sound sources including seismic surveys and explosives. The NAEMO also does not account for the implementation of mitigation, which would prevent many of the model-predicted injurious and mortal exposures to explosives. Therefore, the model-estimated mortality and Level A effects are further analyzed and adjusted to account for animal movement (avoidance) and implementation of mitigation measures (Section 3.8.3.1.6, Quantitative Analysis), using identical procedures to those described in the technical report *Post-Model Quantitative Analysis of Animal Avoidance Behavior and Mitigation Effectiveness for the Gulf of Alaska Training* (U.S. Department of the Navy 2014b).

If explosive activities are preceded by multiple vessel traffic or hovering aircraft, harbor porpoise and beaked whales are assumed to move beyond the range to onset mortality before detonations occur. For the Carrier Strike Group exercise events, this is only applicable and assessed to occur during the Sinking Exercise. Because the NAEMO does not include avoidance behavior, the model-estimated mortalities are based on unlikely behavior for these species—that they would tolerate staying in an area of high human activity. Therefore, harbor porpoise and beaked whales that were model-estimated to be within range of a mortality criteria exposure are assumed to avoid the vicinity of a Sinking Exercise and are analyzed as being in the range of potential injury prior to the start of the explosive activity for that event.

The NAEMO does not consider mitigation, which is discussed in detail in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring). As explained in Section 3.8.3.1.8 (Implementing Mitigation to Reduce Sound Exposures), to account for the implementation of mitigation measures, the acoustic analysis assumes a model-predicted mortality or injury would not occur if an animal at the water surface would likely be observed during those activities with Lookouts up to and during the use of explosives, considering the mitigation effectiveness (Table 3.8-19) and sightability of a species based on $g(0)$ (see Table 3.8-9 in Section 3.8.3.1.8, Implementing Mitigation to Reduce Sound Exposures). The mitigation effectiveness is considered over two regions of an activity's mitigation zone: (1) the range to onset mortality closer to the explosion and (2) range to onset PTS. The model-estimated mortalities and injuries are reduced by the portion of animals that are likely to be seen [Mitigation Effectiveness x Sightability, $g(0)$]; these animals are instead assumed to be present within the range to injury and range to TTS, respectively.

Table 3.8-19: Impulsive Activities Adjustment Factors Integrating Implementation of Mitigation into Modeling Analyses for the Study Area

Activity ^{1,2}	Factor for Adjustment of Preliminary Modeling Estimates		Mitigation Platform Used for Assessment
	Injury Zone	Mortality Zone	
Bombing Exercise (Air-to-Surface)	0.5	1	Aircraft
Sinking Exercise	0.5	1	Aircraft

¹ Ranges to effect differ for functional hearing groups based on weighted threshold values. HF = high frequency cetaceans; MF = mid-frequency cetaceans; LF = low frequency cetaceans. The adjustment factor for all other activities (not listed) is zero and there is no adjustment of the preliminary modeling estimates as a result of implemented mitigation for those activities (e.g., Anti-Submarine Tracking Exercise – Extended Echo Ranging; Gunnery Exercises).

² If less than half of the mitigation zone can be continuously visually observed or if the mitigation zone cannot be visually observed during most of the scenarios within the activity due to the type of surveillance platform(s), number of Lookouts, and size of the mitigation zone, mitigation is not considered in the acoustic effects analysis of that activity and the activity is not listed in this table. For activities in which only mitigation in the mortality zone is considered in the analysis, no value is provided for the injury zone.

During an activity with a series of explosions (not concurrent multiple explosions), an animal is expected to exhibit an initial startle reaction to the first detonation followed by a behavioral response after multiple detonations. At close ranges and high sound levels approaching those that could cause PTS, avoidance of the area around the explosions is the assumed behavioral response for most cases. The ranges to PTS for each functional hearing group for a range of explosive sizes (single detonation) are shown in Table 3.8-18. Animals not observed by Lookouts within the ranges to PTS at the time of the initial couple of explosions are assumed to experience PTS; however, all animals that exhibit avoidance reactions beyond the initial range to PTS are assumed to move away from the expanding range to PTS effects with each additional explosion.

Odontocetes have been demonstrated to have directional hearing, with best hearing sensitivity facing a sound source (Kastelein et al. 2005b, Mooney et al. 2008, Popov and Supin 2009). Therefore, an odontocete avoiding a source would receive sounds along a less sensitive hearing axis, potentially reducing impacts. Because the NAEMO does not account for avoidance behavior, the model-estimated effects are based on the unlikely behavior that animals would remain in the vicinity of potentially injurious sound sources. Therefore, only the initial exposures resulting in model-estimated PTS are expected to actually occur. The remaining model-estimated PTS exposures (resulting from accumulated energy) are considered to be TTS due to avoidance. Activities involving multiple non-concurrent explosive or other impulsive sources are listed in Table 3.8-20.

Table 3.8-20: Activities during the Carrier Strike Group Exercise with Multiple Non-Concurrent Explosions

Activity
Bombing Exercise (Air-to-Surface)
Gunnery Exercise (Surface-to-Surface) – Large-Caliber, Ship
Sinking Exercise

3.8.3.3.7 Model Predicted Effects from Use of Explosives

Tables 3.8-21 through 3.8-23 present the annual predicted effects to marine mammals from activities involving the use of explosives for the No Action Alternative, Alternative 1, and Alternative 2. Annual totals presented in these tables are the summation of all annual activities involving explosives associated with the Carrier Strike Group exercise occurring between April and October each year (see Chapter 2, Table 2.3-1).

This analysis uses the NAEMO (Section 3.8.3.1.6.3) to predict effects using the explosive criteria and thresholds described in Section 3.8.3.1.4 (Thresholds and Criteria for Predicting Acoustic and Explosive Impacts on Marine Mammals) and avoidance and mitigation factors are then used as described in Section 3.8.3.1.6 (Quantitative Analysis) to more accurately enumerate likely effects to marine mammals.

It is also important to note that acoustic impacts presented in Table 3.8-21 through 3.8-23 are the total number of exposures under the effects criteria and not necessarily the number of individuals exposed. As discussed in Section 3.8.3.1.5 (Behavioral Responses), an animal could be predicted to receive more than one acoustic effect over the course of a year. Species presented in tables had species density values (i.e., theoretically present to some degree) within the areas modeled for the given alternative and activities, although modeling may still indicate no effects after summing all annual exposures. This acoustic effects analysis uses the NAEMO followed by post-model consideration of avoidance and implementation of mitigation to predict effects using the explosive criteria and thresholds.

The NAEMO does not account for several factors that must be considered in the overall explosive analysis. When there is uncertainty in model input values, a conservative approach is often chosen to assure that potential effects are not underestimated. As a result, the NAEMO provides estimates that are conservative (overestimates the likely impacts). The following is a list of several such factors that cause the model to overestimate potential effects:

- The onset mortality criterion is based on the impulse at which 1 percent of the animals receiving an injury would not recover. Therefore, many animals that the modeling would count as a mortality under the current criteria may actually recover from their injuries.
- Slight lung injury criteria are based on the impulse at which 1 percent of the animals exposed would incur a slight lung injury from which full recovery would be expected. Therefore, many animals that are estimated to suffer slight lung injury in this analysis may actually not incur injuries.
- The metrics used for the threshold for slight lung injury and mortality (i.e., acoustic impulse) are based on the animal's mass. The smaller an animal, the more susceptible that individual is to these effects. In this analysis, all individuals of a given species are assigned the weight of that species newborn calf or pup weight. Since many individuals in a population are larger than a newborn calf or pup of that species, this assumption causes the acoustic model to overestimate the number of animals that may suffer slight lung injury or mortality. As discussed in the explanation of onset mortality and onset slight lung injury criteria, the volumes of water in which the threshold for onset mortality may be exceeded are generally less than a fifth for an adult animal versus a calf or pup.
- Many explosions from munitions such as bombs and missiles will actually occur upon impact with above-water targets. However, for this analysis, sources such as these were modeled as exploding at approximately 1 yd. (1 m) depth. This overestimates the amount of explosive and acoustic energy entering the water and therefore overestimates effects on marine mammals.

These predicted impacts shown below are the result of the acoustic analysis, including acoustic effect modeling followed by consideration of animal avoidance of multiple exposures, avoidance of areas with high level of activity by sensitive species, and mitigation. It is important to note that acoustic impacts presented in the following tables are the total number of impacts and not necessarily the number of individuals impacted. As discussed in Section 3.8.3.1.5 (Behavioral Responses), an animal could be predicted to receive more than one acoustic impact over the course of the Carrier Strike Group exercise or Sinking Exercise.

As detailed previously (see Section 3.4.2.7.3, Distribution, concerning North Pacific right whale feeding and Section 3.4.2.12.3, Distribution, concerning gray whale migration), NMFS has identified a North Pacific right whale feeding area and a gray whale migration area that spatially overlap the TMAA boundary (see Ferguson et al. 2015b). NMFS recognition of an area as the location for important feeding or migrating behavior does not cause the area to rise to level of designated critical habitat. Additionally, these identified areas were not intended as exclusionary zones, nor were they meant to be locations that serve as sanctuaries from human activity, or areas analogous to marine protected areas (Ferguson et al. 2015a).

Given the standard operating procedures and mitigation measures involving the safety (as detailed in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) and the volume of commercial vessels and civilian aircraft moving through this boundary margin of the TMAA, it is very unlikely that there would be any Navy training involving the use of explosives taking place in that general area. To ensure that the Navy is able to conduct realistic training, Navy aircraft and vessels must maintain sufficient room to maneuver and the ability to ensure a safety zone is clear of any non-participants. Therefore, training activities will typically take place some distance away from a boundary like the TMAA's border, commercial shipping lanes, and civilian air traffic routes to ensure sufficient sea or air space is available for tactical maneuvers and for safety. In short, the corners of the TMAA are seldom if ever a suitable location for training involving the use of explosives. As noted in Section 3.8.3.3.2 (Model Predicted Effects from Use of Sonar and Other Active Acoustic Sources), a Navy vessel or aircraft will generally be only one of many that are likely to be present in the designated feeding area or designated migration area. When marine mammals are detected, Navy has procedures in place to maneuver away from and around these marine species. The Navy's stand-off distance of 500 yd. (457 m) and mitigation procedures (see Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring, for details) specific to the use of explosives further reduce the potential that there would be any biologically meaningful affect to feeding or migration before or during an activity should a North Pacific right whale or a gray whale be detected in the identified areas.

Based on the information provided in the paragraphs above, North Pacific right whales and gray whales in the NMFS-identified feeding area or migration area at the boundary of the TMAA are very unlikely to have their feeding or migration activities affected by Navy training activities involving the use of explosives. In the summer time period, passive acoustic monitoring buoys have recorded the presence of routine non-Navy underwater explosions believed to be "seal bombs" that fishermen use to deter pinnipeds from interfering with their catch (U.S. Department of the Navy 2014d), documenting an ongoing and widespread level of disturbance to marine mammals in general from the civilian use of explosives in these areas. Navy's current standard operating procedures and mitigation include marine mammal standoffs, lookouts, and safety zones. No additional mitigation requirements are reasonable or practicable given the likely low risk of having any effect, let alone any meaningful effect, to North Pacific right whale feeding behavior or gray whale migration behavior in the designated areas. This conclusion is applicable to all alternatives as discussed in the subsequent sections.

