3.8 Marine Mammals

3.8 MARINE MAMMALS

3.8.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for marine mammals is the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). The TMAA is more than 12 nautical miles (nm) (22 kilometers [km]) from the closest point of land and is therefore outside of United States (U.S.) territorial Seas. Thus, this section provides an overview of the species, distribution, and occurrence of marine mammals that are either resident, are seasonally present, or migratory through the GOA TMAA. This section also presents the information concerning the affected environment of the GOA TMAA as it relates to marine mammals, provides an analysis of the environmental consequences resulting from the Proposed Action, and summarizes mitigation measures as they relate to protections of marine mammals potentially affected by the Proposed Action. The mitigation measures relating to the protection of marine mammals are presented in detail in Section 5.1.7 of Chapter 5, Mitigation Measures, of this EIS/OEIS.

All marine mammals are protected under the Marine Mammal Protection Act (MMPA). In addition, specific "listed species" are protected under the Endangered Species Act (ESA). Both the MMPA and ESA are administered by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS).

Information on species listed under the ESA is presented first, followed by non-ESA listed marine mammals subject to regulation under the Marine Mammal Protection Act (MMPA). These lists are further subdivided by taxonomic Order with the species listed by common name in alphabetical order. Tables are provided to summarize this information where appropriate.

Seven of the marine mammals found in the TMAA are designated "listed species" under the ESA. The ESA has additional requirements when assessing the effect of proposed activities on those species and their critical habitats. Sections 3.8.7.1 and 3.8.7.2 provide further details. All marine mammals are protected under the Marine Mammal Protection Act (MMPA) of 1972, amended in 1994. The MMPA is administered by the NMFS and the USFWS.

Marine mammals that are expected to be present within the TMAA belong to two taxonomic groups:

- *Cetaceans* is the generalized term describing both *mysticetes* (large whales with baleen) and *odontocetes* (toothed whales, porpoises, and dolphins).
- *Pinnipeds* (seals and sea lions) are divided into eared seals or *otariids* such as Steller sea lions and Northern fur seals, and earless seals or *phocids* such as harbor seals and elephant seals. Although pinnipeds come ashore to rest, molt, breed, and bear young, the waters of the TMAA are locations where they may hunt and feed.

There are 26 species of marine mammals with possible or confirmed occurrence in the waters of the GOA (Carretta et al. 2007, Angliss and Allen 2009, Rone et al. 2009, Stafford 2009), but not all inhabit waters within the TMAA (Table 3.8-1). Six species, the beluga whale (*Delphinapterus leucas*), false killer whale (*Pseudorca crassidens*), northern right whale dolphin (*Lissodelphis borealis*), Risso's dolphin (*Grampus griseus*), short-finned pilot whale (*Globicephala macrorhynchus*), and sea otter (*Enhydra lutris*), are considered extralimital in the TMAA and not expected to be present given their documented habitat preferences (Department of the Navy [DoN] 2006, Angliss and Outlaw 2007). Since the TMAA is well outside the normal range of these species, they will be discussed briefly and then dismissed from further analysis.

Table 3.8-1: Summary of Marine Mammal Species Found in the GOA

Common Name *Species Name*	**Abundance[a] (CV)**	**Stock**	**Calculated Density in the TMAA[b] (animals per km^2)**	**Population Trend**	**Occurrence in the TMAA (Apr - Dec)**	**Designated Critical Habitat**
ESA Listed Cetaceans						
Blue whale[1,3,4] *Balaenoptera musculus*	1,368 (0.22)	Eastern North Pacific	No Density	May be increasing	Rare	None in North Pacific
Cook Inlet Beluga Whale[1,3,4] *Delphinapterus leucas*	375[c]	Cook Inlet	NA	Decreasing	Extralimital	None
Fin whale [1,3,4] *Balaenoptera physalus*	2,636 (0.15)	Northeast Pacific	0.010	Increasing 4.8 percent annually	Common	None
Humpback whale[1,3,4] *Megaptera novaeangliae*	4,005 (0.95)	Central North Pacific and Western North Pacific	0.0019	May be increasing	Common	None
North Pacific Right Whale[1,3,4] *Eubalaena japonica*	Unknown[6] (may be < 100 whales)	Eastern North Pacific	No Density	Unknown (may be decreasing)	Very rare	Yes - Outside of the TMAA
Sei whale[1,3,4] *Balaenoptera borealis*	43 (0.61)	Eastern North Pacific	No Density	May be increasing	Very rare	None
Sperm whale[1,3,4] *Physeter macrocephalus*	Unknown	North Pacific	0.0003	Unknown	Rare	None
ESA Listed Pinnipeds						
Steller sea lion [2,3,4] *Eumetopias jubatus*	45,095-55,832	Eastern Distinct Population Segments (DPS).	0.0098	Increasing (3.1 percent/year)	Common	Yes- Outside of the TMAA
Steller sea lion [1,3,4] *Eumetopias jubatus*	38,988	Western DPS	0.0098	Decreasing (5.4 percent/year)	Common	Yes- Outside of the TMAA
ESA listed Mustelid						
Sea otter *Enhydra lutris*	Unknown	South Central, Southeast and South West Alaska[2,3]	NA	Increasing	Extralimital	None
Non-ESA Listed Cetaceans						
Baird's beaked whale *Berardius bairdii*	Unknown	Alaska	0.0005	Unknown	Rare	None
Cuvier's beaked whale *Ziphius cavirostris*	Unknown	Alaska	0.0022	Unknown	Common	None

Table 3.8-1: Summary of Marine Mammal Species Found in the GOA (continued)

Common Name *Species Name*	**Abundance[a] (CV)**	**Stock**	**Calculated Density in the TMAA[b] (animals per km^2)**	**Population Trend**	**Occurrence in the TMAA (Apr - Dec)**	**Designated Critical Habitat**
Non-ESA Listed Cetaceans (continued)						
Dall's porpoise *Phocoenoides dalli*	83,400 (0.097)	Alaska	0.1892	Unknown	Common	None
False killer whale *Pseudorca crassidens*	Unknown	Hawaii	NA	Unknown	Extralimital	None
Gray whale *Eschrichtius robustus*	18,813 (0.069)	Eastern North Pacific	0.0125	Increasing	Common	None
Harbor porpoise[3] *Phocoena phocoena*	41,854 (0.224)	Gulf of Alaska	No Density	Stable	Rare	None
Killer whale- *Orcinus orca* (Multiple stocks that may occur in the TMAA)	249-1,123	Eastern North Pacific Alaska Resident & Northern Resident, Gulf of Alaska, Aleutian Islands and Bering Sea, AT1[3,4], West Coast and Offshore	0.010 (for all killer whales)	Increasing	Common	None
Minke whale *Balaenoptera acutorostrata*	Unknown	Alaska	0.0006	Unknown	Rare	None
Northern right whale dolphin *Lissodelphis borealis*	12,876 (0.30)	California/ Oregon/ Washington	NA	No trend	Extralimital	None
Pacific white-sided dolphin *Lagenorhynchus obliguidens*	26,880 (0.90)	North Pacific	0.0208	Unknown	Common	None
Risso's Dolphin *Grampus griseus*	11,621 (0.17)	California, Oregon, and Washington	NA	Unknown	Extralimital	None
Short-finned pilot whale *Globicephala macrorhynchus*	245 (0.97)	California, Oregon, and Washington	NA	Unknown	Extralimital	None
Stejneger's beaked whale *Mesoplodon stejnegeri*	Unknown	Alaska	Density of Cuvier's beaked whale used as a surrogate[d]	Unknown	Common	None

Table 3.8-1: Summary of Marine Mammal Species Found in the GOA (continued)

Common Name *Species Name*	**Abundance[a] (CV)**	**Stock**	**Calculated Density in the TMAA[b] (animals per km²)**	**Population Trend**	**Occurrence in the TMAA (Apr - Dec)**	**Designated Critical Habitat**
Non-ESA Listed Pinnipeds						
California sea lion *Zalophus californianus*	238,000	U.S.	No Density	Increasing	Very rare	None
Harbor seal *Phoca vitulina richardii*	45,975 (0.04)	Gulf of Alaska	NA	Stable	Very rare	None
Northern elephant seal *Mirounga angustirostris*	124,000	California Breeding	0.0022	Increasing	Common	None
Northern fur seal[3,4] *Callorhinus ursinus*	665,550	Eastern Pacific	0.1180	Decreasing[5]	Common	None
Ribbon seal Histriophoca fasciata	58,000[7]	Alaska	NA	NA	Rare	None

Sources: Barlow and Forney 2007, Angliss and Allen 2009, Carretta et al. 2007, DoN 2007, Dahlheim et al. 2009

Notes: ESA notations: [1]endangered; [2]threatened. MMPA designations: [3]strategic stock; [4]depleted.

[5]The assessment of the population trend in fur seals was performed by obtaining counts of adult males and estimates of the numbers of pups born. Although the most recently obtained numbers of adult male fur seals in the Pribilof Islands shows an increase, since 1998, pup production at the primary Pribilof Island breeding colonies has declined at an annual rate of 5.2% (Alaska Fisheries Science Center 2008).

[6] Wade et al. (2010) estimated abundance for North Pacific right whales in the Bering Sea and Aleutian Islands at 28 to 31 individuals based on genotypic and photographic data, respectively; this includes 8 females and 20 males. These estimates may relate to a Bering Sea subpopulation, although other data suggest that the total eastern North Pacific population is unlikely to be much larger.

[7] Numbers are for ribbon seals present in the central Bering Sea; Peter Boveng, National Marine Mammal Laboratory, personal communication, 12 Aug 2010. A reliable abundance estimate for the Alaska stock of ribbon seals is currently not available (Angliss and Allen 2009).

[a] Abundance numbers reported are for the entire stock (as listed in the next column) and not representative of the abundance present in the TMAA or GOA.

[b] Densities calculated for summer as discussed in Appendix E

[c] NOAA 2008a; Endangered Status for the Cook Inlet Beluga Whale

[d] No current estimates of abundance for Stejneger's beaked whales are available. Given that sufficient information exists for Cuvier's beaked whale, they are in the same taxonomic family, and the predicted density of Cuvier's beaked whale in the GOA is higher than that of Baird's beaked whales, estimates therefore err on the side of overestimation.

CV = Coefficient of Variation
km^2 = square kilometer
TMAA = temporary Maritime Activities Area
NA = not applicable given species is extralimital to TMAA.

The abundance for each species is specific to that species and varies seasonally in Alaska waters (Table 3.8-1; in simple terms, abundance is the number in a specified area and the density is the number per unit area). For purposes of analysis of environmental effects in this section, the abundance of the marine mammal species has been estimated using the summer months, which is when they are most abundant and when the proposed action would occur. As reflected in Table 3.8-1, many species are listed as common, indicating that they occur routinely, either year-round or during annual migrations into or through the area.

Blue, North Pacific right, and sei whales are considered rare, are too few in number to allow for quantitative analysis, and are included here only for discussion purposes given they are endangered species. Some species are indicated as "rare" because of sporadic sightings and species listed as "very rare" are very few in number globally, very few in number in the TMAA, or are unlikely to be present in the TMAA. Those species considered "extralimital" are considered outside their normal habitat range in the TMAA although their past presence may have been documented on a few occasions in GOA. Odontocetes occurring regularly include sperm whale, Cuvier's, Baird's, and Stejneger's beaked whales, killer whale, Pacific white-sided dolphin, and Dall's porpoise (Angliss and Allen 2009, Rone et al. 2009). All of the species that occur in the TMAA are either cosmopolitan (occur worldwide), or associated with the temperate and sub-Arctic oceans (Leatherwood et al. 1988). For many species, the TMAA constitutes a small portion of their total range given seasonal migrations to warmer waters where breeding and calving occur. These species, for example, include the humpback whale (*Megaptera noveangliae*) and gray whale (*Eschrichtius robustus*), which both feed in Alaska waters in roughly the May to September timeframe.

The 20 species that occur in the TMAA include 7 species of baleen whales (mysticetes), 8 species of toothed whales/dolphins/porpoises (odontocetes), and 5 species of seals and sea lions (pinnipeds). Tables 3.8-1 and 3.8-2 summarize the available information regarding their density, ESA and MMPA status, population trends, and occurrence in the area.

Table 3.8-2: Summary of Marine Mammal Species, Density, and Information Sources for the TMAA in Summer (April – October)

Species	Density (animal /km^2)	Source
ESA Listed Species		
Fin whale	0.010	Rone et al. (2009)
Humpback whale	0.0019	Rone et al. (2009)
Sperm whale	0.0003	Waite (2003), Mellinger et al. (2004)
Steller sea lion	0.0098	Angliss and Allen (2008), Bonnell and Bowlby (1992)
Non-ESA Listed Species		
Gray whale	0.0125	Moore et al. (2007)
Minke whale	0.0006	Waite (2003)
Baird's beaked whale	0.0005	Waite (2003)
Cuvier's beaked whale	0.0022	Waite (2003)
Dall's porpoise	0.1892	Waite (2003)
Killer whale	0.0100	Zerbini et al. (2007)
Pacific white-sided dolphin	0.0208	Waite (2003)
Northern elephant seal	0.0022	Carretta et al., 2009
Northern fur seal	0.1180	Carretta et al., 2009

Notes: ESA = Endangered Species Act, km^2 = squared kilometers

Information presented in Tables 3.8-1 and 3.8-2 was compiled mainly from NMFS Stock Assessment Reports (Angliss and Outlaw 2007, Angliss and Allen 2009, Carretta et al. 2008) and supporting literature as referenced. Life history and habitat information for these species in the GOA was previously detailed in the Marine Resources Assessment for the GOA Operating Area (DoN 2006). Much of the species-specific information in that comprehensive assessment has been brought forward into this section of the EIS/OEIS in summary or verbatim for the convenience of the reader.