3.8.3.3.8 No Action Alternative

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.3-1, training activities under the No Action Alternative would use explosive ordnance that results in underwater sound or energy. Training activities involving explosions could be conducted throughout the Study Area but typically would not occur in the portion of the TMAA on the shelf or near the shelf break.

As presented in Table 3.8-21, for the No Action Alternative, the acoustic modeling and post-modeling analyses predicts that for all species except Dall's porpoise, there will be no exposures resulting in Level B or Level A harassment as defined under the MMPA for military readiness activities. The acoustic modeling and post-modeling analyses predicts that during the Carrier Strike Group exercise, there would be an estimated 22 exposures to Dall's porpoises from impulsive sound (explosives) resulting in Level B¹⁹ harassment and no exposures resulting in Level A²⁰ as defined under the MMPA for military readiness activities. There are no exposures resulting in mortality predicted by the modeling for any marine mammal species and none are expected based on the history of having conducted identical events in other training range complexes for decades.

3.8.3.3.8.1 Mysticetes

During the GOALS II survey (Rone et al. 2013), 318 mysticetes were detected and identified by species with an additional 119 large whales also detected, some of which were likely to be mysticete species. Acoustic modeling indicates that mysticetes would not be exposed during the Carrier Strike Group exercise to sound or energy from explosives associated with training activities, which would exceed the current impact thresholds. Table 3.8-21 presents predicted ranges to specified effects for low-frequency cetaceans (mysticetes).

As presented in detail in Section 3.8.3.3.4.1 (Mysticetes) in an analysis of sonar and other active acoustic stressors, review of the NMFS-identified feeding and migration areas showed there is only minimal spatial overlap with the Navy TMAA and the North Pacific right whale feeding area southeast of Kodiak Island and minimal overlap with the edge of the gray whale migration area offshore of Kenai Peninsula (Ferguson et al. 2015b). For the same reasons Navy training activities using sonar and other active acoustic stressors are unlikely at the margins of the TMAA, training resulting in underwater explosions is also unlikely to occur in those areas of overlap at the corners of the TMAA. Therefore, it is very unlikely there would be an effect to feeding or migrating activities if right whales or gray whales were present in those areas. Additionally, appropriate standard operating procedures and mitigation measures (as detailed in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) would be implemented for any detected marine mammals and thus further reducing the potential for the feeding or migration activities to be affected in those areas.

¹⁹ This is the combined summation of all non-TTS and TTS exposures (behavioral effects) for all species and stocks in the Study Area for an annual total based on a 12-month period.

²⁰ This is the combined summation of all PTS, gastrointestinal, and slight lung injury exposures for all species and stocks in the Study Area for an annual total based on a 12-month period.

Table 3.8-21: Annual Predicted Effects to Marine Mammals from Explosives Use under the No Action Alternative

Species	Stock	Behavioral	TTS	PTS	GI	SLI	Mortality
North Pacific right whale	Eastern North Pacific	0	0	0	0	0	0
Humpback whale	Western North Pacific	0	0	0	0	0	0
	Central North Pacific	0	0	0	0	0	0
	California, Washington, and Oregon	0	0	0	0	0	0
Blue whale	Eastern North Pacific	0	0	0	0	0	0
	Central North Pacific	0	0	0	0	0	0
Fin whale	Northeast Pacific	0	0	0	0	0	0
Sei whale	Eastern North Pacific	0	0	0	0	0	0
Minke whale	Alaska	0	0	0	0	0	0
Gray whale	Eastern North Pacific	0	0	0	0	0	0
	Western North Pacific	0	0	0	0	0	0
Sperm whale	North Pacific	0	0	0	0	0	0
Killer whale	Alaskan Resident	0	0	0	0	0	0
	Eastern North Pacific Offshore	0	0	0	0	0	0
	AT1 Transient	0	0	0	0	0	0
	GOA, Aleutian Island, and Bering Sea Transient	0	0	0	0	0	0
Pacific white-sided dolphin	North Pacific	0	0	0	0	0	0
Harbor porpoise	Gulf of Alaska	0	0	0	0	0	0
	Southeast Alaska	0	0	0	0	0	0
Dall's porpoise	Alaska	22	1	0	0	0	0
Cuvier's beaked whale	Alaska	0	0	0	0	0	0
Baird's beaked whale	Alaska	0	0	0	0	0	0
Stejneger's beaked whale	Alaska	0	0	0	0	0	0
Steller sea lion	Eastern U.S.	0	0	0	0	0	0
	Western U.S.	0	0	0	0	0	0
California sea lion	U.S.	0	0	0	0	0	0
Northern fur seal	Eastern Pacific-Alaska	0	0	0	0	0	0
Northern elephant seal	California Breeding	0	0	0	0	0	0
Harbor seal	North Kodiak	0	0	0	0	0	0
	South Kodiak	0	0	0	0	0	0
	Prince William Sound	0	0	0	0	0	0
	Glacier Bay/Icy Strait	0	0	0	0	0	0
	Sitka/Chatham	0	0	0	0	0	0
	Dixon/Cape Decision	0	0	0	0	0	0
Ribbon seal	Alaska	0	0	0	0	0	0
Northern sea otter	Southeast Alaska	0	0	0	0	0	0
	Southcentral Alaska	0	0	0	0	0	0
	Southwest Alaska	0	0	0	0	0	0
Sub-Total		22	1	0	0	0	0
MMPA Totals		Level B		Level A		Mortality	
		23		0		0	

Notes: GI = gastrointestinal, GOA = Gulf of Alaska, PTS = Permanent Threshold Shift, SLI = Slight Lung Injury, TTS = Temporary Threshold Shift, U.S. = United States

North Pacific Right Whales (Endangered Species Act-Listed)

North Pacific right whales are not expected to be present in the Study Area (Section 3.8.2.6.3, Distribution). Within the Gulf of Alaska, a July 2012 sighting of a North Pacific right whale approximately 50 mi. (80 km) from the southern edge of the TMAA Study Area (Matsuoka et al. 2013) and subsequent acoustic detections in July 2013 (U.S. Department of the Navy 2013g) also occurred outside the Study Area in the near the designated right whale Critical Habitat off Kodiak Island. A bottom-moored passive acoustic monitoring device on Quinn Seamount also detected North Pacific right whale calls between July and September 2013, but these calls were believed to have originated over 100 km from the hydrophone (Debich et al. 2014).

It is also not expected that North Pacific right whale would be exposed to sound or energy associated with the use of explosives during training activities given those activities only occur during limited intervals of the 21-day Carrier Strike Group exercise. Given that a North Pacific right whale has not been seen in the Study Area since at least the 1960s (indicating a highly unlikely presence), it would be extremely unlikely for there to be a co-occurrence of a right whale in the Study Area while use of explosives was occurring. Additionally, mitigation measures would be implemented if a North Pacific right whale were detected within the mitigation zone. Even in the event of an extremely unlikely co-occurrence, given that any effect would likely not be measureable, detectable, or significant, the Navy has determined possible effects to North Pacific right whale from Navy training in the Study Area are discountable. As discussed in Section 3.8.3.2.1 (Application of the Endangered Species Act to Marine Mammals), because it is possible that a North Pacific right whale may potentially be present and may potentially detect or otherwise be exposed to sound resulting from Navy training, use of explosives in the Study Area may affect and is not likely to adversely affect North Pacific right whale.

Blue Whales (Endangered Species Act-Listed)

Blue whales were visually detected five times during the GOALS II survey (Rone et al. 2013) as single individuals or in pairs. Blue whales would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, blue whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Humpback Whales (Endangered Species Act-Listed)

Humpback whales visually detected during the GOALS II survey (Rone et al. 2013) had an average group size of 3.12. Humpback whales would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, humpback whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Sei Whales (Endangered Species Act-Listed)

During the GOALS II survey (Rone et al. 2013), three large whales determined to be either fin or sei whales were detected. Sei whales would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, sei whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore,

pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Fin Whales (Endangered Species Act-Listed)

As noted above for sei whales, during the GOALS II survey (Rone et al. 2013), only three large whales determined to be either fin or sei whales were detected. Acoustic modeling indicates fin whales would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, fin whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Gray Whales, Western North Pacific Stock (Endangered Species Act-Listed)

No gray whales were detected in the TMAA Study Area during the GOALS II survey (Rone et al. 2013). Acoustic modeling indicates that gray whales would not be exposed to sonar or other active acoustic sources associated with training activities, which would exceed the current impact thresholds. Gray whales of the Western North Pacific stock may migrate through the Study Area although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur. Since gray whales of the Western North Pacific stock could potentially be present in the Study Area, they may be exposed to low levels of sound or energy. Pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

3.8.3.3.2 Odontocetes

Acoustic modeling indicates that except for Dall's porpoise, odontocetes would not be exposed to sound or energy from explosives associated with training activities during the Carrier Strike Group exercise, which would exceed the current impact thresholds under the No Action Alternative.

Sperm Whales (Endangered Species Act-Listed)

Sperm whales are classified as mid-frequency cetaceans (Section 3.8.2.3.2, Mid-Frequency Cetaceans). Sperm whales were visually detected 19 times during the GOALS II survey (Rone et al. 2013). Acoustic modeling predicts that sperm whales would not be exposed to sound or energy from explosions associated with proposed activities, which would exceed the current impact thresholds. Straley et al. (2014) reported on findings from satellite tags attached to 10 sperm whales in the Gulf of Alaska. The tags demonstrated that at least three of these animals went as far south as waters off Mexico. This suggests that potential behavioral disturbances resulting in avoidance of Navy events or acoustic sources are unlikely to have any meaningful consequences for animals that cover such distances. Long-term consequences for individuals or populations would not be expected. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, sperm whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Dall's Porpoise

Dall's porpoise (classified as high-frequency cetaceans [Section 3.8.2.3.1, High-Frequency Cetaceans]) are present in the Study Area and are part of the Alaska stock. Dall's porpoise were encountered as individuals and in groups 337 times during the GOALS II survey (Rone et al. 2013). Acoustic modeling predicts that Dall's porpoise could be exposed to sound or energy from explosions that may result in 1 TTS and 22 behavioral reactions; both of these effects are considered behavioral harassment under

the MMPA. The population of Dall's porpoises for which these effects are predicted has a stock exceeding approximately 83,000 animals (Table 3.8-1).

Acoustic modeling for the No Action Alternative predicts one TTS effect annually for Dall's porpoises from use of explosives during training. As discussed in Section 3.8.3.3.1 (Range to Effects), the range to TTS (a temporary partial loss of hearing sensitivity) for a high frequency cetacean such as Dall's porpoise is on average less than approximately 1,400 yd. (1,280 m) from the largest explosive (Bin E12) used in the TMAA. Recovery from a TTS can take a few minutes to a few days, depending on the severity of the initial shift. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. Mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) would further reduce the predicted impacts.

Acoustic modeling indicates 22 effects to Dall's porpoises as a result of sound or energy from underwater explosions that would result in a behavioral response. Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that if high frequency cetaceans are exposed to explosions, they may react by alerting, ignoring the stimulus, changing their behaviors or vocalizations, or avoiding the area by swimming away or diving. Some behavioral impacts from the largest explosive (Bin E12) used in the TMAA could take place at distances exceeding approximately 4.5 nm (Table 3.8-18), although biologically meaningful behavioral effects are much more likely at higher received levels closer to the explosion. Overall, predicted effects are low, and mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) would further reduce potential impacts. Occasional behavioral reactions to intermittent explosions are unlikely to cause long-term consequences for individual animals or populations.

3.8.3.3.3 Pinnipeds

During the GOALS II survey (Rone et al. 2013), 16 elephant seals, 78 Northern fur seals, and 6 unidentified pinnipeds were visually detected. Acoustic modeling indicates that during the Carrier Strike Group exercise, pinnipeds would not be exposed to sound or energy from explosives associated with training activities, which would exceed the current impact thresholds.

Steller Sea Lion (Endangered Species Act-Listed Threatened Western Distinct Population Segment and the Recovered Eastern Distinct Population Segment)

Acoustic modeling predicts that Steller sea lions would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. The Western U.S. stock of Steller sea lions (also constituting the Western DPS) is listed as depleted under the MMPA and endangered under the ESA. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, the Western U.S. stock of Steller sea lions may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species. The Eastern U.S. stock of Steller sea lions has recovered and been removed from the List of Endangered and Threatened Wildlife under the ESA. In the Alaska region, critical habitat has been designated for Steller sea lions in the Aleutian Islands and Western Alaska. There would be no impact to Critical Habitat designated for Steller sea lion since it does not occur within the Study Area.

3.8.3.3.4 Mustelid (Northern Sea Otters)

The sea otter may on rare occasion be present in the Study Area. Because it is unlikely that a sea otter would be in waters where depths exceed 35 m (115 ft.), it is extremely unlikely that sea otters would be

present within the range to effects for training events using explosives (see Table 3.8-24). Acoustic modeling for sea otter was not undertaken given they are far from where activities involving in water explosives are proposed to occur, they inhabit complex shallow water environments where acoustic modeling is very imprecise and therefore not representative, and they spend little time underwater thus very much limiting the potential for sea otter to hear underwater sound in any case. Research indicates sea otters often remained undisturbed, quickly become tolerant of the various sounds, and even when purposefully harassed, they generally moved only a short distance (100–200 m) before resuming normal activity. The USFWS has determined that previous Department of Defense actions have not posed a threat to the San Nicolas Island (California) colony of southern sea otter and the average growth rate for the translocated colony has been higher than that for those inhabiting the central California coastline in recent years (U.S. Fish and Wildlife Service 2011). Given these factors, long-term consequences for individuals or the population would not be expected.

3.8.3.3.5 Conclusion

Training activities under the No Action Alternative include sound or energy from underwater explosions resulting from activities as described in Table 2.3-1 of Chapter 2 (Description of Proposed Action and Alternatives). These activities could result in inadvertent exposure of marine mammals in the Study Area to sound or energy from the use of explosives.

Pursuant to the MMPA, the use of explosives during training activities under the No Action Alternative:

- *May expose Dall's porpoises up to 23 times annually to sound or pressure levels that would be considered Level B harassment, as defined by the MMPA*
- *Would not result in Level A harassment, serious injury, or incidental mortality to any marine mammals*

Pursuant to the ESA, the use of explosives during training activities as described under the No Action Alternative:

- *May affect, and is not likely to adversely affect, North Pacific right whale, humpback whale, blue whale, fin whale, sei whale, Western North Pacific gray whale, sperm whale, the Western stock of Steller sea lion, and the Southwest Alaska stock of Northern sea otter*
- *Would have no effect on North Pacific right whale, Steller sea lion, or Northern sea otter critical habitat*

3.8.3.3.9 Alternative 1

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.3-1, training activities under Alternative 1 would use explosive ordnance that results in underwater sound or energy. Training activities involving explosions could be conducted throughout the Study Area but typically would not occur in the portion of the TMAA on the shelf or near the shelf break.

As presented in Table 3.8-22 for Alternative 1, the acoustic modeling and post-modeling analyses predicts that for all species except Dall's porpoise, there will be no exposures resulting in Level B or Level A harassment as defined under the MMPA for military readiness activities. The acoustic modeling and post-modeling analyses predicts that during the Carrier Strike Group exercise there would be 36 exposures to Dall's porpoises from impulsive sound (explosives) resulting in Level B²¹ harassment and

²¹ This is the combined summation of all non-TTS and TTS exposures (behavioral effects) for all species and stocks in the Study Area for an annual total based on a 12-month period.

1 exposure resulting in Level A²² as defined under the MMPA for military readiness activities. There are no exposures resulting in mortality predicted by the modeling for any marine mammal species and none are expected based on the history of having conducted identical events in other training range complexes for decades.

3.8.3.3.9.1 Mysticetes

During the GOALS II survey (Rone et al. 2013), 318 mysticetes were detected and identified by species with an additional 119 large whales also detected, some of which were likely to be mysticete species. Acoustic modeling indicates that during the Carrier Strike Group exercise, mysticetes would not be exposed to sound or energy from explosives associated with training activities, which would exceed the current impact thresholds. Table 3.8-22 presents predicted ranges to specified effects for low-frequency cetaceans (mysticetes).

As presented in detail in Section 3.8.3.3.8.1 (Mysticetes) for the No Action, review of the NMFS-identified feeding and migration areas showed there is only minimal spatial overlap with the Navy TMAA and the North Pacific right whale feeding area southeast of Kodiak Island and minimal overlap with the edge of the gray whale migration area offshore of Kenai Peninsula (Ferguson et al. 2015b). Those areas of overlap at the corners of the TMAA are very unlikely to have any Navy training activity. Therefore, it is very unlikely there would be an effect to feeding or migrating activities if right whales or gray whales were present. Additionally, appropriate standard operating procedures and mitigation measures (as detailed in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) would be implemented for any detected marine mammals and thus further reducing the potential for the feeding or migration activities to be affected.

North Pacific Right Whales (Endangered Species Act-Listed)

North Pacific right whales are not expected to be present in the Study Area (Section 3.8.2.6.3, Distribution). Within the Gulf of Alaska, a July 2012 sighting of a North Pacific right whale approximately 50 mi. (80 km) from the southern edge of the TMAA Study Area (Matsuoka et al. 2013) and subsequent acoustic detections in July 2013 (U.S. Department of the Navy 2013g) also occurred outside the Study Area in the near the designated right whale Critical Habitat off Kodiak Island. A bottom moored passive acoustic monitoring device on Quinn Seamount also detected North Pacific right whale calls between July and September 2013, but these calls were believed to have originated over 100 km from the hydrophone (Debich et al. 2014).

It is also not expected that North Pacific right whale would be exposed to sound or energy associated with the use of explosives during training activities given those activities only occur during limited intervals of the 21-day Carrier Strike Group exercise. Given that a North Pacific right whale has not been seen in the Study Area since at least the 1960s (indicating a highly unlikely presence), it would be extremely unlikely for there to be a co-occurrence of a right whale in the Study Area while use of explosives was occurring. Additionally, mitigation measures would be implemented if a North Pacific right whale were detected within the mitigation zone. Even in the event of an extremely unlikely co-occurrence, given that any effect would likely not be measureable, detectable, or significant, the Navy has determined possible effects to North Pacific right whale from Navy training in the Study Area are discountable. As discussed in Section 3.8.3.2.1 (Application of the Endangered Species Act to Marine Mammals), because it is possible that a North Pacific right whale may potentially be present and may

²² This is the combined summation of all PTS, gastrointestinal, and slight lung injury exposures for all species and stocks in the Study Area for an annual total based on a 12-month period.

Table 3.8-22: Annual Predicted Effects to Marine Mammals from Use of Explosives under Alternative 1

Species	Stock	Behavioral	TTS	PTS	GI	SLI	Mortality
North Pacific right whale	Eastern North Pacific	0	0	0	0	0	0
Humpback whale	Western North Pacific	0	0	0	0	0	0
	Central North Pacific	0	0	0	0	0	0
	California, Washington, and Oregon	0	0	0	0	0	0
Blue whale	Eastern North Pacific	0	0	0	0	0	0
	Central North Pacific	0	0	0	0	0	0
Fin whale	Northeast Pacific	0	0	0	0	0	0
Sei whale	Eastern North Pacific	0	0	0	0	0	0
Minke whale	Alaska	0	0	0	0	0	0
Gray whale	Eastern North Pacific	0	0	0	0	0	0
	Western North Pacific	0	0	0	0	0	0
Sperm whale	North Pacific	0	0	0	0	0	0
Killer whale	Alaskan Resident	0	0	0	0	0	0
	Eastern North Pacific Offshore	0	0	0	0	0	0
	AT1 Transient	0	0	0	0	0	0
	GOA, Aleutian Island, and Bering Sea Transient	0	0	0	0	0	0
Pacific white-sided dolphin	North Pacific	0	0	0	0	0	0
Harbor porpoise	Gulf of Alaska	0	0	0	0	0	0
	Southeast Alaska	0	0	0	0	0	0
Dall's porpoise	Alaska	47	8	0	0	0	0
Cuvier's beaked whale	Alaska	0	0	0	0	0	0
Baird's beaked whale	Alaska	0	0	0	0	0	0
Stejneger's beaked whale	Alaska	0	0	0	0	0	0
Steller sea lion	Eastern U.S.	0	0	0	0	0	0
	Western U.S.	0	0	0	0	0	0
California sea lion	U.S.	0	0	0	0	0	0
Northern fur seal	Eastern Pacific-Alaska	0	0	0	0	0	0
Northern elephant seal	California Breeding	0	0	0	0	0	0
Harbor Seal	North Kodiak	0	0	0	0	0	0
	South Kodiak	0	0	0	0	0	0
	Prince William Sound	0	0	0	0	0	0
	Glacier Bay/Icy Strait	0	0	0	0	0	0
	Sitka/Chatham	0	0	0	0	0	0
	Dixon/Cape Decision	0	0	0	0	0	0
Ribbon seal	Alaska	0	0	0	0	0	0
Northern sea otter	Southeast Alaska	0	0	0	0	0	0
	Southcentral Alaska	0	0	0	0	0	0
	Southwest Alaska	0	0	0	0	0	0
Sub-Total		47	8	0	0	0	0
MMPA Totals		Level B		Level A			Mortality
		55		0			0

potentially detect or otherwise be exposed to sound resulting from Navy training, use of explosives in the Study Area may affect and is not likely to adversely affect North Pacific right whale.

Blue Whales (Endangered Species Act-Listed)

Blue whales were visually detected five times during the GOALS II survey (Rone et al. 2013) as single individuals or in pairs. Blue whales would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, blue whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Humpback Whales (Endangered Species Act-Listed)

Humpback whales visually detected during the GOALS II survey (Rone et al. 2013) had an average group size of 3.12. Humpback whales would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, humpback whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Sei Whales (Endangered Species Act-Listed)

During the GOALS II survey (Rone et al. 2013), three large whales determined to be either fin or sei whales were detected. Sei whales would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, sei whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Fin Whales (Endangered Species Act-Listed)

As noted above for sei whales, during the GOALS II survey (Rone et al. 2013), only three large whales determined to be either fin or sei whales were detected. Acoustic modeling indicates fin whales would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, fin whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Gray Whales, Western North Pacific Stock (Endangered Species Act-Listed)

No gray whales were detected in the TMAA Study Area during the GOALS II survey (Rone et al. 2013). Acoustic modeling indicates that gray whales would not be exposed to sonar or other active acoustic sources associated with training activities, which would exceed the current impact thresholds. Gray whales of the Western North Pacific stock may migrate through the Study Area although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur. Since gray whales of the Western North Pacific stock could potentially be present in the Study Area, they may be exposed to low levels of sound or energy. Pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

3.8.3.3.9.2 Odontocetes

Under Alternative 1, acoustic modeling indicates that except for Dall's porpoise, odontocetes would not be exposed during the Carrier Strike Group exercise to sound or energy from explosives associated with training activities, which would exceed the current impact thresholds.