Much of the analysis in this section deals with potential consequences resulting from exposure to underwater sound associated with Navy training activities. Behavioral responses to sound are greatly influenced by the context of the exposure and the individual animal's experience, motivation, and conditioning (Southall et al. 2007). While this leads to great variance in potential responses to a given sound, measurements of marine mammal sound production and hearing capabilities provide some basis for assessment of whether exposure to a particular sound source (its frequency and sound level) may affect a marine mammal behaviorally or potentially result in direct injury. Table 3.8-3 provides a summary of sound production and hearing capabilities for marine mammal species in the TMAA.

Table 3.8-3: Sound Production and Hearing Capabilities of Marine Mammals in the TMAA

Common Name	Sound Production		Hearing Ability
	Frequency Range (kHz)	Source Level Sound (dB re 1 μPa @ 1 m)	Frequency Range (kHz)
Baleen whales			
Blue whale	0.012 - 0.4	188 (maximum)	Not Available
Fin whale	0.010 - 0.75	155 - 186	Not Available
Gray whale	0.020 - 20	142 - 185	<2
Humpback whale	0.020 - 10	144 - 192	0.7 - 10 (predicted)
Minke whale	0.060 - 20	150 - 175	Not Available
North Pacific right whale	0.050 - 0.6	137 - 192	0.010 - 22 (predicted)
Sei whale	0.433 (+/- 0.192) - 3.5	156 +/- 3.6	Not Available
Toothed whales			
Baird's beaked whale	4 - 42	Not Available	Not Available
Cuvier's beaked whale	0.3 - 135	214 (maximum)	Not Available
Dall's porpoise	0.04 - 160	120 - 175	Not Available
Harbor porpoise	0.04 - 160	135 - 177	16 - 140
Killer whale	0.1 - 35	137 - 224	<0.5 - 105
Pacific white-sided dolphin	0.002 - 80	170 (peak amplitude)	0.075 - 150
Stejneger's beaked whale	Not Available	Not Available	Not Available
Sperm whale	0.1 - 30	140 - 236	5 - 20 (measured from 1 neonatal sperm whale)
Pinnipeds			
Harbor seal	0.1 - 150	Not Available	1 - 180
Northern elephant seal	0.2 - 1	Not Available	0.075 - 45
Northern fur seal	Not Available	Not Available	0.5 - 60
Steller sea lion	0.03 - 3 (female calls only)	Not Available	1 - 25
California sea lion	0.25 - 6	Not Available	1 - 40

Notes: Information presented in this table was compiled from numerous literature and technical sources, which are identified in each species profile.dB re 1 μPa @ 1 m = decibels referenced to 1 micropascal at 1 meter, kHz = kilohertz, TMAA = Temporary Maritime Activities Area

3.8.1.1 Marine Mammal Species Excluded from Further Analysis

Cook Inlet Beluga Whales

Only 28 sightings of beluga in the GOA have been reported from 1936 to 2000 (Laidre et al. 2000). The nearest beluga whales to the TMAA are in Cook Inlet with an abundance estimate of 375 whales in the Cook Inlet stock as of 2008 (NOAA 2008a). Cook Inlet beluga whales were listed as endangered on 22 October 2008 and have been previously designated as depleted under the MMPA (NOAA 2008a). Cook Inlet beluga whales do not leave the waters of Cook Inlet (NOAA 2007, 2008a). Cook Inlet is approximately 70 nm (129.6 km) from the nearest edge of the TMAA. Based on this information, and the regulatory definition of the stock as those beluga whales confined to the waters of Cook Inlet, this stock of beluga whales will not be present in the TMAA, so this species will not be considered in greater detail in the remainder of this analysis.

False Killer Whale

False killer whales should not occur in the TMAA. False killer whales are found in tropical and temperate waters, generally between 50°S and 50°N latitude (Baird et al. 1989, Odell and McClune 1999). The southernmost point boundary of the TMAA is well north of 55°N latitude. There have been records of false killer whale sightings as far north as the Aleutian Islands and Prince William Sound in the past (Leatherwood et al. 1988). A solitary false killer whale was sighted in May 2003 near Juneau, but this was considered to be far north of its normal range (DoN 2006). There are no abundance estimates available for this species in the NMFS stock assessment report for this area of the Pacific. In summary, false killer whales are considered extralimital to the TMAA and will not be considered further in this analysis.

Northern Right Whale Dolphin

Northern right whale dolphins (*Lissodelphis borealis*) should not occur in the TMAA. This species occurs in North Pacific oceanic waters and along the outer continental shelf and slope in cool temperate waters colder than 20°C. This species is distributed approximately from 30°N to 55°N and 145°W to 118°E (both south and east of the TMAA). There are two records of northern right whale dolphins in the GOA (one just south of Kodiak Island), but these are considered extremely rare (DoN 2006). There are no abundance estimates available for this species in the NMFS stock assessment report for this area of the Pacific. In summary, northern right whale dolphins are considered extralimital to the TMAA and will not be considered further in this analysis.

Ribbon Seal

Ribbon seals primarily inhabit areas of the Arctic Ocean, Bering Sea, Chukchi, and western Beaufort Sea (Angliss and Allen 2009). Ribbon seals disperse widely from their winter sea ice habitat and are solitary during the summer while they forage at sea. In 2007, one adult female ribbon seal was observed and captured on shore in upper Cook Inlet and in autumn 2009 another was observed on the Copper River Delta (Boveng 2010). Tagging studies in 2009 (unpublished) showed one of 14 tagged seals spent time in the western GOA 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 common (Boveng 2010). Ribbon seal were not detected in the recent Gulf of Alaska Line-Transect Survey (GOALS), but they are hard to detect at sea so their non-detection during previous surveys is not indicative of absence from the area.

Recent preliminary data indicate it is possible that ribbon seal may be present in the TMAA. Given however, that the number of ribbon seals would likely be limited to a few individuals and because the proposed events will take place spread over the TMAA area of 42,146 square nautical miles (145,482 square kilometers), it is unlikely that ribbon seal will be encountered. For this reason, potential effects to ribbon seal will not be considered further in this analysis.

Risso's Dolphin

The Risso's dolphin is distributed worldwide in tropical to warm-temperate waters, roughly between 60°N and 60°S, where surface water temperature is usually greater than 50°F (10°C) (Kruse et al. 1999). The average sea surface temperature for the GOA is reported to be approximately 49.3°F (9.6°C) and has undergone a warming trend since 1957 (Aquarone and Adams 2008). The average summer temperature within the upper 328 ft (100 m) of the TMAA is approximately 52°F (11°C) based on data as presented in the modeling analysis. In the eastern Pacific, Risso's dolphins range from the GOA to Chile (Leatherwood et al. 1980, Reimchen 1980, Braham 1983, Olavarria et al. 2001). Water temperature appears to be a factor that affects the distribution of Risso's dolphins in the Pacific (Leatherwood et al. 1980, Kruse et al. 1999). Risso's dolphins are expected to be extralimital in the TMAA. They prefer tropical to warm-temperate waters and have been seldom sighted in the cold waters of the GOA. There are a few records of this species near the TMAA. Risso's dolphins have been sighted near Chirikof Island (southwest of Kodiak Island) and offshore in the GOA, just south of the TMAA boundary (Consiglieri et al. 1980, Braham 1983). Based on the above information, there is a very low likelihood of Risso's dolphins being present in the action area, so this species will not be considered in greater detail in the remainder of this analysis.

Short-finned Pilot Whale

Short-finned pilot whales should not occur in the TMAA. This species is found in tropical to warm-temperate seas, generally in deep offshore areas and they do not usually range north of 50°N (DoN 2006). 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 (DoN 2006). There are no abundance estimates available for this species in the NMFS stock assessment report for this area of the Pacific. In summary, short-finned pilot whales are considered extralimital to the TMAA and will not be considered further in this analysis.

Sea Otter

On 16 December 2008, the USFWS proposed to designate critical habitat for the Southwest Alaska stock of the northern sea otter (*Enhydra lutris kenyoni*) under the ESA (Department of the Interior [DOI] 2008). This critical habitat designation was effective as of 9 November 2009. This species is under the federal jurisdiction of the USFWS.

Sea otters are primarily found within 1-2 km (0.5-1.1 nm) of the shore and/or the 30 fathom (55 m) isobath (DOI 2008, NMFS 2005). Critical habitat map unit boundaries for "Unit 5" in the Kodiak Island area are for nearshore waters within approximately 328 ft (100 m) from the mean high tide line. The closest point from the critical habitat to the TMAA is located more than 24 nm (44 km) from the western corner of the TMAA. Sea otters are considered extralimital to the TMAA and none were encountered within the TMAA during the April 2009 GOALS survey (Rone et al. 2009).

Sea otters dive to gather food from the ocean floor in relatively shallow water in areas with both rocky substrate and soft bottom sediments. Sea otter feeding habits are directly correlated with water depth. Best available science suggests that female sea otters typically dive in 20 m (65.6 ft) or less to forage while male sea otters dive in 40 m (131.2 ft) or less. Data suggests that it is possible for sea otters to dive down to 80 m (262.4 ft) of water and in more extreme instances up to 100 m (328 ft). It is not known if sea otters can dive deeper than 100 m (328 ft). As shown in Figure 3.5-1, the bathometry of the TMAA typically ranges from 100 m (328 ft) to over 3,000 m (9,842.5 ft) in depth. While sea otters are not typically found in areas where the water depth is over 100 m (328 ft), they may occur in deeper waters due to drifting or competition for foraging areas (Burn 2010). However, with the exception of the area east of Kodiak Island, sea otters are not expected to regularly be present in the TMAA. Therefore, sea otters are not likely to occur within the TMAA area because of two factors: foraging diving depth limitations (ranging from 2 to 75 m [6.5 to 246 ft]) and the bathymetry of the TMAA (typically deeper than 100 m [328 ft]).

3.8.2 Estimated Marine Mammal Densities and Distribution

Baleen and toothed whales as well as dolphins and porpoises, collectively known as cetaceans, spend their entire lives in the water and spend most of the time (>90 percent for most species) entirely submerged below the surface. When at the surface, cetacean bodies are almost entirely below the water's surface, with only the blowhole exposed to allow breathing. This makes cetaceans difficult to locate visually and also exposes them to underwater noise, both natural and anthropogenic, essentially 100 percent of the time because their ears are nearly always below the water's surface. Seals and sea lions (pinnipeds) spend significant amounts of time out of the water during breeding, molting and hauling out periods. In the water, pinnipeds spend varying amounts of time underwater, as some species regularly undertake long, deep dives (e.g., elephant seals) and others are known to rest at the surface in large groups for long amounts of time (e.g., California sea lions). Sea lions often forage in bouts and then rest at the surface therefore their overall time underwater is much less than a cetacean. When not actively diving, pinnipeds at the surface often hold their heads above the water surface. Consequently, pinnipeds may not be exposed to underwater sounds to the same extent as cetaceans.

For the purposes of this analysis, the Navy has adopted a conservative approach to modeling underwater noise exposure to marine mammals, in that it will tend to overestimate exposures as follows:

- *Cetaceans – assume 100 percent of time is spent underwater and therefore exposed to noise.*
- *Pinnipeds – adjust densities to account for time periods spent at breeding areas, haulouts, etc.; but for those animals in the water, assume 100 percent of time is spent underwater and therefore exposed to noise.*

3.8.2.1 Derivation of Marine Mammal Density Estimates for TMAA

Recent survey data for marine mammals in the GOA was limited and most survey efforts were localized and extremely near shore. In addition to the visual surveys, there is evidence of occurrence of several species based on acoustic studies, but these do not provide measurements of abundance (e.g., Stafford 2009).

In April 2009, the Navy funded and NMFS conducted the Gulf of Alaska Line-Transect Survey (GOALS) to address the data needs for this analysis (Rone et al. 2009). Line-transect survey visual data to support distance sampling statistics and acoustic data were collected over a 10-day period both within and outside the TMAA. This survey resulted in sightings of several species and allowed for the derivation of densities for fin and humpback whale (Rone et al. 2009). In addition to this latest survey, two previous vessel surveys conducted in the near shore region of the TMAA were also used to derive the majority of the density data used in acoustic modeling for this analysis. The methods used to derive density estimates for all remaining species in the TMAA are detailed in Appendix E and summarized below.

Zerbini et al. (2006) conducted dedicated vessel surveys for large whales in summer 2001-2003 from Resurrection Bay on the Kenai Peninsula to Amchitka Island in the Aleutian Islands. Survey effort near the TMAA was nearshore (within approximately 46 nm [85 km] of shore), and is delineated as "Block 1" in the original paper. Densities for this region were published for fin and humpback whales.