Sperm Whales (Endangered Species Act-Listed)

Sperm whales are classified as mid-frequency cetaceans (Section 3.8.2.3.2, Mid-Frequency Cetaceans). Sperm whales were visually detected 19 times during the GOALS II survey (Rone et al. 2013). Acoustic modeling predicts that sperm whales would not be exposed to sound or energy from explosions associated with proposed activities, which would exceed the current impact thresholds. Straley et al. (2014) reported on findings from satellite tags attached to 10 sperm whales in the Gulf of Alaska. The tags demonstrated that at least three of these animals went as far south as waters off Mexico. This suggests that potential behavioral disturbances resulting in avoidance of Navy events or acoustic sources are unlikely to have any meaningful consequences for animals that cover such distances. Long-term consequences for individuals or populations would not be expected. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, sperm whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Dall's Porpoise

Dall's porpoise (classified as high-frequency cetaceans [Section 3.8.2.3.1, High-Frequency Cetaceans]) are present in the Study Area and are part of the Alaska stock. Dall's porpoise were encountered as individuals and in groups 337 times during the GOALS II survey (Rone et al. 2013). Acoustic modeling for Alternative 1 predicts that Dall's porpoise could be exposed to sound or energy from explosions that may result in 8 TTS and 47 behavioral reactions. The population of Dall's porpoises for which these effects are predicted has a stock exceeding approximately 83,000 animals (Table 3.8-1).

Acoustic modeling predicts eight TTS effects annually for Dall's porpoises from use of explosives during training. As discussed in Section 3.8.3.3.6.1 (Range to Effects), the range to TTS (a temporary partial loss of hearing sensitivity) for a high frequency cetacean such as Dall's porpoise is on average less than approximately 1,400 yd. (1,280 m) from the largest explosive (Bin E12) used in the TMAA. Recovery from a TTS can take a few minutes to a few days, depending on the severity of the initial shift. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. Mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) would further reduce the predicted impacts.

Acoustic modeling indicates 47 effects to Dall's porpoises as a result of sound or energy from underwater explosions that would result in a behavioral response. Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that if high frequency cetaceans are exposed to explosions, they may react by alerting, ignoring the stimulus, changing their behaviors or vocalizations, or avoiding the area by swimming away or diving. Some behavioral impacts from the largest explosive (Bin E12) used in the TMAA could take place at distances exceeding approximately 4.5 nm (Table 3.8-18), although biologically meaningful behavioral effects are much more likely at higher received levels closer to the explosion. Overall, predicted effects are low, and mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) would further reduce potential impacts. Occasional behavioral reactions to intermittent explosions are unlikely to cause long-term consequences for individual animals or populations.

3.8.3.3.9.3 Pinnipeds

During the GOALS II survey (Rone et al. 2013), 16 elephant seals, 78 Northern fur seals, and 6 unidentified pinnipeds were visually detected. Acoustic modeling indicates that during the Carrier Strike Group exercise, pinnipeds would not be exposed to sound or energy from explosives associated with training activities, which would exceed the current impact thresholds.

Steller Sea Lion (Endangered Species Act-Listed Threatened Western Distinct Population Segment and the Recovered Eastern Distinct Population Segment)

Acoustic modeling predicts that Steller sea lions would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. The Western U.S. stock of Steller sea lions (also constituting the Western DPS) is listed as depleted under the MMPA and endangered under the ESA. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, the Western U.S. stock of Steller sea lions may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species. The Eastern U.S. stock of Steller sea lions has recovered and been removed from the List of Endangered and Threatened Wildlife under the ESA. In the Alaska region, critical habitat has been designated for Steller sea lions in the Aleutian Islands and Western Alaska. There would be no impact to Critical Habitat designated for Steller sea lion since it does not occur within the Study Area.

3.8.3.3.9.4 Mustelid (Northern Sea Otters)

The sea otter may on rare occasion be present in the Study Area. Because it is unlikely that a sea otter would be in waters where depths exceed 35 m (115 ft.), it is extremely unlikely that sea otters would be present within the range to effects for training events using explosives (see Table 3.8-26). Acoustic modeling for sea otter was not undertaken given they are far from where activities involving in water explosives are proposed to occur, they inhabit complex shallow water environments where acoustic modeling is very imprecise and therefore not representative, and they spend little time underwater thus very much limiting the potential for sea otter to hear underwater sound in any case. Research indicates sea otters often remained undisturbed, quickly become tolerant of the various sounds, and even when purposefully harassed, they generally moved only a short distance (100–200 m) before resuming normal activity. The USFWS has determined that previous Department of Defense actions have not posed a threat to the San Nicolas Island (California) colony of southern sea otter and the average growth rate for the translocated colony has been higher than that for those inhabiting the central California coastline in recent years (U.S. Department of the Interior 2012a). Given these factors, long-term consequences for individuals or the population would not be expected. Pursuant to the ESA, training activities in the Study Area may affect and are not likely to adversely affect the ESA-listed Southwestern Alaska stock of Northern sea otter. In the Alaska region, critical habitat has been designated for Northern sea otters, but those nearshore areas are not present within the Study Area.

3.8.3.3.9.5 Conclusion

Training activities under Alternative 1 include sound or energy from underwater explosions resulting from activities as described in Table 2.3-1 of Chapter 2 (Description of Proposed Action and Alternatives). These activities could result in inadvertent exposure of marine mammals in the Study Area to sound or energy from the use of explosives.

Pursuant to the MMPA, the use of explosives during training activities under Alternative 1:

- *May expose Dall's porpoises up to 55 times annually to sound or pressure levels that would be considered Level B harassment, as defined by the MMPA*
- *Would not result in serious injury or incidental mortality to any marine mammals*

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1:

- *May affect, and is not likely to adversely affect, North Pacific right whale, humpback whale, blue whale, fin whale, sei whale, Western North Pacific gray whale, sperm whale, the Western stock of Steller sea lion, and the Southwest Alaska stock of Northern sea otter*
- *Would have no effect on North Pacific right whale, Steller sea lion, or Northern sea otter critical habitat*

3.8.3.3.10 Alternative 2

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.3-1, training activities under Alternative 2 would use explosive ordnance that results in underwater sound or energy. Training activities involving explosions could be conducted throughout the Study Area but typically would not occur in the portion of the TMAA on the shelf or near the shelf break.

As presented in Table 3.8-23 for Alternative 2, the acoustic modeling and post-modeling analyses predicts that as a result of the two annual Carrier Strike Group exercises, for all species except Dall's porpoise, there will be no exposures resulting in Level B or Level A harassment as defined under the MMPA for military readiness activities. The acoustic modeling and post-modeling analyses predicts 111 exposures to Dall's porpoises from impulsive sound (explosives) resulting in Level B²³ harassment and 2 exposures resulting in Level A²⁴ as defined under the MMPA for military readiness activities. There are no exposures resulting in mortality predicted by the modeling for any marine mammal species and none are expected based on the history of having conducted identical events in other training range complexes for decades.

3.8.3.3.10.1 Mysticetes

During the GOALS II survey (Rone et al. 2013), 318 mysticetes were detected and identified by species with an additional 119 large whales also detected, some of which were likely to be mysticete species. Acoustic modeling indicates that mysticetes would not be exposed to sound or energy from explosives associated with training activities during the Carrier Strike Group exercises, which would exceed the current impact thresholds. Table 3.8-23 presents predicted ranges to specified effects for low-frequency cetaceans (mysticetes).

²³ This is the combined summation of all non-TTS and TTS exposures (behavioral effects) for all species and stocks in the Study Area for an annual total based on a 12-month period.

²⁴ This is the combined summation of all PTS, gastrointestinal, and slight lung injury exposures for all species and stocks in the Study Area for an annual total based on a 12-month period.

Table 3.8-23: Annual Predicted Effects to Marine Mammals from Use of Explosives under Alternative 2

Species	Stock	Behavioral	TTS	PTS	GI	SLI	Mortality
North Pacific right whale	Eastern North Pacific	0	0	0	0	0	0
Humpback whale	Western North Pacific	0	0	0	0	0	0
	Central North Pacific	0	0	0	0	0	0
	California, Washington, and Oregon	0	0	0	0	0	0
Blue whale	Eastern North Pacific	0	0	0	0	0	0
	Central North Pacific	0	0	0	0	0	0
Fin whale	Northeast Pacific	0	0	0	0	0	0
Sei whale	Eastern North Pacific	0	0	0	0	0	0
Minke whale	Alaska	0	0	0	0	0	0
Gray whale	Eastern North Pacific	0	0	0	0	0	0
	Western North Pacific	0	0	0	0	0	0
Sperm whale	North Pacific	0	0	0	0	0	0
Killer whale	Alaskan Resident	0	0	0	0	0	0
	Eastern North Pacific Offshore	0	0	0	0	0	0
	AT1 Transient	0	0	0	0	0	0
	GOA, Aleutian Island, and Bering Sea Transient	0	0	0	0	0	0
Pacific white-sided dolphin	North Pacific	0	0	0	0	0	0
Harbor porpoise	Gulf of Alaska	0	0	0	0	0	0
	Southeast Alaska	0	0	0	0	0	0
Dall's porpoise	Alaska	94	17	1	0	1	0
Cuvier's beaked whale	Alaska	0	0	0	0	0	0
Baird's beaked whale	Alaska	0	0	0	0	0	0
Stejneger's beaked whale	Alaska	0	0	0	0	0	0
Steller sea lion	Eastern U.S.	0	0	0	0	0	0
	Western U.S.	0	0	0	0	0	0
California sea lion	U.S.	0	0	0	0	0	0
Northern fur seal	Eastern Pacific-Alaska	0	0	0	0	0	0
Northern elephant seal	California Breeding	0	0	0	0	0	0
Harbor seal	North Kodiak	0	0	0	0	0	0
	South Kodiak	0	0	0	0	0	0
	Prince William Sound	0	0	0	0	0	0
	Glacier Bay/Icy Strait	0	0	0	0	0	0
	Sitka/Chatham	0	0	0	0	0	0
	Dixon/Cape Decision	0	0	0	0	0	0
Ribbon seal	Alaska	0	0	0	0	0	0
Northern sea otter	Southeast Alaska	0	0	0	0	0	0
	Southcentral Alaska	0	0	0	0	0	0
	Southwest Alaska	0	0	0	0	0	0
Sub-Total		94	17	1	0	1	0
MMPA Totals		Level B		Level A		Mortality	
		111		2		0	

Notes: GI = gastrointestinal, GOA = Gulf of Alaska, PTS = Permanent Threshold Shift, SLI = Slight Lung Injury, TTS = Temporary Threshold Shift, U.S. = United States

As presented in detail in Section 3.8.3.3.8.1 (Mysticetes) for the No Action, review of the NMFS-identified feeding and migration areas showed there is only minimal spatial overlap with the Navy TMAA and the North Pacific right whale feeding area southeast of Kodiak Island and minimal overlap with the edge of the gray whale migration area offshore of Kenai Peninsula (Ferguson et al. 2015b). Those areas of overlap at the corners of the TMAA are very unlikely to have any Navy training activity. Therefore, it is very unlikely there would be an effect to feeding or migrating activities if right whales or gray whales were present. Additionally, appropriate standard operating procedures and mitigation measures (as detailed in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) would be implemented for any detected marine mammals and thus further reducing the potential for the feeding or migration activities to be affected.