Waite (2003) conducted vessel surveys for cetaceans near Kenai Peninsula, within Prince William Sound and around Kodiak Island, during acoustic-trawl surveys for pollock in summer 2003. Surveys extended offshore to the 1,000 meter (3,280 feet [ft]) isobath and therefore overlapped with some of the TMAA. Waite (2003) did not calculate densities, but did provide some of the elements necessary for calculating density (see Appendix E).

Gray whale density was calculated from data obtained from feeding studies near shore in the GOA. Gray whales are found almost exclusively in near shore areas; therefore, they would not be expected to be found in the majority of the TMAA (>50 nm [93 km] offshore and >5,997 ft [1,828 m] depth). (DoN 2006) The recent 2009 survey encountered one group of two gray whales on the shelf within the western edge of the TMAA and two groups well outside the TMAA near shore at Kodiak Island (Rone et al. 2009).

In Alaskan waters, harbor porpoises inhabit nearshore areas and are common in bays, estuaries, and tidal channels. In the GOA, harbor porpoise inhabit coastal waters where depths are less than 328 ft (100 m) in depth (DoN 2006, Angliss and Allen 2009). The majority of the TMAA is well offshore of the normal habitat range for harbor porpoise. There is no density data available for this species in the nearshore fraction of the TMAA overlapping the harbor porpoise range. An estimated quantification of impacts for harbor porpoise was, however, undertaken as is described in Section 3.8.4.6.

Pinnipeds occurring regularly include Steller sea lion, northern fur seal, and northern elephant seal. California sea lion range extends as far north as the Pribilof Islands in the Bering Sea. Tagging data indicate that most northern fur seal forage and migration takes place to the west of the TMAA (Ream et al. 2005), although the derived density for this species assumed the population would be present in the area for modeling purposes. Harbor seals are primarily a coastal species and are rarely found more than 12 miles (mi) (20 km) from shore (DoN 2006). Harbor seals should be very rare in the TMAA and there was no attempt to model for this species.

Pinniped at-sea density is not often available because pinniped abundance is obtained via shore counts of animals at known rookeries and haulouts. Lacking any other available means of quantification, densities of pinnipeds were derived using shore counts. Several parameters were identified for pinnipeds from the literature, including area of stock occurrence, number of animals (which may vary seasonally) and season, and those parameters were then used to calculate density. Once density per “pinniped season” was determined, those values were prorated to fit the warm water (June-October) and cold water (November-May) seasons. Determining density in this manner is risky as the parameters used usually contain error (e.g., geographic range is not exactly known and needs to be estimated and abundance estimates usually have large variances). As is true of all density estimates, they assume that animals are always distributed evenly within an area which is likely never true. Table 3.8-2 presents all available densities of species for the TMAA and pertinent references.

Additional information on all species can be found in the Marine Resources Assessment for the GOA Operating Area (DoN 2006). The Marine Resource Assessment listed 6 mysticetes, 12 odontocetes, and 5 pinnipeds as occurring or possibly occurring in the GOA region (DoN 2006; Table 3.8-1). However, several of the species listed are extralimital to the TMAA. Only species for which densities are available are included in Table 3.8-2.

3.8.2.2 Depth Distribution

There is limited depth distribution data for most marine mammals. There are a few different methodologies/techniques that can be used to determine depth distribution percentages, but by far the most widely used technique currently is the time-depth recorder. These instruments are attached to the animal for a fairly short period of time (several hours to a few days) via a suction cup or glue, and then retrieved immediately after detachment or when the animal returns to the beach. Depth information can also be collected via satellite tags, sonic tags, digital tags, and, for sperm whales, via acoustic tracking of sounds produced by the animal itself.

There are somewhat suitable depth distribution data for a few marine mammal species. Sample sizes are usually extremely small, nearly always fewer than 10 animals total and often only 1 or 2 animals. Depth distribution information often must be interpreted from other dive and/or preferred prey characteristics. Depth distributions for species for which no data are available are extrapolated from surrogate species (example in Section 3.8.4.9).

3.8.2.3 Density and Depth Distribution Combined

Marine mammal density is nearly always reported for an area as animals per square kilometer (km^2). Analyses of survey results using Distance Sampling techniques include correction factors for animals at the surface but not seen, as well as animals below the surface and not seen. Therefore, although the area (e.g., km^2) appears to represent only the surface of the water (two-dimensional [2-D]), density actually implicitly includes animals anywhere within the water column under that surface area. Density assumes that animals are uniformly distributed within the prescribed area, even though this is likely rarely true. Marine mammals are usually clumped in areas of greater importance, for example, areas of high productivity, lower predation, safe calving, etc. Density can occasionally be calculated for smaller areas that are used regularly by marine mammals, but more often than not there is insufficient data to calculate density for small areas. Therefore, assuming an even distribution within the prescribed area remains the norm.

The ever-expanding database of marine mammal behavioral and physiological parameters obtained through tagging and other technologies has demonstrated that marine mammals use the water column in various ways, with some species capable of regular deep dives (<2,625 ft [<800 m]) and others regularly diving to <656 ft (<200 m), regardless of the bottom depth. Assuming that all species are evenly distributed from surface to bottom is almost never appropriate and can present a distorted view of marine mammal distribution in any region.

By combining marine mammal density with depth distribution information, a more accurate three-dimensional (3-D) density estimate is possible. These 3-D estimates allow more accurate modeling of potential marine mammal exposures from specific noise sources. See Appendix D for additional modeling information.

3.8.3 ESA Species

3.8.3.1 Blue Whale

Stock

Eastern North Pacific

Regulatory Status

Blue whales (*Balaenoptera musculus*) are listed as endangered under the ESA and a recovery plan has been prepared (NMFS 1998b). The Eastern North Pacific (ENP) stock is designated depleted and classified as strategic under the MMPA.

Habitat Preferences & Critical Habitat

Blue whales inhabit both coastal and oceanic waters in temperate and tropical areas (Yochem and Leatherwood 1985). Important foraging areas include the edges of continental shelves and upwelling regions (Reilly and Thayer 1990, Schoenherr 1991). There is an absence of information available for blue whales in Alaska waters. Feeding grounds have been identified in coastal upwelling zones off the coast of California (Croll et al. 1998, Fiedler et al. 1998, Burtenshaw et al. 2004) and Baja California, Mexico (Reilly and Thayer 1990). Blue whales off the coast of southern California appear to feed exclusively on dense schools of krill between 328 and 656 ft (100 and 200 m; Croll et al. 1998, Fiedler et al. 1998). These concentrations form downstream from upwelling centers in close proximity to regions of steep topographic relief off the continental shelf break (Croll et al. 1999). Migratory movements of blue whales in California probably reflect seasonal patterns and productivity (Croll et al. 2005). Blue whales also feed in cool, offshore, upwelling-modified waters in the eastern tropical and equatorial Pacific (Reilly and Thayer 1990, Palacios 1999). Moore et al. (2002) determined that blue whale call locations in the western north Pacific were associated with relatively cold, productive waters and fronts. Stafford et al. (2007), however, reports that the distribution of northeastern Pacific blue whales was not correlated to sea surface temperature.

Critical habitat has not been designated for blue whales.

Population Size and Trends

Two stocks are recognized within U.S. North Pacific waters: the Western North Pacific stock (Hawaiian) and the ENP (NMFS 2006c). The ENP stock includes animals found from the northern GOA to the eastern tropical pacific. There is a minimum population estimate of 1,368 (Coefficient of Variation [CV] = 0.22) individuals in the ENP blue whale stock (Carretta et al. 2007) but no estimates for blue whales are available for the Alaska Stock Assessment (Angliss and Allen 2009). There are insufficient numbers of individuals of this species present in the TMAA to allow for acoustic impact modeling given they are rare.

While it is expected that the north Pacific population of blue whales has increased since being given protected status in 1966, there is no clear information on the population structure or population trend of species. The abundance of blue whales along the California coast has clearly been increasing (Calambokidis et al. 1990, Barlow 1994, Calambokidis 1995). However, the scarcity of blue whales in areas of former abundance (e.g., GOA near the Aleutian Islands) suggests that the potential increasing trend does not apply to the species' entire range in the eastern north Pacific (Calambokidis et al. 1990).

Distribution

Blue whales are distributed from the ice edges to the tropics in both hemispheres. In the North Pacific Ocean, blue whales are sighted from Kamchatka (Russia) to southern Japan in the west, and from the GOA south to at least Costa Rica in the east. Historical areas of concentrations include the eastern GOA, the eastern Aleutians, and the far western Aleutians (DoN 2006).

Blue whales as a species are thought to summer in high latitudes and move into the subtropics and tropics during the winter. A discovery tag on a blue whale by whalers off Vancouver Island in May 1963 was recovered a year later in June 1964 just south of Kodiak Island and a blue whale photoidentified south of Prince William Sound was identified five times between 1995 and 1998 off southern California. These occurrences support the hypothesis that blue whales seasonally migrate to and from feeding areas in the GOA (DoN 2006). Data from both the Pacific and Indian Oceans, however, indicate that some individuals may remain year-round in low latitudes, such as over the Costa Rican Dome. The productivity of the Costa Rican Dome may allow blue whales to feed during their winter calving/breeding season and not fast, like humpback whales are believed to do.

In the GOA, three blue whales were sighted in the summer of 2004 during survey work (Calambokidis et al. 2008). Blue whale calls, with a strong seasonal pattern, have been acoustically detected in the GOA in mid-July to mid-December with the peak occurrence from August through November (Moore et al. 2006, DoN 2006). The area of primary occurrence is seaward of the shelf break, with waters over the shelf area of a secondary occurrence (DoN 2006).

Life History

The eastern North Pacific stock of blue whales feeds in waters from California to Alaska in summer and fall and migrates south to the waters of Mexico to Costa Rica in winter for breeding and to give birth (Mate et al. 1999).

Reproduction/Breeding

Calving occurs primarily during the winter (Yochem and Leatherwood 1985) and blue whales move south from feeding areas to give birth. There are no known areas used by blue whales for reproduction or calving in the TMAA.

Diving Behavior

Blue whales spend more than 94 percent of their time below the water's surface (Lagerquist et al. 2000). Croll et al. (2001) determined that blue whales dived to an average of 462 ft (141 m) and for 7.8 minutes (min) when foraging and to 222 ft (68 m) and for 4.9 min when not foraging. Calambokidis et al. (2003) deployed tags on blue whales and collected data on dives as deep as about 984 ft (300 m).

Acoustics

In 1994 off the coast of California, blue whale vocalizations at 17 hertz (Hz) were estimated to have source levels in the range of 195 decibels (dB) referenced to 1 micropascals at a distance of 1 meter (dB re 1 µPa @ 1 m) (Aburto et al. 1997). Blue whale vocalizations are long, patterned low-frequency sounds with durations up to 36 seconds repeated every 1 to 2 min. Their frequency range is 12 to 400 Hz, with dominant energy in the infrasonic range at 12 to 25 Hz (see Table 3.8-3) (Ketten 1998, Mellinger and Clark 2003). Vocalizations of blue whales in Alaska appear be of two distinct types suggestive of separate populations consisting of western Pacific and northeastern Pacific types (Moore et al. 2006). While no data on hearing ability for this species are available, it is hypothesized that mysticetes have excellent low frequency hearing (Ketten 1997).

Impacts of Human Activity

Historic Whaling

Blue whales were occasionally hunted by the sailing-vessel whalers of the 19th century (Carretta et al. 2008). The introduction of steam power in the second half of that century made it possible for boats to overtake large, fast-swimming blue whales and other rorquals. From the turn of the century until the mid-1960s, blue whales from various stocks were intensely hunted in all the world's oceans (NMFS 1998b). Blue whales were protected in portions of the Southern Hemisphere beginning in 1939, but were not fully protected in the Antarctic until 1965. In 1966, they were given complete protection in the North Pacific under the International Convention for the Regulation of Whaling (Gambell 1979, Best 1993). Some illegal whaling by the Union of Soviet Socialist Republics have occurred in the north Pacific (Yablokov 1994); it is likely that blue whales were among the species taken by these operations, but the extent of the catches is not known. Since gaining complete legal protection from commercial whaling in 1966, some populations have shown signs of recovery, while others have not been adequately monitored to determine their status (NMFS 1998b). Removal of this threat has allowed increased recruitment in the population, and therefore, the blue whale population in the eastern north Pacific is expected to have grown.

The blue whale population was severely depleted by commercial whaling in the twentieth century (NMFS 1998b). In the North Pacific, pre-exploitation population size is speculated to be approximately

4,900 blue whales, and the current population estimate is a minimum of 3,300 blue whales (Wade and Gerrodette 1993, NMFS 2006c).

Fisheries Interactions

Because little evidence of entanglement in fishing gear exists and large whales such as the blue whale may often die later and drift further offshore, it is difficult to estimate the numbers of blue whales killed and injured by gear entanglements. The offshore drift gillnet fishery is the only fishery that is likely to take blue whales from this stock, but no fishery mortalities or serious injuries have been observed. In addition, the injury or mortality of large whales due to interactions or entanglements in fisheries may go unobserved because large whales swim away with a portion of the net or gear. Fishermen have reported that large whales tend to swim through their nets without entangling and causing little damage to nets. (Carretta et al. 2008)

Ship Strikes

There is no record of any ship strike involving a blue whale in Alaska waters (Jensen and Silber 2004). According to NMFS, the average number of blue whale mortalities in California attributed to ship strikes was 0.6 whales per year for 2002-2006 (Carretta et al. 2008). As recently as September 2007, commercial vessels were implicated in the deaths of three blue whales in the Santa Barbara Channel off southern California. Additional mortality from ship strikes probably goes unreported because the whales do not strand, or if they do, they do not always have obvious signs of trauma. However, several blue whales have been photographed in California with large gashes in their dorsum that appear to be from ship strikes. (Carretta et al. 2008)

3.8.3.2 Fin Whale

Stock

Northeast Pacific

Regulatory Status

Fin whales (*Balaenoptera physalus*) are listed as endangered under the ESA. The Northeast Pacific stock is designated as depleted and classified as strategic under the MMPA. A draft species recovery plan for fin whales has been prepared (NMFS 2006b).

Habitat Preferences & Critical Habitat

Fin whales are found in continental shelf, slope, and oceanic waters (Gregr and Trites 2001, Reeves et al. 2002). Globally, this species tends to be aggregated in locations where populations of prey are most plentiful, irrespective of water depth, although those locations may shift seasonally or annually (Payne et al. 1986, 1990; Kenney et al. 1997; Notarbartolo-di-Sciara et al. 2003). Littaye et al. (2004) determined that fin whale distribution in the Mediterranean Sea was linked to frontal areas and upwelling within large zooplankton patches. Fin whales in the north Pacific spend the summer feeding along the cold eastern boundary currents and appear to prefer krill and large copepods, but also eat schooling fish such as Pacific herring (*Clupea harengus pallasi*), walleye pollock (*Theragra chalcogramma*), and capelin (*Mallotus villosus*) (Nemoto and Kawamura 1977, Perry et al. 1999). Critical habitat has not been designated for fin whales.

Population Size and Trends

In the north Pacific, the total pre-exploitation population size of fin whales is estimated at 42,000 to 45,000 whales (Ohsumi and Wada 1974). From whaling records, fin whales that were marked in winter 1962 to 1970 off southern California were later taken in commercial whaling operations between central

California and the GOA in summer (Mizroch et al. 1984). In summer 2003, a cetacean survey in the Shelikof Strait (north of Kodiak), Cook Inlet, Prince William Sound and on the shelf between Kodiak and Montague Island detected 165 fin whales along the shelf break and having an average group size of 2.9 observed over 57 sightings (Waite 2003). The April 2009 GOALS survey in the TMAA had 24 visual observations of fin whale groups totaling 64 individuals during a 10-day period (Rone et al. 2009).

Currently there are no reliable estimates of current or historical abundance numbers for the Northeast Pacific fin whale stock. Fin whales have a worldwide distribution, with three distinct stocks recognized in the Pacific: (1) Alaska (Northeast Pacific), (2) California/Washington/ Oregon, and (3) Hawaii. Provisional estimates for the Northeastern Pacific based on surveys in 1999 and 2000 are 3,368 (CV = 0.18) for the central-eastern Bering Sea and 683 (CV = 0.32) for the eastern Bering Sea. (Angliss and Allen 2009)

The population trend for this species estimated for 1987 to 2003 is reported as growing at 4.8 percent annually, which is consistent with the estimated growth rates of other large whales (Angliss and Allen 2009). For purposes of acoustic impact modeling, a density of 0.010 individuals per km^2 was used for fin whales in the TMAA as provided by Rone et al. (2009) and described in detail in Appendix E.

Distribution

Fin whales are broadly distributed throughout the world's oceans, usually in temperate to polar latitudes and less commonly in the tropics (Reeves et al. 2002). Single fin whales are most common, but they gather in groups, especially when good sources of prey are aggregated.

Fin whales in the North Pacific spend the summer feeding along the cold eastern boundary currents and have been observed as far north as the Chukchi and Bering Seas (Gambell 1985, Perry et al. 1999, DoN 2006, Angliss and Allen 2009). However, although fewer in number, fin whales have also been sighted in the Bering Sea all winter (Mizroch et al. 1999). Acoustic signals from fin whales are detected year-round in the GOA with most calls from August through February (Moore et al. 2006, Mizroch et al. 2009). Around Kodiak Island (in the vicinity of the TMAA) fin whales have been observed year-round with most sightings from April to September (DoN 2006).

Life History

Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggest annual natural mortality rates may range from 0.04 to 0.06 (based on studies of northeast Atlantic fin whales). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in fin whales and may be preventing some fin whale stocks from recovering from whaling (Lambertsen 1992). Killer whale or shark attacks may result in serious injury or death in very young and sick whales (Perry et al. 1999).

Reproduction/Breeding

Fin whales become sexually mature between 6 to 10 years of age, depending on density-dependent factors (Gambell 1985). Reproductive activities for fin whales occur primarily in the winter. Gestation lasts about 12 months and nursing occurs for 6 to 11 months (Perry et al. 1999). Although fin whales are present in GOA in the winter, there are no known calving areas in GOA (Mizroch et al. 2009) Peak calving is in October through January (Hain et al. 1992) and fin whales likely move south from feeding areas to give birth. There are no known areas used by fin whales for reproduction or calving in the TMAA.

Diving Behavior

Details of diving behavior and the derivation of parameters used in the acoustic modeling are presented in Appendix D. Kopelman and Sadove (1995) found significant differences in blow intervals, dive times, and blows per hour between surface feeding and nonsurface-feeding fin whales. Various researchers have reported foraging fin whales have dive durations of approximately 4 to 15 min and to depths between approximately 200 and 500 ft (61 and 152 m) (DoN 2006). Dives are followed by sequences of four to five blows at 10- to 20-second (sec) intervals (Cetacean and Turtle Assessment Program [CETAP] 1982, Stone et al. 1992, Lafortuna et al. 2003).

Acoustics

Fin whales produce calls with the lowest frequency and highest source levels of all mysticetes. Fin whales produce a variety of sounds with a frequency range from 15 to 750 Hz (see Table 3.8-3). The long-patterned 15- to 30-Hz vocal sequence 1 second in duration with a source level of 184 to 200 dB re 1 Pa @ 1 m is most typically recorded (Richardson et al. 1995, Charif et al. 2002). Only males are known to produce infrasonic pulses, suggesting they may function as a male breeding display (Croll et al. 2002, Moore et al. 2006). Although data on hearing ability for fin whales are unavailable, it is hypothesized that based on their anatomy and vocalizations, fin whales have acute infrasonic hearing (Ketten, 1997).

Impacts of Human Activity

Historic Whaling

Between 1947 and 1987, approximately 46,000 fin whales were taken from the North Pacific by commercial whalers. In addition, approximately 3,800 were taken off the west coast of North America between 1919 and 1929. In 1976 Fin whales in the North Pacific were given protected status by the IWC. (Carretta et al. 2008)

Fisheries Interactions

The incidental take of fin whales in fisheries is extremely rare. In the California/Oregon drift gillnet fishery, observers recorded the entanglement and mortality of one fin whale, in 1999, off southern California (NMFS 2000). Based on a worst-case scenario, NMFS estimates that a maximum of six fin whales (based on calculations that adjusted the fin whale observed entangled and killed in 1999 by the number of sets per year) could be captured and killed in a given year by the California-Oregon drift gillnet fleet (NMFS 2000). Anecdotal observations from fishermen suggest that large whales swim through their nets rather than get caught in them (NMFS 2000). Because of their size and strength, fin whales probably swim through fishing nets, which might explain why these whales are rarely reported as having become entangled in fishing gear. NMFS has no records of fin whales being killed or injured by commercial fisheries operating in the North Pacific (Ferrero et al. 2000).

Vessel Collisions

Worldwide historical records indicate fin whales were the most likely species to be struck by vessels (Laist et al. 2001). For Alaska waters, the available whale-vessel collision data has been presented in an unpublished preliminary summary of opportunistically collected reports involving 62 whale-vessel collisions between 1978 and 2006 (Gabriele et al. 2006). Recognizing that this report is likely biased toward near shore reports and inland waters of Southeast Alaska where the authors were located and where nearshore vessels and a population of humpback whales overlap, there have been no recorded vessel collisions with fin whales in Alaska waters.

3.8.3.3 Humpback Whale

Stock

Central and Western North Pacific

Regulatory Status

Humpback whales are listed as endangered under the ESA. They are designated as depleted throughout their range under the MMPA and the Western North Pacific stock is classified as strategic. A final species recovery plan has been prepared (NMFS 1991).

In addition to being listing as endangered, there are regulations that have been issued governing the approach to humpback whales in Alaska waters, "within 200 miles of the coast" (NOAA 2001b). These regulations were issued to manage the threat caused by whale watching activities by: (1) prohibiting approach to within 100 yards (yd) (91.4 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).

Habitat Preferences & Critical Habitat

Although humpback whales typically travel over deep, oceanic waters during migration, their feeding and breeding habitats are mostly in shallow, coastal waters over continental shelves (Clapham and Mead 1999). Shallow banks or ledges with high sea-floor relief characterize feeding grounds (Payne et al. 1990, Hamazaki 2002). The habitat requirements of wintering humpbacks appear to be determined by the conditions necessary for calving and breeding consisting mainly of relatively shallow or protected areas around and between islands, over banks, and along continental coasts. Critical habitat has not been designated for humpback whales in the North Pacific.

Population Size and Trends

Three Pacific stocks of humpback whales are recognized in the Pacific Ocean and include the Western North Pacific stock, Central North Pacific stock, and ENP stock (Calambokidis et al. 1997, Baker et al. 1998). In the entire North Pacific Ocean basin prior to 1905, it is estimated that there were 15,000 humpback whales basin-wide (Rice 1978). Whaling in the North Pacific continued until 1976 by the Japanese and Soviet pelagic whaling fleets. After the end of commercial whaling, approximate humpback numbers were estimated to be between 1,200 to 1,400 whales (Calambokidis et al. 2008), although it is unclear if estimates were for the entire north Pacific or just the eastern north Pacific. The population of humpbacks in the Pacific is increasing and has undergone substantial recovery since the end of whaling. The Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific (SPLASH) study suggested the current (2008) best estimate for the overall abundance in the North Pacific is 18,302 (Calambokidis et al., 2008).

It has been recently estimated there are 3,000 to 5,000 humpback whales in the GOA area (Calambokidis et al. 2008). The best abundance estimate for the Central North Pacific Stock, is 4,005 (CV = 0.095) individuals (Angliss and Allen 2009). In summer 2003, a survey in the Shelikof Strait (north of Kodiak), Cook Inlet, Prince William Sound and between Kodiak and Montague Island detected 128 humpbacks whales along the shelf break and having an average group size of 2.7 (Waite 2003). An April 2009 survey in the TMAA had 11 visual observations of humpback groups totaling 20 individuals during a 10-day period (Rone et al. 2009). Density for the entire TMAA was 0.0019/km^2 (Table 9, Rone et al. 2009) for the April-December timeframe (Table 3.8-2) as described in detail in Appendix E. As the humpback whales tend to prefer shallow water and are concentrated nearshore over the shelf, this is likely an overestimate for humpback density in the TMAA.

Distribution

Humpback whales live in all major ocean basins from equatorial to subpolar latitudes, migrating from tropical breeding areas to polar or subpolar feeding areas (Jefferson et al. 1993, NMFS 2006c). North Pacific humpback whales are distributed primarily in four more-or-less distinct wintering areas: the

Ryukyu and Ogasawara (Bonin) Islands (south of Japan), the Hawaiian Islands, the Revillagigedo Islands off Mexico, and along the coast of mainland Mexico (Calambokidis et al. 2008). There is known to be some interchange of whales among different wintering grounds, and matches between Hawaii and Japan and Hawaii and Mexico have been found (Calambokidis et al. 2008). However, it appears that the overlap is relatively small between the western north Pacific humpback whale population and Central North Pacific and ENP populations (Calambokidis et al. 2008).

Humpbacks in the Pacific are generally found during the summer on high-latitude feeding grounds in a nearly continuous band from southern California to the Aleutian Islands, Kamchatka Peninsula, and the Bering and Chukchi seas (Calambokidis et al. 2001). The U.S./Canada border is an approximate geographic boundary between the California and Alaska feeding groups (Carretta et al. 2006). There is much interchange of whales among different feeding grounds, although some site fidelity occurs.

During the winter, humpbacks generally migrate to the tropics and subtropics where they can be found around islands, over shallow banks, and along continental coasts, where calving and breeding occur. Humpbacks have one of the longest migrations known for any mammal with individuals traveling nearly 4,320 nm (8,000 km) between feeding and breeding areas (Clapham and Mead 1999). 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 (Clapham and Mattila 1990, Calambokidis et al. 2001). Migratory transits between the Hawaiian Islands and southeastern Alaska have been documented to take as little as 36 to 39 days (Gabriele et al. 1996, Calambokidis et al. 2001).