North Pacific Right Whales (Endangered Species Act-Listed)

North Pacific right whales are not expected to be present in the Study Area (Section 3.8.2.6.3, Distribution). Within the Gulf of Alaska, a July 2012 sighting of a North Pacific right whale approximately 50 mi. (80 km) from the southern edge of the TMAA Study Area (Matsuoka et al. 2013) and subsequent acoustic detections in July 2013 (U.S. Department of the Navy 2013g) also occurred outside the Study Area in the near the designated right whale Critical Habitat off Kodiak Island. A bottom moored passive acoustic monitoring device on Quinn Seamount also detected North Pacific right whale calls between July and September 2013, but these calls were believed to have originated over 100 km from the hydrophone (Debich et al. 2014). It is also not expected that North Pacific right whale would be exposed to sound or energy associated with the use of explosives during training activities given those activities only occur during limited intervals of the 21-day Carrier Strike Group exercise. Given that a North Pacific right whale has not been seen in the Study Area since at least the 1960s (indicating a highly unlikely presence), it would be extremely unlikely for there to be a co-occurrence of a right whale in the Study Area while use of explosives was occurring. Additionally, mitigation measures would be implemented if a North Pacific right whale were detected within the mitigation zone. Even in the event of an extremely unlikely co-occurrence, given that any effect would likely not be measureable, detectable, or significant, the Navy has determined possible effects to North Pacific right whale from Navy training in the Study Area are discountable. As discussed in Section 3.8.3.2.1 (Application of the Endangered Species Act to Marine Mammals), because it is possible that a North Pacific right whale may potentially be present and may potentially detect or otherwise be exposed to sound resulting from Navy training, use of explosives in the Study Area may affect and is not likely to adversely affect North Pacific right whale.

Blue Whales (Endangered Species Act-Listed)

Blue whales were visually detected five times during the GOALS II survey (Rone et al. 2013) as single individuals or in pairs. Blue whales would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, blue whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Humpback Whales (Endangered Species Act-Listed)

Humpback whales visually detected during the GOALS II survey (Rone et al. 2013) had an average group size of 3.12. Humpback whales would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, humpback whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives.

Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Sei Whales (Endangered Species Act-Listed)

During the GOALS II survey (Rone et al. 2013), three large whales determined to be either fin or sei whales were detected. Sei whales would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, sei whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Fin Whales (Endangered Species Act-Listed)

As noted above for sei whales, during the GOALS II survey (Rone et al. 2013), only three large whales determined to be either fin or sei whales were detected. Acoustic modeling indicates fin whales would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, fin whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Gray Whales, Western North Pacific Stock (Endangered Species Act-Listed)

No gray whales were detected in the TMAA Study Area during the GOALS II survey (Rone et al. 2013). Acoustic modeling indicates that gray whales would not be exposed to sonar or other active acoustic sources associated with training activities, which would exceed the current impact thresholds. Gray whales of the Western North Pacific stock may migrate through the Study Area although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur. Since gray whales of the Western North Pacific stock could potentially be present in the Study Area, they may be exposed to low levels of sound or energy. Pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

3.8.3.3.10.2 Odontocetes

Under Alternative 2, acoustic modeling indicates that, except for Dall's porpoise, odontocetes would not be exposed to sound or energy from explosives associated with training activities during the Carrier Strike Group exercises, which would exceed the current impact thresholds.

Sperm Whales (Endangered Species Act-Listed)

Sperm whales are classified as mid-frequency cetaceans (Section 3.8.2.3.2, Mid-Frequency Cetaceans). Sperm whales were visually detected 19 times during the GOALS II survey (Rone et al. 2013). Acoustic modeling predicts that sperm whales would not be exposed to sound or energy from explosions associated with proposed activities, which would exceed the current impact thresholds. Long-term consequences for individuals or populations would not be expected. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, sperm whales may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species.

Dall's Porpoise

Dall's porpoise (classified as high-frequency cetaceans [Section 3.8.2.3.1, High-Frequency Cetaceans]) are present in the Study Area and are part of the Alaska stock. Dall's porpoise were encountered as individuals and in groups 337 times during the GOALS II survey (Rone et al. 2013). Acoustic modeling for Alternative 2 predicts that Dall's porpoise could be exposed to sound or energy from explosions that may result in 1 slight lung injury, 1 PTS, 17 TTS, and 94 behavioral reactions.

The explosive impact injury criteria are based upon newborn calf weights, and therefore these effects are over predicted by the model, assuming most animals within the population are larger than a newborn calf. Furthermore, as explained in Section 3.8.3.1.4.8 (Mortality and Injury from Explosives), the criteria for slight lung injury are very conservative (e.g., overestimate the effect). Mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) are designed to avoid potential effects from underwater detonations, especially higher order effects such as injury and death. Nevertheless, conservative modeling predicts it is possible for Dall's porpoise to be injured by an explosion. Considering that Dall's porpoises for which these effects are predicted have a stock exceeding approximately 83,000 animals (Table 3.8-1), the one recoverable slight lung injury predicted annually for an animal in the population would be extremely unlikely to have measurable long-term consequences to the population.

A total of 1 PTS and 17 TTS effects are predicted for Dall's porpoises from use of explosives during training. As discussed in Section 3.8.3.3.6.1 (Range to Effects), ranges to PTS as an injury effect are on average less than approximately 730 yd. (670 m) for the high frequency cetaceans from the largest explosive (Bin E12) used in the TMAA. Recovery from a TTS (i.e., TTS; temporary partial loss of hearing sensitivity) can take a few minutes to a few days, depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect hearing sensitivity across all frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent loss of hearing sensitivity over a part of a marine mammal's hearing range would have long-term consequences for that individual, given many mammals lose hearing ability as they age. Mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) would further reduce the predicted impacts.

Acoustic modeling indicates 94 effects to Dall's porpoises as a result of sound or energy from underwater explosions that would constitute a behavioral response. Research and observations (Section 3.8.3.1.2.6, Behavioral Reactions) show that if high frequency cetaceans are exposed to explosions, they may react by alerting, ignoring the stimulus, changing their behaviors or vocalizations, or avoiding the area by swimming away or diving. Some behavioral impacts from the largest explosive (Bin E12) used in the TMAA could take place at distances exceeding approximately 4.5 nm (Table 3.8-18), although biologically meaningful behavioral effects are much more likely at higher received levels closer to the explosion. Overall, predicted effects are low, and mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) would further reduce potential impacts. Occasional behavioral reactions to intermittent explosions are unlikely to cause long-term consequences for individual animals or populations.

3.8.3.3.10.3 Pinnipeds

During the GOALS II survey (Rone et al. 2013), 16 elephant seals, 78 Northern fur seals, and 6 unidentified pinnipeds were visually detected. Acoustic modeling indicates that pinnipeds would not be exposed to sound or energy from explosives associated with training activities during the Carrier Strike Group exercise, which would exceed the current impact thresholds.

Steller Sea Lion (Endangered Species Act-Listed Threatened Western Distinct Population Segment and the Recovered Eastern Distinct Population Segment)

Acoustic modeling predicts that Steller sea lions would not be exposed to sound or energy from explosions associated with training activities, which would exceed the current impact thresholds. The Western U.S. stock of Steller sea lions (also constituting the Western DPS) is listed as depleted under the MMPA and endangered under the ESA. Although acoustic modeling indicates any effects are discountable as being extremely unlikely to occur, the Western U.S. stock of Steller sea lions may be exposed to low levels of sound or energy from a training activity involving the use of explosives. Therefore, pursuant to the ESA, use of explosives during Navy training may affect and is not likely to adversely affect this species. The Eastern U.S. stock of Steller sea lions has recovered and been removed from the List of Endangered and Threatened Wildlife under the ESA. In the Alaska region, critical habitat has been designated for Steller sea lions in the Aleutian Islands and Western Alaska. There would be no impact to Critical Habitat designated for Steller sea lion since it does not occur within the Study Area.

3.8.3.3.10.4 Mustelid (Northern Sea Otters)

The sea otter may on rare occasion be present in the Study Area. Because it is unlikely that a sea otter would be in waters where depths exceed 35 m (115 ft.), it is extremely unlikely that sea otters would be present within the range to effects for training events using explosives (see Table 3.8-18). Acoustic modeling for sea otter was not undertaken given they are far from where activities involving in water explosives are proposed to occur, they inhabit complex shallow water environments where acoustic modeling is very imprecise and therefore not representative, and they spend little time underwater, thus very much limiting the potential for a sea otter to hear underwater sound in any case. Research indicates sea otters often remained undisturbed, quickly become tolerant of the various sounds and, even when purposefully harassed, they generally moved only a short distance (100–200 m) before resuming normal activity. The USFWS has determined that previous Department of Defense actions have not posed a threat to the San Nicolas Island (California) colony of southern sea otter and the average growth rate for the translocated colony has been higher than that for those inhabiting the central California coastline in recent years (U.S. Department of the Interior 2012a). Given these factors, long-term consequences for individuals or the population would not be expected.

3.8.3.3.10.5 Conclusion

Training activities under Alternative 2 include sound or energy from underwater explosions resulting from activities as described in Table 2.3-1 of Chapter 2 (Description of Proposed Action and Alternatives). These activities could result in inadvertent exposure of marine mammals in the Study Area to sound or energy from use of explosives.

Pursuant to the MMPA, the use of explosives during training activities under Alternative 2:

- *May expose Dall's porpoises up to 111 times annually to sound or pressure levels that would be considered Level B harassment, as defined by the MMPA*
- *May expose Dall's porpoises up to 2 times annually to sound or pressure levels that would be considered Level A harassment, as defined by the MMPA*
- *Would not result in serious injury or incidental mortality to any marine mammals*

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2:

- *May affect, and is not likely to adversely affect, North Pacific right whale, humpback whale, blue whale, fin whale, sei whale, Western North Pacific gray whale, sperm whale, the Western stock of Steller sea lion, and the Southwest Alaska stock of Northern sea otter*
- *Would have no effect on North Pacific right whale, Steller sea lion, or Northern sea otter critical habitat*

3.8.4 SUMMARY OF IMPACTS (COMBINED IMPACTS OF ALL STRESSORS) ON MARINE MAMMALS

This section discusses the potential for combined impacts of all stressors from the Proposed Action when considered with the new supplemental analysis of acoustic stressors (i.e., sonar and other active acoustic sources; explosives) presented in the sections above, and summarized in Sections 3.8.6 (Marine Mammal Protection Act Determinations) and 3.8.7 (Endangered Species Act Determinations).