In the GOA, peak abundance occurs in late November and early December and slowly declines in January as humpback whales migrate to southerly breeding grounds (Consiglieri et al. 1982, Straley 1990, DoN 2006). Humpback whales that have migrated south begin to return to Alaskan feeding grounds in April (Consiglieri et al. 1982).

Identifications made between feeding areas and wintering areas indicate that the majority of humpbacks in the GOA winter in Hawaii (about 57 percent of the population) with the remainder wintering in Mexican waters around the Revillagigedo Islands, Baja, and the Mexican mainland (Calambokidis et al. 2008). Whales from Southeast Alaskan waters almost exclusively go to Hawaii. However, approximately 15 to 17 percent of the whales identified in the Western GOA could not be matched to known wintering areas, suggesting the existence of undocumented humpback wintering area(s) (Calambokidis et al. 2008). As noted previously, a small number of humpbacks humpback whales occur in the GOA year-round (DoN 2006).

Life History

Humpbacks primarily feed on small schooling fish and krill (Angliss and Allen 2009). The whales primarily feed along the shelf break and continental slope (Green et al. 1992, Tynan et al. 2005).

Reproduction/Breeding

Humpback whales migrate to calving/breeding grounds (e.g. Hawaii and Central America) in the lower latitudes each winter (Calambokidis et al. 2008). There are no known areas used by humpback whales for reproduction or calving in the TMAA.

Diving Behavior

Details of diving behavior and the derivation of parameters used in the acoustic modeling are presented in Appendix D. Humpback whale diving behavior depends on the time of year (Clapham and Mead 1999). In summer, most dives last less than 5 min; those exceeding 10 min are atypical. Although humpback whales have been recorded to dive as deep as about 1,638 ft (500 m) (Dietz et al. 2002), on the feeding grounds they spend the majority of their time in the upper 400 ft (120 m) of the water column (Dolphin 1987, Dietz et al. 2002). In winter, dives average 10 to 15 min; dives of greater than 30 min have been recorded (Clapham and Mead 1999) and with recorded dives to 577 ft (176 m) (Baird et al. 2000).

Acoustics

Humpback whales produce three classes of vocalizations: (1) “songs” in the late fall, winter, and spring by solitary males primarily on wintering grounds and much less frequently on northern feeding grounds; (2) sounds made within groups on the wintering (calving) grounds; and (3) social sounds made on the feeding grounds (Thomson and Richardson 1995). The best-known types of sounds produced by humpback whales are songs, which are thought to be breeding displays used only by adult males (Helweg et al. 1992). Singing is most common on breeding grounds during the winter and spring, but is occasionally heard on feeding grounds outside breeding areas and season (Matilla et al. 1987, Clark and Clapham 2004). There is geographical variation in humpback whale song, with different populations singing different songs, and all members of a population using the same basic song. The song evolves over the course of a breeding season, but remains nearly unchanged from the end of one season to the start of the next (Payne et al. 1983). Social calls are from 50 Hz to over 10 kilohertz (kHz), with the highest energy below 3 kHz (Silber, 1986).

Female humpback whale vocalizations appear to be simple: Simão and Moreira (2005) noted little complexity. The male song, however, is complex and changes between seasons. Components of the song range from under 20 Hz to 4 kHz and occasionally 8 kHz, at source levels of 144 to 174 dB re 1 µPa @ 1 m, with a mean of 155 dB re 1 µPa @ 1 m. The main energy lies between 0.2 and 3.0 kHz, with frequency peaks at 4.7 kHz (Table 3.8-3). Au et al. (2001) reported source levels (between 171 and 189 dB re 1 µPa @ 1 m) of humpback whale songs.

No tests of humpback whale hearing have been made. Houser et al. (2001) constructed a humpback audiogram using a mathematical model based on the internal structure of the ear. The predicted audiogram indicates sensitivity to frequencies from 700 Hz to 10 kHz, with maximum relative sensitivity between 2 kHz and 6 kHz. Au et al. (2006) took recordings of whales off Hawaii and found high-frequency harmonics of songs extending beyond 24 kHz, which may indicate that they can hear at least as high as this frequency. A single study suggested that humpback whales responded to mid-frequency active (MFA) sonar (3.1 to 3.6 kHz) sound (Maybaum 1989). The hand-held sonar system had a sound artifact below 1,000 Hz which caused a response to the control playback (a blank tape) and may have affected the response to sonar (i.e., the humpback whale responded to the low-frequency artifact rather than the MFA sonar sound).

Impacts of Human Activity

Historic Whaling

Commercial whaling, the single most significant population impact on humpback whales, ceased operation in the Pacific Ocean in 1966. Intensive commercial whaling removed more than 28,000 animals from the North Pacific during the 20th century. From 1961 to 1971, an additional 6,793 humpback whales were killed illegally by the former Soviet Union. Many animals during this time were taken from the GOA and Bering Sea; however, catches occurred across the North Pacific, from the Kuril Islands to the Queen Charlottes, and additional illegal catches in earlier years may have gone unrecorded (Angliss and Allen 2009).

Fisheries Interactions

Entanglement in fishing gear poses a threat to individual humpback whales throughout the Pacific. A number of fisheries based out of West Coast ports may incidentally take the ENP stock of humpback whales, and documented interactions are summarized in the U.S. Pacific Marine Mammal Stock Assessments: 2006 (Carretta et al. 2007). The estimated impact of fisheries on the ENP humpback whale stock is probably underestimated; the serious injury or mortality of large whales from entanglement in gear may go unobserved because whales swim away with a portion of the net, line, buoys, or pots. In 1996 and again in 2001, gear traced to fishing activities in Alaska were removed from two entangled humpback whales in Hawaii. According to the NMFS Pacific Islands Region Marine Mammal Response Network Activity Update (dated July 2007 [NMFS 2007b]), there were reports of 26 distressed marine mammals in Hawaii found entangled in fishing gear for the 6-month period, November to April 2007.

NMFS estimates that between 2002 and 2006, there were incidental serious injuries to 0.2 humpback annually in the Bering Sea/Aleutian Islands sablefish longline fishery. This estimation is not considered reliable. Observers have not been assigned to a number of fisheries known to interact with the Central and Western North Pacific stocks of humpback whale. In addition, the Canadian observation program is also limited and uncertain. (Angliss and Allen 2009)

Ship Strikes

Humpback whales, especially calves and juveniles, are highly vulnerable to ship strikes and other interactions with nonfishing vessels. Younger whales spend more time at the surface, are less visible, and are found closer to shore (Herman et al. 1980, Mobley et al. 1999), thereby making them more susceptible to collisions. Nine ship strikes were implicated in mortality or serious injuries of humpback whales between 2001 and 2005. Seven of these ship strikes occurred in Southeast Alaska and two occurred in the northern portion of the Central North Pacific’s range (Angliss and Allen 2009). Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not have obvious signs of trauma.

Whale-watching tours are becoming increasingly popular, and ship strikes have risen in recent years. Regulations governing the approach to humpback whales in Alaska were promulgated in 2001 to manage the threat caused by whale watching activities (NOAA 2001b). Two whale watch vessel strikes in Alaska waters have also involved humpback whales (Jensen and Siber, 2004). Available whale-vessel collision data presented in an unpublished preliminary summary indicates that most of the 62 recorded collisions between vessels and whales in Alaska waters involve humpback whales (Gabriele et al. 2006).

As noted previously, many of the humpbacks feeding in GOA winter in Hawaii. In the Hawaiian Islands, ship strikes of the humpback whale are of particular concern. According to the NMFS Pacific Islands Region Marine Mammal Response Network Activity Update (dated January 2007 [NMFS 2007]), there were nine reported collisions with humpback whales in 2006 (none involved the Navy).

Whale Watching Disturbance

Whale-watching boats and scientific research vessels specifically direct their activities toward whales, and may have direct or indirect impacts on humpback whales. The growth of the whale-watching industry has not increased as rapidly for the ENP stock of humpback whales as it has for the Central North Pacific stock (wintering grounds in Hawaii and summering grounds in Alaska), but whale-watching activities do occur throughout the ENP stock’s range. There is concern regarding the impacts of close vessel approaches to large whales because harassment may occur, preferred habitats may be abandoned, and fitness and survivability may be compromised if disturbance levels are too high. While a 1996 study in Hawaii measured the acoustic noise of different whale-watching boats (Au and Green 2000) and determined that the sound levels were unlikely to produce grave effects on the humpback whale auditory system, the potential direct and indirect effects of harassment due to vessels cannot be discounted. Several investigators have suggested that shipping noise may have caused humpback whales to avoid or leave feeding or nursery areas (Jurasz and Jurasz 1979, Dean et al. 1985), while others have suggested that humpback whales may become habituated to vessel traffic and its associated noise. Still other researchers suggest that humpback whales may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle et al. 1993, Wiley et al. 1995).

Other Threats

Humpback whales are potentially affected by a resumption of commercial whaling, loss of habitat, loss of prey (for a variety of reasons including climate variability), underwater noise, and pollutants. Very little is known about the effects of organochlorine pesticides, heavy metals, polychlorinated biphenyls, and other toxins on baleen whales, although the impacts may be less than higher trophic level odontocetes due to baleen whales' lower levels of bioaccumulation from prey (Angliss and Allen 2009).

Anthropogenic noise may also affect humpback whales, because humpback whales seem to respond to moving sound sources, such as whale-watching, fishing, and recreational vessels and low-flying aircraft (Richardson et al. 1995). Their responses to noise are variable and affected by the context of the exposure and the animal's experience, motivation, and conditioning (Wartzok et al. 2003, Southall et al. 2007).

3.8.3.4 North Pacific Right Whale

Stock

Eastern North Pacific

Regulatory Status

North Pacific right whales (*Eubalaena japonica*) are classified as endangered under the ESA and are considered one of the world's most endangered large whale species. The right whale is designated as depleted and the ENP stock is classified as strategic under the MMPA. (DoN 2006)

Habitat Preferences & Critical Habitat

Feeding habitat for right whales is defined by the presence of sufficiently high densities of prey, especially zooplankton (calanoid copepods). Development of those patches is essentially a function of oceanic conditions, such as stratification, bottom topography, and currents which concentrate zooplankton, and concentration is probably enhanced by the behavior of the organisms themselves. The apparent shift in Bering Sea right whale occurrences from deep waters in the mid-twentieth century to the mid-shelf region in the late 1900s was attributed to changes in the availability of optimal zooplankton patches, possibly relating to climatic forcing (variability in oceanic conditions caused by changes in atmospheric patterns). Sightings in the Bering Sea have been clustered in relatively shallow water (waters with a bottom depth of 164 to 262 ft (50 to 80 m). Information from a tagged individual documented movement between the middle and outer portions of the continental shelf in the Bering Sea, which is consistent with historical distribution patterns. Additionally, sightings of some other right whale individuals during the 2004 survey were made on the outer continental shelf (DoN 2006).

North Pacific right whales in locations other than Alaska waters have been sighted in even deeper depths, as evidenced by a sighting off California with a bottom depth as deep as 5,577 ft (1,700 m). The International Whaling Commission (IWC) noted a surprising absence of evidence for coastal calving grounds, since right whales in the North Atlantic and in the Southern Hemisphere have calving grounds located in shallow bays, lagoons, or in waters over the continental shelf (DoN 2006).

Sightings of North Pacific right whales in 1996 during an Alaska Fisheries Science Center groundfish assessment cruise led to intense photoidentification and vessel surveys from 1998 to 2004 in the south-eastern Bering Sea. According to Moore et al. (2006), the sighting locations indicated that right whales preferred the relatively shallow waters of the southeastern Bering Sea middle shelf, which are approximately 230 ft (70 m) in depth. Also determined during these surveys was that right whale calls occurred from May through November, with the greatest number of calls recorded in September and October (Moore et al. 2006).

In July 1998, a lone North Pacific right whale was sighted among humpback whales during an aerial survey southeast of Kodiak Island. Acoustic surveys of this area produced very few North Pacific right whale calls; however, unambiguous right whale calls were detected in August and early September in western GOA. In addition calls were recorded from locations where right whales were formerly abundant but have not been seen in recent decades (Moore et al. 2006).

In August 2004, a NMFS researcher observed a single right whale among a group of humpbacks. In August 2005, a NMFS researcher reported yet another sighting of a right whale within 820 to 1,640 ft (250 to 500 m) of groups of humpback and fin whales. (Angliss and Allen 2009) There were no right whales detected acoustically or visually during the April 2009 survey of the TMAA (Rone et al. 2009).

In May 2008, NMFS issued a final rule designating two areas as North Pacific right whale critical habitat, one in the GOA and one in the Bering Sea. The location of the critical habitat for North Pacific right whales in the GOA is shown on Figure 3.8-1. This area is located beyond approximately 16 nm (30 km) west of the southwest corner of the TMAA. The final rule for this critical habitat designation cites consistent sightings of right whales—both single individuals and pairs—in specific areas in spring and summer over an extended period as an indicator of primary constituent element (dense concentrations of prey) in a feeding area. While sightings of right whales are fewer in number in the GOA than in the Bering Sea, just prior to the final rule three individuals were sighted in the critical habitat area in the GOA (Angliss and Allen 2009).

Population Size and Trends

There are no reliable estimates of current abundance or trends for right whales in the North Pacific, and the population may only number at least in the low hundreds (Angliss and Allen 2009). There are not sufficient numbers of individuals of this species present in the TMAA to allow for acoustic impact modeling, given they are rare. The population in the eastern north Pacific is considered to be very small, perhaps only in the tens of animals. Over the past 40 years, most sightings in the eastern north Pacific have been of single whales. However, during the last few years, small groups of right whales have been sighted (such as the group of 17 documented in 2004; Angliss and Allen 2009). An analysis of both photoidentification and biopsy efforts in 2004 in the Bering Sea revealed 17 individuals. However, of 13 individual animals photographed during aerial surveys in 1998, 1999, and 2000, 2 have already been rephotographed. This photographic recapture rate is consistent with a very small population size (Angliss and Outlaw 2006). Observers in 2002 and 2004 reported one confirmed calf sighting and two probable calves (Angliss and Allen 2009). Recently, photographic and genotype data were used to estimate right whale abundance in the Bering Sea and Aleutian Islands using the two data sets (Wade et al. 2010). The estimates were very similar with photoidentification indicating 31 individuals[1] and biopsy genotyping indicating 28 individuals[2] (Wade et al. 2010). Researchers also estimated the population contains eight females[3] and 20 males[4]. Although these estimates may relate to a Bering Sea subpopulation, they are consistent with previous findings suggesting that the total eastern North Pacific population is unlikely to be much larger.

1 Common Language effect size (CL) statistic at 95%, CL 23–54. For purposes of this discussion, CL measures the difference between the numbers provided by the two data sets in terms of the probability that a number sampled at random from the first dataset will be greater than a number sampled at random from the second.

2 95% CL 24–42
3 95% CL 7–18
4 95% CL 17–37

Distribution

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 (DoN 2006). However, Right whale calls have been detected as early as May and as late as November in southeast Bering Sea region (Munger et al. 2008).

Current distribution patterns and migration routes of North Pacific right whales are not known. Historical whaling records provide virtually the only information on North Pacific right whale distribution. North Pacific right whales historically occurred across the Pacific Ocean north of 35°N, with concentrations in the GOA south of Kodiak Island, the eastern Aleutian Islands, south-central Bering Sea, Okhotsk Sea, and the Sea of Japan. Presently, sightings are extremely rare, occurring primarily in the Okhotsk Sea and the eastern Bering Sea in roughly the same location. There is evidence that the GOA was used as a feeding ground, and recent surveys suggest that some individuals continue to use the shelf east of Kodiak as a feeding area, which has now been designated as critical habitat. It is not known whether there is an interchange between the Bering Sea and GOA areas; for example, an individual right whale that was photographed off Kodiak Island did not match to any photographs of individuals seen in the Bering Sea (DoN 2006, Moore et al. 2006).

The area of densest concentration of North Pacific right whales in the GOA is roughly east from 170°W to 150°W and south to 52°N. (DoN 2006). In GOA off Kodiak Island, sightings of a single lone right whale have occurred in 1998, 2004, 2005, and 2006 (Angliss and Allen 2009). Many of the recent sightings of right whales in GOA are individuals seen in association with humpback whales.

There have since been 10 acoustic detections of probable right whale calls off the continental shelf near Kodiak Island (Moore et al. 2006).

The highly endangered status of North Pacific right whales necessitates an extremely conservative determination of this species' occurrence in the GOA. Right whales will be rare in the TMAA due to the small number in population. There is sparse survey effort during the winter, and this species is believed to be largely absent in Alaska waters during December through April. It is assumed right whales would be on their breeding grounds, which are likely located further south, although the location of the breeding grounds is unknown (DoN 2006).

Life History

Feeding habitat for right whales is defined by the presence of sufficiently high densities of prey, especially calanoid copepods. Development of those patches is essentially a function of oceanic conditions, such as stratification, bottom topography, and currents which concentrate zooplankton, and concentration is probably enhanced by the behavior of the organisms themselves. The apparent shift in Bering Sea right whale occurrences from deep waters in the mid-twentieth century to the mid-shelf region in the late 1900s was attributed to changes in the availability of optimal zooplankton patches, possibly relating to climatic forcing (variability in oceanic conditions caused by changes in atmospheric patterns).

Sightings in the Bering Sea are clustered in relatively shallow water (waters with a bottom depth of 50 m to 80 m [164 to 262 ft]). Recently, however, a tagged individual moved between the middle and outer portions of the continental shelf in the Bering Sea, which is consistent with historical distribution patterns.

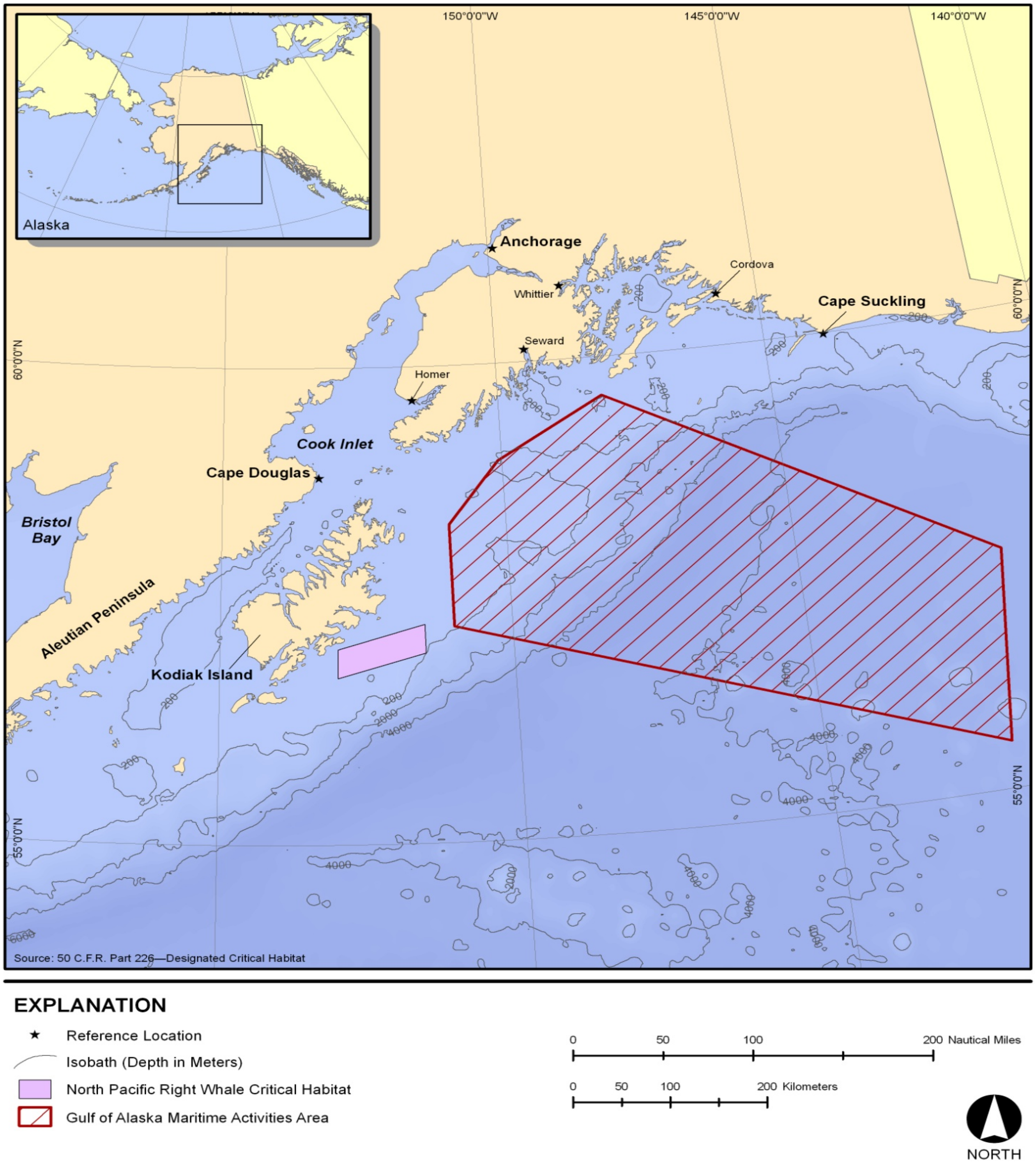


Figure 3.8-1: Right Whale Critical Habitat in the Vicinity of the TMAA

Additionally, sightings of some other right whale individuals during the 2004 survey were made on the outer continental shelf. In other locations, North Pacific right whales have been sighted in even deeper waters, as evidenced by a sighting off California in waters with a bottom depth as deep as 1,700 m (5,577 ft). The IWC noted a surprising absence of evidence for coastal calving grounds, since right whales in the

North Atlantic and in the Southern Hemisphere have calving grounds located in shallow bays, lagoons, or in waters over the continental shelf (DoN 2006).

Reproduction/Breeding

The location of calving grounds for the eastern North Pacific population is unknown. There were no records in the last 100 years of newborn or very young calves in the eastern North pacific until 2004 when the presence of at least two calves was documented in the eastern Bering Sea (DoN 2006). There are no known areas used by right whales for reproduction or calving in the TMAA.

Diving Behavior

There is almost nothing known of North Pacific right whale diving abilities. Dives of 5 to 15 min or even longer have been reported for North Atlantic right whales. Observations of North Atlantic right whales found that the average depth dive was strongly correlated with both the average depth of peak copepod abundance and the average depth of the bottom mixed layer's upper surface. North Atlantic right whale feeding dives are characterized by a rapid descent from the surface to a particular depth between 262 and 574 ft (80 and 175 m), remarkable fidelity to that depth for 5 to 14 min, and then rapid ascent back to the surface. Longer surface intervals have been observed for reproductively active females and their calves (DoN 2006).

Acoustics

North Pacific right whale calls are classified into five categories: (1) up, (2) down-up, (3) down, (4) constant, and (5) unclassified. The "up" call is the predominant type and is typically a signal sweeping from about 90 to 150 Hz in 0.7 sec. Right whales commonly produce calls in a series of 10 to 15 calls lasting 5 to 10 min, followed by silence lasting an hour or more. Some individuals do not call for periods of at least 4 hours. Morphometric analyses of the inner ear of right whales resulted in an estimated hearing frequency range of approximately 0.01 to 22 kHz, based on established marine mammal models (see Table 3.8-3).

Nowacek et al. (2004, 2007) documented observations of the behavioral response of North Atlantic right whales exposed to alert stimuli (containing mid-frequency components) in an experiment to help develop a potential ship strike avoidance tool. To assess risk factors involved use of the tool, a multisensor acoustic tag was used to measure the responses of whales to passing ships and experimentally tested their responses to the controlled exposures to various alert stimuli sounds, which included recordings of ship noise, the social sounds of conspecifics, and a signal designed to alert the whales. The alert signal was 18 min of exposure consisting of three 2-min signals played sequentially three times over. The three signals had a 60-percent duty cycle and consisted of (1) alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz) to high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. The purposes of the alert signal were (1) to provoke an action from the whales via the auditory system with disharmonic signals that cover the whales' estimated hearing range, (2) to maximize the signal to noise ratio (obtain the largest difference between background noise), and (3) to provide localization cues for the whale.

At maximum received levels ranging from 133 to 148 dB re 1µPa/√Hz, five out of six whales reacted to the signal designed to elicit a behavioral reaction. The reaction documented, however, was that the whales ceased feeding and came to the surface, which is not a desired effect given the purpose for the exposure was meant as an alert signal to prevent whale/ship interactions.

Impacts of Human Activity

Historic Whaling

Since right whales are considered large, slow-swimming whales and have a thick layer of blubber which results in their floating when killed, they were an easy and profitable species for early (pre-modern) whalers. It has been estimated that between 26,500 and 37,000 right whales were killed during the period from 1839 to 1909. From 1900 to 1999, a total of 742 North Pacific right whales were killed by whaling; of those, 331 were killed in the western North Pacific and 411 in the eastern north Pacific. This includes 372 whales killed illegally by the former U.S.S.R. in the period from 1963 to 1967, primarily in the GOA and Bering Sea (Angliss and Allen 2009).

Fisheries Interactions

Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989. No other incidental takes of right whales are known to have occurred in the North Pacific. Based on the available records, the estimated annual mortality rate incidental to U.S. commercial fisheries approaches zero whales per year from this stock. Therefore, the annual human-caused mortality level is considered to be insignificant and approaching a zero mortality and serious injury rate (Angliss and Outlaw 2006).

Ship Strikes

In the North Pacific, ship strikes and entanglements may pose a threat to right whales but information is lacking. Using what is known for the North Atlantic right whale, the species seems generally unresponsive to vessel sounds and given they are slow moving, they are susceptible to vessel collisions (Nowacek et al. 2004). In contrast to conditions for the North Atlantic right whale, however, ship strikes and entanglement impacts to the North Pacific right whale population may pose less of a threat because of their rare occurrence and scattered distribution in the GOA (NMFS 2007b). Thus, the estimated annual rate of human-caused mortality and serious injury appears minimal (Angliss and Outlaw 2006).

3.8.3.5 Sei Whale

Stock

Eastern North Pacific

Regulatory Status

Sei whales (*Balaenoptera borealis*) are listed as endangered under the ESA. A species recovery plan has not been prepared. The ENP stock is considered a “depleted” and “strategic” stock under the MMPA.