As presented in the introduction to Section 3.8.3 (Environmental Consequences), there are no changes to the proposed activities from those analyzed in the 2011 GOA Final EIS/OEIS. The analysis in this supplemental document is based on (1) a revision of the criteria and thresholds for quantifying impacts to marine mammals, (2) a new modeling methodology, and (3) the findings from the latest scientific research and new data available since 2010 regarding marine mammals that may be present in the Study Area. These improvements since the Final EIS/OEIS have provided a more accurate quantification of the likely effects to marine mammals from the Proposed Action, and the resulting analysis of acoustic stressors indicates an approximate 90 percent reduction in the number of predicted effects from sonar and other active acoustic sources and an approximate 80 percent reduction in the number of predicted effects from the use of explosives compared to the conclusions of the 2011 GOA Final EIS/OEIS.

Overall, there is a large reduction in the number of predicted acoustic stressor impacts and there is no change in activities from what was presented in the 2011 GOA Final EIS/OEIS regarding other potential stressors under the current Proposed Action. In comparison to the analysis in the 2011 GOA Final EIS/OEIS, it is therefore less likely that there would be any impacts from multiple stressors that would result in long-term consequences for individuals or populations of marine mammals.

Based on the 2011 GOA Final EIS/OEIS Proposed Action, NMFS issued an MMPA LOA (National Oceanic and Atmospheric Administration 2011b) and a Biological Opinion pursuant to the ESA (National Oceanic and Atmospheric Administration 2011c, d). In the Biological Opinion, NMFS concluded that Navy activities in the Study Area are not likely to jeopardize the continued existence of threatened and endangered marine mammal species and that designated marine mammal critical habitat is not likely to be adversely affected. Given that the re-analysis in this Supplemental EIS/OEIS estimates fewer effects to ESA-listed marine mammals, it supports the same previous conclusions by NMFS (see subsequent discussions in Section 3.8.6 [Marine Mammal Protection Act Determinations] pursuant to the MMPA and Section 3.8.7 [Endangered Species Act Determinations] for the ESA). However, the Navy must seek a

new Letter of Authorization under the MMPA because the previous authorization has a 5-year limit. This letter will then necessitate a new Biological Opinion regarding ESA-listed species.

3.8.5 SUMMARY OF OBSERVATIONS DURING PREVIOUS NAVY ACTIVITIES

The Navy and NMFS have long recognized the public interest and concern over the welfare of marine species in areas of the ocean where the Navy has been training and testing for decades. Since 2006, in an intensive effort to specifically address the concerns over potential impact of ongoing training and testing, the Navy, non-Navy marine mammal scientists, and research institutions in consultation with NMFS have conducted scientific monitoring and research in and around ocean areas in the Atlantic and Pacific oceans where the Navy has been and proposes to continue training and testing. Data collected from Navy monitoring, scientific research findings, and annual reports are available for the public to review. These reports have been provided to NMFS²⁵ and may provide information relevant to the analysis of impacts to marine mammals for a variety of reasons, including data on species distribution, habitat use, and evaluating potential animal responses to Navy activities. Monitoring is performed using a variety of methods, including visual surveys from surface vessels and aircraft, as well as passive acoustics, satellite tagging, photo-identification, and biopsy sampling. Navy monitoring can generally be divided into two types of efforts: (1) collecting long-term data on distribution, abundance, and habitat use patterns within Navy activity areas; and (2) collecting data during individual training or testing activities. The Navy also contributes to funding of basic research, including behavioral response studies specifically designed to determine the effects to marine mammals from the Navy's main mid-frequency surface ship anti-submarine warfare active acoustic (sonar) system. These reports and associated peer-reviewed, published studies provide the current best data on observed marine mammal responses to Navy activities.

Worldwide, the majority of the training and testing activities Navy is proposing for the next 5 years are similar if not identical to activities that have been occurring in the same locations for decades. For example, the mid-frequency sonar system on the cruisers, destroyers, and frigates has the same sonar system components in the water as was first deployed in the 1970s. While the signal analysis and computing processes onboard these ships have been upgraded with modern technology, the power and output of the sonar transducer, which puts signals into the water, have not changed. For this reason, the history of past marine mammal observations, research, and monitoring reports remain applicable to the analysis of effects from the proposed future training and testing activities.

3.8.5.1 Alaska Specific Monitoring and Research

During the LOA development process for the 2011 GOA Final EIS/OEIS, the Navy and NMFS agreed that monitoring in the Gulf of Alaska should focus on augmenting existing baseline data, since regional data on species occurrence and density are extremely limited. There have been four reports to date covering work in the Gulf of Alaska (U.S. Department of the Navy 2011c, 2011d, 2012, 2013f). Collecting baseline data was deemed a priority prior to focusing on exercise monitoring and behavioral response as is now being done in other Navy operating areas and ranges. There have been no previous dedicated monitoring efforts during Navy training activities in the TMAA with the exception of deployed HARPs. Research undertaken by the Navy in the Gulf of Alaska includes the following:

²⁵ Navy monitoring reports are available at the Navy website, www.navy.mil/speciesmonitoring.us/, and also at the NMFS website, www.nmfs.noaa.gov/pr/permits/incidental/

- Deployment (July 2011) of two long-term bottom-mounted passive acoustic monitoring buoys resulting in over 5,756 hours of passive acoustic data (Baumann-Pickering et al. 2012b, 2013; Debich et al. 2013; U.S. Department of the Navy 2013f)
- An additional passive acoustic monitoring buoy deployed (September 2012) at Pratt Seamount (U.S. Department of the Navy 2013f)
- Two additional passive acoustic monitoring buoys deployed from June 2013 to May 2014 within the TMAA Study Area, totaling 33,707 hours and covering 1,404 days of acoustic data (Debich et al. 2014)
- Line transect survey (GOALS) conducted by NMFS in April 2009 (see Rone et al. 2010)
- An additional line-transect survey in the TMAA Study Area (GOALS II) in summer 2013 (Rone et al. 2013)

The final cruise report from the GOALS II survey was prepared in April 2014, and the following has been summarized from Rone et al. (2014). Overall, the GOALS II survey provided first time estimates of abundance and density for five species in the central Gulf of Alaska region. Satellite tags on a blue whale and a Baird's beaked whale provided the first movement and habitat use data for the region. Photographic identification data gathered will build upon the growing Pacific catalog. In total, the visual team surveyed 4,504 kilometers (km). Based on the total effort, there were 802 sightings (1,998 individuals) of 13 confirmed marine mammal species, with an additional 162 sightings (228 individuals) of unidentified cetaceans and pinnipeds. Passive acoustic monitoring was conducted continuously totaling approximately 456 hours of effort and resulting in 379 acoustic detections and 267 localizations of six confirmed cetacean species. There were also 186 passive sonobuoys deployed, which resulted in seven confirmed cetacean species acoustically detected. The GOALS II survey has provided one of the most comprehensive datasets on marine mammal occurrence, abundance, and distribution within the central Gulf of Alaska region (Rone et al. 2014).

The Navy is committed to structuring the Navy-sponsored research and monitoring program to address both NMFS' regulatory requirements as part of any MMPA authorizations while at the same time making significant contributions to the greater body of marine mammal science (see U.S. Department of the Navy 2013f).

In 2016, monitoring in the Gulf of Alaska will be a transitional year so that ongoing data collection from the Navy's current GOA rulemaking can be completed. Therefore, monitoring in 2016 may be a combination of previously funded Fiscal Year 2015 (FY-15) "carry-over" projects in the GOA study area, and new FY-16 project starts prioritized across all Navy at-sea training and testing ranges based on the Navy-wide strategic planning process. A more detailed description of the status of the Navy's planned projects of its monitoring program funded in 2016 will be updated through their Navy Marine Species Monitoring web portal at <http://www.navy-marine-species-monitoring.us/>.

3.8.5.2 U.S. West Coast Baleen Whale Tagging

A Navy-funded effort in the Pacific Northwest involved attaching long-term satellite tracking tags to migrating gray whales off the coast of Oregon and northern California (U.S. Department of the Navy 2013e). This study is being conducted by the University of Oregon and has also included tagging of other large whale species such as humpback whales, fin whales, and killer whales when encountered. This effort is not programmed, affiliated, or managed as part of the GOA TMAA monitoring, and is a separate regional project, but has provided information on marine mammals and their movements that has application to the Gulf of Alaska.

In one effort between May 2010 and May 2013, satellite tracking tags were placed on 3 gray whales, 11 fin whales, 5 humpback whales, and 2 killer whales off the Washington coast (Schorr et al. 2013). One tag on an Eastern North Pacific Offshore stock killer whale in a pod encountered off Washington at Grays Harbor Canyon, remained attached and continued to transmit for approximately 3 months. In this period, the animal transited a distance of approximately 4,700 nm, which included time spent in the nearshore margins of the TMAA in the Gulf of Alaska where it would be considered part of the Offshore stock (for stock designations, see Allen and Angliss 2014). In a second effort between 2012 and 2013, tags were attached to 11 Pacific Coast Feeding Group gray whales near Crescent City, California; in general, the tag-reported positions indicated these whales were moving southward at this time of year (Mate 2013a). The Navy's 2013 annual monitoring report for the Northwest Training and Testing Range contains the details of the findings from both research efforts described above (U.S. Department of the Navy 2013e). Finally, the Navy will be continuing a multi-year long-term satellite track tagging of blue and fin whales along the U.S. west coast. Tag attachment on blue and fin whales occurred in August 2014 and again in July 2015 in Southern California. Additional tagging is planned for summer of 2016, and possibly summer of 2017 (funding permitting). Mate et al. (2015a) detailed individual animal movement for the 2014 field season. Blue whales, for instance, traveled quite extensively, although none of the tagged whales travelled as far north as the Gulf of Alaska. However, 2014 was oceanographically an abnormal warm water year and many blue whales left the U.S. West Coast earlier than anticipated and headed to the eastern tropical Pacific breeding grounds. Elevated warm water conditions are not preferred by blue whale prey (krill). It is suspected limited prey availability along the California coast in summer and fall of 2014 caused many blue whales to shorten their North Pacific foraging early.

Information from these Navy-funded tagging efforts are considered along with other research, such as the tagging results reported on by Mate et al. (2015b) for Western North Pacific gray whales, which all add to the scientific knowledge regarding our understanding of whale movements across their extensive ranges.

3.8.5.3 Monitoring and Research at Other Pacific Navy Range Complexes

In the Pacific, the vast majority of scientific field work, research, and monitoring efforts have been expended in Southern California and Hawaii where the Navy has historically concentrated training and testing activities (see U.S. Department of the Navy 2013a, b). For example, between 2006 and 2013 across all Navy Range Complexes (in the Atlantic, Gulf of Mexico, and the Pacific), there were over 80 reports (Major Exercise Reports, Annual Exercise Reports, and Annual Monitoring Reports; see Table 3.8-24) submitted to NMFS to further research goals aimed at understanding Navy's impact on the environment as it carries out its mission to train and test. In addition to this multi-year record of reports from across the Navy, there has also been ongoing behavioral response research efforts (in Southern California and the Bahamas) specifically focused on determining the potential effects from Navy mid-frequency sonar (De Ruiter et al. 2013a, Goldbogen et al. 2013, Tyack et al. 2011). Overall, this has included deployment of instruments, surveys, and monitoring before, during, and after Navy training and testing activities that has been undertaken by scientists from universities, independent research organizations, and the Navy. This multi-year compendium of monitoring, observation, study, and broad scientific research is informative with regard to assessing the effects of Navy training and testing in general. Given this record involves the same Navy training activities being considered for the TMAA and includes all the marine mammal taxonomic families present and many of the same species as those expected within the TMAA, this broad record covering Navy activities elsewhere is applicable to assessing locations such as the TMAA.

For example, in the Hawaii and Southern California Navy training and testing ranges from 2008 to 2012, Navy-funded marine mammal monitoring research completed over 5,000 hours of visual survey effort covering over 76,400 nm, sighted 338,875 individual marine mammals, took more than 64,600 digital photos and 45 hours of digital video, attached 74 satellite tracking tags to individual marine mammals, and collected over 45,000 hours of passive acoustic recordings. In Hawaii alone between 2006 and 2012, there were 21 scientific marine mammal surveys conducted before, during, or after major exercises.

The Navy has continued to review emergent science and fund research to better assess the potential impacts that may result from the continuation of ongoing training and testing in the historically used range complexes worldwide. Along with behavioral response studies and the results of research efforts and monitoring before, during, and after training and testing events across the Navy since 2006, the Navy's assessment is that it is unlikely there will be impacts to populations of marine mammals (such as whales, dolphins, and porpoise) having any long-term consequences as a result of the proposed continuation of training in the ocean areas historically used by the Navy including the TMAA.

This assessment of likelihood is based on four indicators from areas in the Pacific where Navy training and testing has been ongoing for decades: (1) evidence suggesting or documenting increases in the numbers of marine mammals present, (2) examples of documented presence and site fidelity of species and long-term residence by individual animals of some species, (3) use of training and testing areas for breeding and nursing activities, and (4) 9 years of comprehensive monitoring data indicating a lack of any observable effects to marine mammal populations as a result of Navy training and testing activities.²⁶ While there is evidence that shows increases and/or viability of marine mammal populations there is no direct evidence from years of monitoring on Navy ranges (since 2006) that indicate any long term consequences to marine mammal populations as a result of ongoing training and testing. Barring any evidence to the contrary, therefore, what limited and preliminary evidence there is from the Navy's 100+ reports and other focused scientific investigations should be considered. This is especially the case given the seemingly widespread public misperception that Navy training and testing, especially involving use of mid-frequency sonar, will cause large numbers of marine mammals to be injured or die. Examples to the contrary where the Navy has conducted training and testing activities for decades can be found throughout the literature.

²⁶ Monitoring of Navy activities began in July 2006 as a requirement under issuance of an Incidental Harassment Authorization by NMFS for the Rim of the Pacific exercise and has continued to the present for Major Training Events in Hawaii, Southern California, and the Mariana Islands as well as other monitoring as part of the coordinated efforts under the Navy's Integrated Comprehensive Monitoring Plan developed in coordination with NMFS and other interested parties.

Table 3.8-24: Navy Exercise and Monitoring Report Submissions for the Pacific from 2011 through 1 January 2016

Year Submitted	Range	Document
2011	SOCAL Range Complex and Hawaii Range Complex	Annual Range Complex Exercise Report, Aug 2010–Aug 2011
		Marine Mammal Monitoring, 2011 Annual Report
	Mariana Islands Range Complex	Annual Range Complex Exercise Report, Aug 2010–Feb 2011
		Marine Species Monitoring, Annual Report
	Keyport Range Complex	Annual Range Complex Exercise Report, Year 1, Apr 2011–Sept 2011
		Annual Range Complex Monitoring Report, Year 1, Apr 2011–Nov 2011
	Northwest Training Range Complex	Annual Range Complex Exercise Report, Year 1, Nov 2010–May 2011
		Annual Range Complex Monitoring Report, Year 1, Nov 2010 –May 2011
2012	Gulf of Alaska	Annual Monitoring Report, 2011, Year 1
		Annual Exercise Report, 17 May 2011–31 Oct 2011
	SOCAL Range Complex and Hawaii Range Complex	Annual Range Complex Exercise Report, 2 Aug 2011–1 Aug 2012
		Marine Species Monitoring, 2012 Annual Report
	Mariana Islands Range Complex	Marine Species Monitoring, 2012
		Annual Range Complex Exercise Report, 16 Feb 2011–15 Feb 2012
	Keyport Range Complex	Annual Range Complex Exercise Report, Year 2
		Annual Range Complex Monitoring Report, Year 2

Table 3.8-24: Navy Exercise and Monitoring Report Submissions for the Pacific from 2011 through 1 January 2016 (continued)

Year Submitted	Range	Document
2012 (continued)	Northwest Training Range Complex	Annual Range Complex Unclassified Exercise Report, Year 2, May 2011–May 2012
		Annual Range Complex Monitoring Report
		Environmental Monitoring Report, EOD/UNDET
	Gulf of Alaska	Annual Monitoring Report, 2012, Year 2
2013	SOCAL Range Complex	Comprehensive Exercise and Monitoring Report For the U.S. Navy's SOCAL Range Complex, 2009–2012
	Mariana Islands Range Complex	Annual Marine Species Monitoring Report, 2013
		Annual Range Complex Exercise Report, Year 4
	Keyport Range Complex	Annual Range Complex Exercise Report, Year 3
		Annual Range Complex Monitoring Report, Year 3
	Northwest Training Range Complex	Annual Range Complex Unclassified Exercise Report, Year 3
		Marine Species Monitoring, 2013 Annual Report
	Hawaii Range Complex	Comprehensive Exercise and Monitoring Report For the U.S. Navy's Hawaii Range Complex, 2009–2012
2014	HSTT Range Complex	Annual Range Complex Unclassified Exercise Report, 2014
		Annual Monitoring Report, 2014
	Mariana Islands Range Complex	Annual Marine Species Monitoring Report, 2014
		Comprehensive Exercise and Monitoring Report For the U.S. Navy's Mariana Islands Range Complex, 2010–2014
	Northwest Training Range Complex	Annual Range Complex Unclassified Exercise Report, Year 4
		Comprehensive Monitoring Report For the U.S. Navy's Northwest Training Range Complex, 2011–2014
	Gulf of Alaska	Annual Monitoring Report, 2014, Year 4
		Annual Monitoring Report, 2014, Year 4
2015	HSTT Range Complex	Report not yet released
	Mariana Islands Range Complex	Annual Marine Species Monitoring Report, 2015
		Annual Range Complex Exercise Report, 2015
	Northwest Training Range Complex	Annual Marine Species Monitoring Report, 2015
		Annual Range Complex Unclassified Exercise Report, Year 5
	Gulf of Alaska	Annual Monitoring Report, 2015
		Annual Exercise Report for Exercise Northern Edge 2015 Conducted 15–26 June 2015

Notes: (1) These reports are publically available at the Navy website (www.navy.mil/marinespeciesmonitoring.us/) and from the NMFS Office of Protected Resources website (www.nmfs.noaa.gov/pr/permits/incidental/). (2) EOD = Explosive Ordnance Disposal, HSTT = Hawaii Southern California Training and Testing, Navy = United States Department of the Navy, SOCAL = Southern California. UNDET = Underwater Detonation, U.S. = United States

Work by Moore and Barlow (2011) indicates that since 1991, there is strong evidence of increasing fin whale abundance in the California Current area, which includes the SOCAL Range Complex. They predict continued increases in fin whale numbers over the next decade, and that perhaps fin whale densities are reaching “current ecosystem limits.” Research by Falcone and Shorr (2012) suggests that fin whales may have population sub-units with higher-than-expected residency to the Southern California Bight, which

includes part of the Navy's SOCAL Range Complex. Passive acoustic monitoring of fin whale calls in the Southern California Bight show an increase in the number of calls detected between 2006 and 2012, also suggesting that the population of fin whales may have increased in that timeframe (Širović et al. 2015). Similar findings have also documented the seasonal range expansion and increasing presence of Bryde's whales south of Point Conception in Southern California (Kerosky et al. 2012, Smultea and Jefferson 2014). Findings from Smultea and Jefferson (2014) for these same waters off Southern California, including the SOCAL Range Complex, appear to show that since the 1950s, humpback whales and Risso's dolphins have increased in relative occurrence while common bottlenose and northern right whale dolphins; Dall's porpoise; and gray whales, killer whales, minke whales, Cuvier's beaked whales, and sperm whales do not appear to have changed. There is possible indication of recent decreased relative occurrence of the Pacific white-sided dolphin, and short-finned pilot whales have not been recorded in the area since the 1990s, concurrent with the observed relative increase in Risso's dolphins (Smultea and Jefferson 2014).

For humpback whales that winter in the Hawaiian Islands, research has confirmed that the overall humpback whale population in the North Pacific has continued to increase and is now greater than some prior estimates of pre-whaling abundance (Barlow et al. 2011). The Hawaiian Islands, the location of the Hawaii Range Complex for decades, continue to function as a critical breeding, calving, and nursing area for this endangered species (National Marine Fisheries Service [2013] has recently proposed humpbacks in the North Pacific be delisted due to their recovery). In a similar manner, the beaches and shallow water areas within the PMRF at Kauai (in the main Hawaiian Islands) continue to be an important haulout and nursing area for endangered Hawaiian monk seals. While there has been a decline in the population of Hawaiian monk seals in the northwestern Hawaiian Islands, in the main Hawaiian Islands the numbers have continued to increase (Littnan 2011); the main Hawaiian Islands is where the Navy trains and tests. In similar findings from Hood Canal, Washington, where Navy training and testing activities have been occurring for decades, surveys of harbor seals show a fairly stable population after years of recovery, suggesting the area's carrying capacity may have been reached (Jeffries et al. 2003) in that location. At the Navy-managed San Nicolas Island, the southern sea otters residing there tend to be larger and heavier than those along the coast, and on average the population has been increasing at approximately 9 percent annually from the early 1990s to the mid-2000s and approximately 7.6 percent in the last 5 years (2008–2013), an increase that has not been matched by sea otter along the central California coastline (U.S. Fish and Wildlife Service 2014). The USFWS has determined that previous Department of Defense actions have not posed a threat to that colony of southern sea otter (U.S. Fish and Wildlife Service 2011).

As increases in population would seem to indicate, evidence for the presence and/or residence of marine mammal individuals and populations would also seem to suggest a lack of long-term or detrimental effects from Navy training and testing historically occurring in the same locations. The intensively used instrumented range at the PMRF remains the likely foraging area (given its proximity) for a resident pod of spinner dolphins that was the focus for part of the monitoring effort during the 2006 Rim of the Pacific Exercise. More recently at the PMRF, Martin and Kok (2011) reported on the presence of minke whales, humpback whales, beaked whales, pilot whales, and sperm whales on or near the range during a Submarine Commander Course involving three surface ships and a submarine using mid-frequency sonar over the span of the multiple-day event. The analysis showed it was possible to evaluate the behavioral response of a localized minke whale and found there did not appear to be a biologically meaningful reaction by the minke whale to the mid-frequency sonar transmissions (although overall minke calling rates were reduced during the training event). In subsequent analysis of the data set, Manzano-Roth et al. (2013) determined that beaked whales (tentatively identified as Blainville's

beaked whales) continued to make foraging dives, but at reduced dive rates, at estimated distances of 13 to 52 km from active mid-frequency sonar. The animals shifted to the southern edge of the range and exhibited differences in the vocal period duration of the diver and dive rate. The estimated mean received levels on the beaked whale group was 109 dB re 1 μ Pa.