Habitat Preferences & Critical Habitat

Sei whales are most often found in deep, oceanic waters of the cool temperate zone. They appear to prefer regions of steep bathymetric relief, such as the continental shelf break, canyons, or basins situated between banks and ledges. These areas are often the location of persistent hydrographic features, which may be important factors in concentrating zooplankton, especially copepods. On the feeding grounds, the distribution is largely associated with oceanic frontal systems. In the north Pacific, sei whales are found feeding particularly along the cold eastern currents. Characteristics of preferred breeding grounds are unknown. In the north Pacific, sei whales particularly feed along the cold eastern currents. In the north Pacific, prey includes calanoid copepods, krill, fish, and squid. (DoN 2006). Critical habitat has not been designated for the ENP stock of sei whales.

Population Size and Trends

The IWC groups all sei whales in the North Pacific Ocean into one stock (Donovan 1991). Mark-recapture, catch distribution, and morphological research, however, indicated that more than one stock exists: one between 175°W and 155°W longitude, and another to the east of 155°W longitude (Masaki 1976, 1977). In the U.S. Pacific Exclusive Economic Zone (EEZ), only the ENP Stock is recognized. Worldwide, sei whales were severely depleted by commercial whaling activities. In the north Pacific, the pre-exploitation population estimate for sei whales is 42,000 whales, and the most current population estimate for sei whales in the entire north Pacific (from 1977) is 9,110 (NMFS 2006c).

Application of various models to whaling catch and effort data suggests that the total population of adult sei whales in the north Pacific declined from about 42,000 to 8,600 between 1963 and 1974 (Tillman 1977). Since 500 to 600 sei whales per year were killed off Japan from 1910 to the late 1950s, the stock size presumably was already, by 1963, below its carrying capacity level (Tillman 1977). Currently, the best estimate for the ENP stock is 43 (CV = 0.61) individuals (Carretta et al. 2007). There are not sufficient numbers of individuals of this species present in the TMAA to allow for acoustic impact modeling, given they are few in number.

Distribution

Sei whales have a worldwide distribution and are currently found primarily in cold temperate north Pacific (north of 40°N) to subpolar latitudes (as far south as 20°N), rather than in the tropics or near the poles. Sei whales range as far south as Baja California, Mexico, Hawaii, and Guam in the Northern Marianas Islands. Whaling data suggest that the northern limit for this species was about 55°N. Sei whales are usually observed singly or in small groups of 2 to 5 animals, but are occasionally found in larger (30 to 50) loose aggregations (DoN 2006).

Sei whales are also known for occasional irruptive occurrences in areas followed by disappearances for sometimes decades. Currently in the Alaskan waters, sei whales are thought to occur mainly south of the Aleutian Islands. 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 GOA during May through August (DoN 2006). There were no sei whales detected during the April 2009 survey of the TMAA (although there were sightings of 38 unidentified large whales; Rone et al. 2009).

Life History

In the North Pacific, sei whales particularly feed along the cold eastern currents (Perry et al. 1999). In the North Pacific, prey includes calanoid copepods, krill, fish, and squid (Nemoto and Kawamura 1977). The dominant food for sei whales off California during June through August is the northern anchovy, while in September and October they eat mainly krill (Rice 1977). The location of winter breeding areas and characteristics of preferred breeding grounds are unknown (Rice 1998, Perry et al. 1999).

Reproduction/Breeding

No breeding areas have been determined but calving is thought to occur from September to March (Rice 1977) and sei whales likely move south for breeding/calving. Their reproductive cycle is about 2 years (Gambell 1985). There are no known areas used by sei whales for reproduction or calving in the TMAA.

Diving Behavior

There are no reported diving depths or durations for sei whales. Sei whales are capable of diving 5 to 20 min to opportunistically feed on plankton (e.g., copepods and krill), small schooling fish, and cephalopods (e.g., squid) by both gulping and skimming (DoN 2006).

Acoustics

Sei whale vocalizations have been recorded on a few occasions. In the North Atlantic off Canada, recorded sounds from sei whales consisted of 10 to 20 short duration frequency-modulated sweeps between 1.5 and 3.5 kHz; source level unknown (Richardson et al. 1995). Sei whales were also recorded in the Antarctic having produced broadband "growls" and "whooshes" at an average frequency of 433 Hz (see Table 3.8-3) and source level of approximately 156 dB re 1 µPa @ 1 m (McDonald et al. 2005). While no data on hearing ability for this species are available, it has been hypothesized that mysticetes have acute infrasonic hearing (DoN 2006).

Impact of Human Activity

Historic Whaling

Several hundred sei whales in the North Pacific were taken each year by whalers based at shore stations in Japan and Korea between 1910 and the start of World War II (Committee for Whaling Statistics 1942). Small numbers were taken sporadically at shore stations in British Columbia from the early 1900s until the 1950s, when their importance began to increase (Pike and MacAskie 1969). More than 2,000 were killed in British Columbia waters between 1962 and 1967, when the last whaling station in western Canada closed (Pike and MacAskie 1969). Small numbers were taken by shore whalers in Washington (Scheffer and Slipp 1948) and California (Clapham et al. 1997) in the early 20th century, and California shore whalers took 386 from 1957 to 1971 (Rice 1977). Perry et al. (1999) reports that from 1910 to 1975, approximately 74,215 sei whales were caught in the entire North Pacific Ocean. Tillman (1977) reported that heavy exploitation by pelagic whalers began in the early 1960s, with total catches throughout the North Pacific averaging 3,643 per year from 1963 to 1974 (total 43,719; annual range 1,280-6,053), while Barlow et al. (1997) reported the capture of sei whales in the North Pacific was 61,500 between 1947 and 1987.

A major area of discussion in recent years has been IWC member nations issuing permits to kill whales for scientific purposes. Since the moratorium on commercial whaling came into effect Japan, Norway, and Iceland have issued scientific permits as part of their research programs. For the last 5 years, only Japan has issued permits to harvest sei whales although Iceland asked for a proposal to be reviewed by the IWC Scientific Committee in 2003. The Government of Japan has issued scientific permits in recent years to capture minke, Bryde's, and sperm whales in the North Pacific, known as JARPA II and JARPN II programmes. The Government of Japan extended the captures to include 50 sei whales from pelagic areas of the western North Pacific (Carretta et al. 2007).

Fisheries Interactions

Sei whales, because of their offshore distribution and relative scarcity in U.S. Atlantic and Pacific waters, probably have a lower incidence of entrapment and entanglement than fin whales. Data on entanglement and entrapment in non-U.S. waters are not reported systematically. Heyning and Lewis (1990) made a crude estimate of about 73 rorquals killed/year in the southern California offshore drift gillnet fishery during the 1980s. Some of these may have been fin whales instead of sei whales. Some balaenopterids, particularly fin whales, may also be taken in the drift gillnet fisheries for sharks and swordfish along the Pacific coast of Baja California, Mexico (Barlow et al. 1997). Heyning and Lewis (1990) suggested that most whales killed by offshore fishing gear do not drift far enough to strand on beaches or to be detected floating in the nearshore corridor where most whale-watching and other types of boat traffic occur. Thus, the small amount of documentation may not mean that entanglement in fishing gear is an insignificant cause of mortality. Observer coverage in the Pacific offshore fisheries has been too low for any confident assessment of species-specific entanglement rates (Barlow et al. 1997). The offshore drift gillnet fishery is the only fishery that is likely to take sei whales from this stock, but no fishery mortalities or serious injuries to sei whales have been observed. Sei whales, like other large whales, may break through or carry away fishing gear. Whales carrying gear may die later, become debilitated or seriously injured, or have normal functions impaired, but with no evidence recorded.

Ship Strikes

The decomposing carcass of a sei whale was found on the bow of a container ship in Boston harbor, suggesting that sei whales, like fin whales, are killed at least occasionally by ship strikes (Waring et al. 1997). Sei whales are observed from whale-watching vessels in eastern North America only occasionally (Edds et al. 1984) or in years when exceptional foraging conditions arise (Weinrich et al. 1986, Schilling et al. 1992). There is no comparable evidence available for evaluating the possibility that sei whales experience significant disturbance from vessel traffic. During 2000-2004, there were an additional five injuries and three mortalities of unidentified large whales attributed to ship strikes. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma (DoN 2006).

Other Threats

No major habitat concerns have been identified for sei whales in either the North Atlantic or the North Pacific. Sei whales have a preference for copepods and euphausiids (i.e., low trophic level organisms), and may be less susceptible to the bioaccumulation of organochlorine and metal contaminants than, fin, humpback, and minke whales, all of which seem to feed more regularly on fish and euphausiids (O’Shea and Brownell 1994). Sei whales off California often feed on pelagic fish as well as invertebrates (Rice 1977). There is no evidence that levels of organochlorines, organotins, or heavy metals in baleen whales generally (including fin and sei whales) are high enough to cause toxic or other damaging effects (O'Shea and Brownell 1994). However, very little is known about the possible long-term and trans-generational effects of exposure to pollutants.

3.8.3.6 Sperm Whale

Stock

North Pacific

Regulatory Status

Sperm whales (*Physeter macrocephalus*) are listed as endangered under the ESA and designated as depleted under MMPA. The North Pacific stock is classified as strategic. A draft species recovery plan has been prepared (NMFS 2006a).

Habitat Preferences & Critical Habitat

Sperm whales show a strong preference for deep waters (Rice 1989), especially in areas with high sea floor relief. Recent research at the Azores Seamounts off Portugal did not, however, demonstrate association of sperm whales with seamounts (Morato et al. 2008). Globally, sperm whale distribution is associated with waters over the continental shelf break, over the continental slope, and into deeper waters (Hain et al. 1985). However, in some areas, such as off New England, on the southwestern and eastern Scotian Shelf, or the northern Gulf of California, adult males are reported to use waters with bottom depths less than 328 ft (100 m) and as shallow as 131 ft (40 m) (Whitehead et al. 1992, Scott and Sadove 1997, Croll et al. 1999, Garrigue and Greaves 2001, Waring et al. 2002). Worldwide, females rarely enter the shallow waters over the continental shelf (Whitehead 2003). In GOA the primary occurrence for the sperm whales is seaward of the 1640 ft (500 m) isobath (DoN 2006).

Sperm whales have a highly diverse diet. Prey includes large mesopelagic squid and other cephalopods, fish, and occasionally benthic invertebrates (Fiscus and Rice 1974, Rice 1989, Clarke 1996).

Critical habitat has not been designated for sperm whales.

Population Size and Trends

Current estimates of population abundance, status, and trends for the North Pacific stock in Alaska of sperm whales are not available. For the North Pacific, sperm whales have been divided into three separate stocks based on where they are found, designated as (1) Alaska (North Pacific stock), (2) California/Oregon/Washington, and (3) Hawaii (Angliss and Allen 2009).

Estimates of pre-whaling abundance in the North Pacific are considered somewhat unreliable, but sperm whales may have totaled 1,260,000 individuals (Angliss and Allen 2009). Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987 (Hill and DeMaster 1999). However, this number may be negatively biased by as much as 60 percent because of under-reporting by Soviet whalers (Brownell et al. 1998). In particular, the Bering Sea population of sperm whales (consisting mostly of males) was severely depleted (Perry et al. 1999). Catches in the north Pacific continued to climb until 1968, when 16,357 sperm whales were harvested. Catches declined after 1968, in part through limits imposed by the IWC (Rice 1989).

The following has been estimated for other stocks in the Pacific:

- California/Oregon/Washington 2,853 (CV = 0.25); Carretta et al. (2008)
- Hawaii 7,082 (CV = 0.30); Carretta et al. (2008)
- North Pacific 102,112 (CV = 0.15); Angliss and Allen (2008)

From 26 June to 15 July 2003, a survey in the Shelikof Strait (north of Kodiak), Cook Inlet, Prince William Sound and between Kodiak and Montague Island detected six sperm whales along the shelf break, with an average group size of 1.2 (Waite 2003). Data from this survey yielded a density of 0.0003/km^2, which is applicable year-round for sperm whales in the TMAA as described in detail in Appendix E. This density was based on only two “on effect” sightings, so confidence in the value is low, but it is the only data from which to derive a density that exists at this time for the region. The April 2009 survey in the TMAA recorded sperm whales acoustically in both the inshore and offshore strata but no sperm whales were detected visually (Rone et al. 2009).

Distribution

Sperm whales occur throughout all ocean basins from equatorial to polar waters, including the entire North Atlantic, North Pacific, northern Indian Ocean, and the southern oceans. Sperm whales are found throughout the North Pacific and are distributed broadly from tropical and temperate waters to the Bering Sea as far north as Cape Navarin. 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). In the North Pacific, the distribution of females and young sperm whales is more limited year-round and generally corresponds to tropical and temperate waters approximately to 50°N latitude (at least 6 degrees south of the TMAA; Whitehead 2003). Summer surveys in the coastal waters around the central and western Aleutian Islands have found sperm whales to be the most frequently sighted large cetacean (Angliss and Allen 2009). Acoustic surveys have detected the presence of sperm whales year-round in the GOA although about twice as many are present in summer as in winter (Mellinger et al. 2004, Moore et al. 2006). Fewer detections in winter are reflected by the documented seasonal movement of whales from Canada and Japan to the GOA/Bering Sea/Aleutian Islands region (Angliss and Allen 2009).