Humpback whales are documented as the species that has received the highest sound pressure levels from training activities using U.S. Navy MFAS (i.e., at least 183 dB re 1 μ Pa) based upon an analysis which utilized shipboard Marine Mammal Observer sightings on 18 February 2011 (Farak et al. 2011) combined with PMRF range hydrophone data (Martin and Manzano-Roth 2012). Analysis of PMRF hydrophone data for the purpose of estimating received levels on marine mammals has also been done in conjunction with satellite tagged animals (Baird et al. 2014) and aerial focal follows (i.e., when a single animal is tracked and observed; Mobley and Pacini 2013). Passive acoustic monitoring of PMRF hydrophones during Navy training for the month of February from 2011 to 2013 has shown that the number of acoustically identified minke whales is reduced during periods when MFAS is used compared to other periods of time (Martin et al. 2014, Martin et al. *in press*). Acoustic analysis has also shown that marine mammals near the sea surface can be exposed to higher estimated receive levels due to ducted sound propagation, which typically exists at PMRF. Behaviors observed during a focal follow aerial survey of a humpback whale in conjunction with estimated received levels derived from passive acoustic data are reported as a case study of a single focal follow occurring in the vicinity of MFAS (Mobley and Pacini 2013).

Sperm whales have been observed by marine mammal observers aboard Navy surface ships and detected by PMRF range hydrophones during Navy training events; however, MFAS was not active so no behavioural response data exists for naval training activities (Miller et al. 2012, Sivle et al. 2012). However, a sperm whale was tagged for a controlled exposure experiment during a behavioral response study at the range. The sperm whale did not appear to demonstrate obvious behavioral changes in dive pattern or production of clicks (Southall et al. 2011).

In Southern California, based on a series of surveys from 2006 to 2008 and the high number encounter rate, Falcone et al. (2009) proposed that their observations suggested the ocean basin west of San Clemente Island may be an important region for Cuvier's beaked whales. For over three decades, this ocean area west of San Clemente has been the location of the Navy's instrumented training range and is one of the most intensively used training and testing areas in the Pacific, given the proximity to the Naval installations in San Diego. Data from visual surveys documenting the presence of Cuvier's beaked whales for the ocean basin west of San Clemente Island (Falcone et al. 2009; Falcone and Schorr 2012, 2013, 2014; Smultea and Jefferson 2014) are consistent with concurrent results from passive acoustic monitoring that estimated regional Cuvier's beaked whale densities were higher than indicated by the NMFS's broad scale visual surveys for the U.S. west coast (Hildebrand and McDonald 2009). Photo identification methods in the SOCAL Range Complex have identified approximately 100 individual Cuvier's beaked whales, with 40 percent having been seen in one or more prior years, with re-sightings up to 7 years apart (Falcone and Schorr 2014). The Navy's use of the SOCAL Range Complex has not precluded beaked whales from continuing to inhabit the area, nor has there been documented declines or beaked whale mortalities in the area associated with Navy training and testing activities. The long-term presence of beaked whales at the Navy range off Southern California is consistent with that for a similar Navy instrumented range (AUTEC) located off Andros Island in the Bahamas where Blainville's beaked whales (*Mesoplodon densirostris*) are routinely acoustically detected (see McCarthy et al. 2011, Tyack et al. 2011).

Moore and Barlow (2013) have noted a decline in beaked whales over a broad area of the Pacific Ocean (the California Current Large Marine Ecosystem) out to 300 nm from the coast and extending from the Canadian-U.S. border to the tip of Baja Mexico and suggested that anthropogenic sound (including sonar) cannot be ruled out as a possible contributing cause in that decline (Moore and Barlow 2013). There are scientific caveats and limitations to the data used for that analysis, as well as oceanographic and species assemblage changes on the U.S. west coast not thoroughly addressed in Moore and Barlow (2013). Interestingly however, and as noted by Moore and Barlow (2013), in the small portion of that area overlapping the Navy's SOCAL Range Complex, long-term residency by individual Cuvier's beaked whales and higher densities provide indications that the proposed decline of beaked whales off the U.S. west coast is not apparent where the Navy has been intensively training and testing with sonar and other systems for decades. The long-term presence of beaked whales at the Navy range off Southern California is consistent with that for a similar Navy instrumented range (the Atlantic Undersea Test and Evaluation Center) located off Andros Island in the Bahamas where Blainville's beaked whales (*Mesoplodon densirostris*) are routinely acoustically detected (see Tyack et al. 2011; McCarthy et al. 2011). Navy funding for monitoring of beaked whale and other marine species (involving visual survey, passive acoustic recording, and tagging studies) will continue in Southern California and elsewhere to develop additional data toward a clearer understanding of marine mammals inhabiting the Navy's range complexes. As noted previously (Falcone and Schorr 2012, 2014; Falcone et al. 2009; Hildebrand and McDonald 2009; Smultea and Jefferson 2014), in the small portion of the California Current Large Marine Ecosystem overlapping the Navy's SOCAL Range Complex, seemingly stable populations, long-term residency by individual Cuvier's beaked whales, and higher densities provide indications that the proposed decline noted elsewhere is not apparent where the Navy has been intensively training and testing with sonar and other systems for decades. Navy funding for monitoring of beaked whale and other marine species (involving visual survey, passive acoustic recording, and tagging studies) will continue in Southern California to develop additional data toward a clearer understanding of marine mammals inhabiting the Navy's range complexes.

To summarize, while the evidence covers most marine mammal taxonomic suborders, it is limited to a few species and only suggestive of the general viability of those species in intensively used Navy training and testing areas. There is no direct evidence that routine Navy training and testing spanning decades has negatively impacted marine mammal populations at any Navy Range Complex. Although there have been a few strandings associated with use of sonar in other locations, as Ketten (2012) has recently summarized, "to date, there has been no demonstrable evidence of acute, traumatic, disruptive, or profound auditory damage in any marine mammal as the result of anthropogenic noise exposures, including sonar." Therefore, based on the best available science (Barlow et al. 2011; Carretta et al. 2009; Falcone and Schorr 2012, 2014; Falcone et al. 2009; Jeffries et al. 2003; Littnan 2011; Manzano-Roth et al. 2013; Martin and Kok 2011; McCarthy et al. 2011; McSweeney et al. 2007, 2009; Moore and Barlow 2011; Southall 2012; Tyack et al. 2011; Southall et al. 2012a, 2012b, 2013, 2014; Smultea and Jefferson 2014; Širović et al. 2015), including data developed in the series of 80+ reports submitted to NMFS, the Navy believes that long-term consequences for individuals or populations are unlikely to result from Navy training activities in the TMAA.

Until an incident in March 2011, there were no known incidents or records of any explosives training activity involving injury to a marine mammal. At the SSTC at Coronado, California, on average per year there are approximately 415 in-water detonations occurring during an estimated 311 training events at that location. Despite the Navy's excellent decades-long track record, on 4 March 2011, it is clear that an

underwater demolition training event resulted in the known mortalities to four²⁷ long-beaked common dolphins. Range clearance procedures had been implemented, and there were no marine mammals in the area when the timed-fuse countdown to detonation began. Personnel moved back from the site, and just before the detonation was to occur, dolphins were observed moving into the clearance zone. Due to the danger to personnel, the Navy could not attempt to divert those animals, stop the timer, or disarm the explosive. As a result of this incident, in consultation with NMFS, the Navy modified the mitigation measures in existence when this incident occurred to prevent a reoccurrence (see Chapter 5 regarding Mine Neutralization Activities Using Diver-Placed Time-Delay Firing Devices). There are no underwater demolition training events or use of timed-fuses associated with underwater demolition proposed for the Study Area or as part of the Carrier Strike Group exercise or Sinking Exercise.

Although potential impacts to Dall's porpoises from the Proposed Action may include injury (but not "serious injury"²⁸), these impacts are not expected to decrease the overall fitness of the Dall's porpoise population in the Study Area. There are no mortalities predicted by the acoustic modeling and none are expected. In cases where potential impacts rise to the level that warrants mitigation, mitigation measures designed to reduce the potential impacts are discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring).

3.8.6 MARINE MAMMAL PROTECTION ACT DETERMINATIONS

Pursuant to the MMPA, the Navy is seeking a 5-year LOA from the NMFS for stressors associated with training activities involving the use of sonar and other active acoustic sources and explosives as described in Chapter 2 (Description of Proposed Action and Alternatives). The use of sonar, other active sources, and explosives may result in Level A harassment and Level B harassment of certain marine mammals.

3.8.7 ENDANGERED SPECIES ACT DETERMINATIONS

The NMFS administers the ESA for marine mammals in the Study Area. The guidelines followed to make a determination of no effect; may affect, not likely to adversely affect; or may affect, likely to adversely affect can be found in the *ESA Consultation Handbook* (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998).

In accordance with ESA requirements, the Navy has undertaken Section 7 consultation with NMFS for the ongoing activities in the TMAA as described in Chapter 2 (Description of Proposed Action and Alternatives). A summary of the Navy's findings are provided in Table 3.8-25, which has the determinations made for each acoustic substressor (sonar and other active acoustic sources and explosives) and ESA-listed marine mammal species pursuant to the ESA from the analysis presented

²⁷ Immediately after the detonation at the Silver Strand Training Complex (Coronado, California), Navy personnel found and recovered three dead long-beaked common dolphin; they reported the incident to the Navy chain of command, who informed NMFS, and Navy then transferred the recovered animals to the local stranding network for necropsy. Three days later, a long-beaked common dolphin was discovered at Oceanside, California (approximately 40 mi. [65 km] up the coast) and another was discovered 10 days after the training event at La Jolla, California (approximately 15 mi. [45 km] from the training site). Due to the species being one which commonly strands and the number of days and distance from the event, the association of this last stranded animals with the event is not certain (see Danil and St. Leger 2011).

²⁸ None of the annual six (total) predicted injuries to Dall's porpoise under Alternative 2 would be considered by NMFS to be "serious injury" under the MMPA regulatory definition. For details regarding the regulatory definition of serious injury, see 50 Code of Federal Regulations 229.2 and the NMFS website at [<http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf>].

previously. There is no designated critical habitat located within the Study Area so for all substressors, training activities would have no effect on any critical habitat.

Table 3.8-25: Endangered Species Act Effects Determinations for Acoustic Stressors

Species	Acoustic Stressor	
	Sonar and Other Active Acoustic Sources	Explosives
North Pacific Right Whale	May affect, likely to adversely affect	May affect, not likely to adversely affect
Humpback Whale	May affect, likely to adversely affect	May affect, not likely to adversely affect
Sei Whale	May affect, likely to adversely affect	May affect, not likely to adversely affect
Fin Whale	May affect, likely to adversely affect	May affect, not likely to adversely affect
Blue Whale	May affect, likely to adversely affect	May affect, not likely to adversely affect
Gray Whale, Western North Pacific Stock	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Sperm Whale	May affect, likely to adversely affect	May affect, not likely to adversely affect
Steller Sea Lion, Western Stock	May affect, likely to adversely affect	May affect, not likely to adversely affect
Northern Sea Otter, Southwest Alaska Stock	May affect, not likely to adversely affect	May affect, not likely to adversely affect

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