Life History

Female sperm whales become sexually mature at about 9 years of age (Kasuya 1991). Male sperm whales take between 9 and 20 years to become sexually mature, but will require another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991). The age distribution of the sperm whale population is unknown, but sperm whales are believed to live at least 60 years (Rice 1978). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (International Whaling Commission 1980).

Reproduction/Breeding

Calving generally occurs in the summer at lower latitudes and the tropics (DoN 2005). Adult females give birth after about 15 months gestation and nurse their calves for 2 to 3 years. The calving interval is estimated to be about 4 to 6 years (Kasuya 1991). There are no known areas used by sperm whales for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the relatively extensive dive behavior information for sperm whales are presented in Appendix D. In general, sperm whales forage during deep dives that routinely exceed a depth of 1,312 ft (400 m) and 30 min duration (Watkins et al. 2002). Sperm whales can dive to depths of over 6,562 ft (2,000 m) with durations of over 60 min (Watkins et al. 1993). Sperm whales spend up to 83 percent of daylight hours underwater (Jaquet et al. 2000, Amano and Yoshioka 2003). Males do not spend extensive periods at the surface (Jaquet et al. 2000). In contrast, females spend prolonged periods at the surface (1 to 5 hours daily) without foraging (Whitehead and Weilgart 1991, Amano and Yoshioka 2003). The average swimming speed is estimated to be 2.3 ft/sec (0.7 m/sec) (Watkins et al. 2002). Dive descents averaged 11 min at a rate of 5.0 ft/sec (1.52 m/sec), and ascents averaged 11.8 min at a rate of 4.6 ft/sec (1.4 m/sec) (Watkins et al. 2002).

Acoustics

Sperm whales produce short-duration (generally less than 3 sec), broadband clicks. These clicks range in frequency from 100 Hz to 30 kHz (Weilgart and Whitehead, 1993, 1997; Goold and Jones 1995; Thode et al. 2002), with dominant energy in two bands (2 to 4 kHz and 10 to 16 kHz). The source levels can be up to 236 dB re 1 µPa @ 1 m (Møhl et al. 2003). Thode et al. (2002) suggested that the acoustic directivity (angular beam pattern) from sperm whales must range between 10 and 30 dB in the 5- to 20-kHz region. The clicks of neonate sperm whales are very different from the usual clicks of adults, in that they are of low directionality, long duration, and low frequency (centroid frequency between 300 and 1,700 Hz) with estimated source levels between 140 and 162 dB re 1 µPa @ 1 m (Madsen et al. 2003). Clicks are heard most frequently when sperm whales are engaged in diving and foraging behavior (Whitehead and Weilgart 1991, Miller et al. 2004, Zimmer et al. 2005). These may be echolocation clicks used in feeding, contact calls (for communication), and orientation during dives. When sperm whales socialize, they tend to repeat series of clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill 1977). Codas are shared between individuals of a social unit, and are considered to be primarily for intragroup communication (Weilgart and Whitehead 1997, Rendell and Whitehead 2004).

The anatomy of the sperm whale's ear indicates that it hears high-frequency sounds (Ketten 1992). Anatomical studies also suggest that sperm whales have some ultrasonic hearing, but at a lower maximum frequency than many other odontocetes (Ketten 1992). Sperm whales may also possess better low-frequency hearing than some other odontocetes, although not as extraordinarily low as many baleen whales (Ketten 1992). Auditory brainstem response in a neonatal sperm whale indicated highest sensitivity to frequencies between 5 and 20 kHz (Ridgway and Carder 2001; Table 3.8-3).

Impacts of Human Activity

Historic Whaling

In 2000, the Japanese Whaling Association announced that it planned to kill 10 sperm whales and harvest 5 sperm whales. Japanese whalers took another 31 sperm whales between 2001 and 2005 (Angliss and Allen 2009). The consequence of these deaths on the status and trend of sperm whales remains uncertain, given the lack of information concerning sperm whale abundance (Institute of Cetacean Research 2010).

Fisheries Interactions

In U.S. waters in the Pacific, sperm whales have been incidentally taken only in drift gillnet operations, which killed or seriously injured an average of nine sperm whales per year from 1991-1995 (Barlow et al. 1997). Of the eight sperm whales taken by the California/Oregon drift gillnet fishery, three were released alive and uninjured (37.5 percent), one was released injured (12.5 percent), and four (50 percent) were killed (NMFS 2000). Therefore, approximately 63 percent of captured sperm whales could be killed accidentally or injured, based on the mortality and injury rate of sperm whales observed taken by the U.S. fleet from 1990 to 2000. Based on past fishery performance, sperm whales were not observed taken in every year; they were observed to be taken in 4 out of 10 years (NMFS 2000). During the 3 years the Pacific Coast Take Reduction Plan has been in place, a sperm whale was taken only once, in a set that did not comply with the Take Reduction Plan (NMFS 2000).

Interactions between sperm whales and longline fisheries in the GOA have been reported since 1995 and are increasing in frequency (Rice 1989, Hill and Mitchell 1998, Hill and DeMaster 1998). Between 2002 and 2006, there were three observed serious injuries (considered mortalities) to sperm whales in the GOA from the sablefish longline fishery (Angliss and Allen 2009). Sperm whales have also been observed in GOA feeding off longline gear (for sablefish and halibut) at 38 of the surveyed stations (Angliss and Allen 2009). Recent findings suggest sperm whales in Alaska may have learned that fishing vessel propeller cavitations (as gear is retrieved) are an indicator that longline gear with fish is present as a predation opportunity (Thode et al. 2007).

Berzin (1972) noted that there were "many" reports of sperm whales of different age classes being struck by vessels, including passenger ships and tug boats. Sperm whales spend long periods (typically up to 10 min) at the surface between deep dives (Jacquet et al. 1998). This behavior could make sperm whales more vulnerable to ship strikes. There is record of one collision between a fishing vessel and a sperm whale within the TMAA (Gabriele et al. 2006).

3.8.3.7 Steller Sea Lion

The Steller sea lion's (*Eumetopias jubatus*) range includes portions of the TMAA. The boundary between the eastern DPS and the western DPS approximately bisects the TMAA, although the TMAA is located offshore of the main habitat/foraging areas.

Stock

Eastern and Western DPS.

Regulatory Status

In 1997, NMFS reclassified Steller sea lions into two distinct subpopulations, based on genetics and population trends (Loughlin 1997, Angliss and Outlaw 2005). The western DPS was designated as endangered and includes animals at and west of Cape Suckling, Alaska (144°W; NMFS 1997c). The eastern DPS remained designated as threatened and includes animals east of Cape Suckling (NMFS 1997c, Loughlin 2002, Angliss and Outlaw 2005) that extend into southeastern Alaska, and Canada. Rookeries of the eastern DPS occur along the coasts of Oregon and California (NMFS 2008b). The Steller sea lion is designated as depleted under MMPA. A final revised species recovery plan addresses both the eastern DPS and western DPS (NMFS 2008b).

Habitat Preferences & Critical Habitat

Steller sea lions are opportunistic predators, feeding primarily on fishes (including walleye pollock, cod, mackerel, and herring), invertebrates, and cephalopods (octopus and squid), with diet varying geographically and seasonally (Merrick et al. 1997, Loughlin 2002, DoN 2006). For the GOA, foraging habitat is primarily shallow, nearshore and continental shelf waters 8 to 24 km (4.3 to 13 nm) offshore with a secondary occurrence inshore of the 1,000 m isobath, and a rare occurrence seaward of the 1,000 m isobath.

Steller sea lions form large rookeries during late spring when adult males arrive and establish territories (Pitcher and Calkins 1981), so the rookeries would normally be occupied during the likely time-period for the annual Northern Edge exercise.

In 1993, NMFS published a final rule to designate critical habitat for Steller sea lions (NMFS 2008b). There is no Critical Habitat for Steller sea lions in the TMAA. The areas designated as critical habitat were based on land use patterns, the extent of foraging trips, and the availability of prey items with particular importance given to the haul out areas where animals rest, pup, nurse, mate, and molt. Two kinds of marine habitat were designated as critical: "aquatic zones" around rookeries and haulouts and three special aquatic feeding areas in Alaska. The special aquatic foraging areas were chosen, "based on 1) at-sea observations indicating that sea lions commonly used these areas for foraging, 2) records of animals killed incidentally in fisheries in the 1980s, 3) knowledge of sea lion prey and their life histories and distributions, and 4) foraging studies" (NMFS 2008b).

For the eastern DPS, the Critical Habitat aquatic zones (located east of 144°W longitude) extend 3,000 ft (0.9 km) seaward in state and federally managed waters from the baseline or basepoint of each major rookery. None of this Critical Habitat is in the vicinity of the TMAA.

For the western DPS, Critical Habitat for aquatic zones located (west of 144°W longitude) extend 20 nm (37 km) seaward in state and federally managed waters. None of the aquatic zones are located within the boundaries of the TMAA. Steller sea lion foraging in GOA primarily occurs in shallow, nearshore, and continental shelf waters within 4.3 to 13 nm (8 to 24 km) from rookeries and haulouts so the aquatic zone based Critical Habitat in GOA is larger by approximately 7 nm (13 km) than the primary foraging area. Critical Habitat for the western DPS in the vicinity of the TMAA is depicted in Figure 3.8-2 (NMFS 2008b).

Population Size and Trends

The minimum abundance estimate for western DPS Steller sea lions is 38,988 individuals, and the eastern DPS is estimated at 45,095 to 55,832 (Angliss and Allen 2009). Given the wide dispersal of individuals, both the western DPS and eastern DPS may occur in the GOA (DoN 2006, Angliss and Outlaw 2007, NMFS 2008b), with about 70 percent of the population living in Alaskan waters. Between 2000 and 2004, the western DPS increased at a rate of approximately 3 percent per year (Fritz and Stinchcomb 2005). The eastern DPS has increased at an annual rate of approximately 3 percent since at least the late 1970s (Pitcher et al. 2007) and may be a candidate for removal from the list of threatened and endangered species (NMFS 2008b). Despite incomplete surveys conducted in 2006 and 2007, the available data indicate that the western Steller sea lion population (non-pups) was stable since 2004 (when the last complete assessment was done). The revised Steller Sea Lion Recovery Plan (NMFS 2008b) contains recovery criteria to change the listing of the western DPS from endangered to threatened ("down-listing") and to remove it from the list of species requiring ESA protection (delist).

For purposes of acoustic impact modeling, a density of 0.0098/km^2 was derived for Steller sea lions in the TMAA as described in detail in Appendix E.

Distribution

Steller sea lions do not migrate, but they often disperse widely outside of the breeding season (Loughlin 2002). Steller sea lions are gregarious animals that often travel or haul out in large groups of up to 45 individuals (Keple 2002). At sea, groups usually consist of females and subadult males; adult males are usually solitary while at sea (Loughlin 2002). An area of high occurrence extends from the shore to the 273-fathom (500-m) depth. For the GOA, foraging habitat is primarily shallow, nearshore, and continental shelf waters 4.3 to 13 nm (8 to 24 km) 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. Steller sea lions have been sighted foraging in the middle of the GOA (DoN 2006). The April 2009 survey in the TMAA encountered two groups of Steller sea lions (Rone et al. 2009).

Life History

Foraging habitat is primarily shallow, nearshore and continental shelf waters, and some Steller sea lions feed in freshwater rivers (Reeves et al. 1992, Robson 2002). They also are known to feed in deep waters past the continental shelf break (DoN 2006). Haulout and rookery sites are located on isolated islands, rocky shorelines, and jetties. Steller sea lions are opportunistic predators, feeding primarily on fish and cephalopods, and their diet varies geographically and seasonally (Merrick et al. 1997). They feed near land or in relatively shallow water (Pitcher and Calkins 1981).

Steller sea lions form large rookeries during late spring when adult males arrive and establish territories. Large males aggressively defend territories while non-breeding males remain at peripheral sites or haulouts. Females arrive soon after and give birth to pups. Females reach sexual maturity at 4 to 5 years of age (Pitcher and Calkins 1981).

Natural mortality in Steller sea lions is thought to result primarily from killer whale predation, diseases and parasites, and habitat loss (NMFS 2008b). The carrying capacity of the North Pacific for Steller sea lions also likely fluctuates in response to changes in the environment.

Reproduction/Breeding

Most births occur from mid-May through mid-July at rookeries outside the boundaries of the MAA, and breeding takes place shortly thereafter (Pitcher and Calkins 1981). Rookeries of the eastern DPS occur along the coasts of Oregon and California (NMFS 2008b). There are no known areas used by Steller sea lions for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for Steller sea lions are provided in Appendix D. Diving and foraging activity varies by sex, age, and season. During the breeding season, females with pups feed mostly at night, while territorial males eat little or no food (Loughlin 2002). In the winter, females make long trips of around 81 mi (130 km) and dive deeply to locate prey (Merrick and Loughlin 1997, Loughlin 2002). In the summer, trip length is about 11 mi (17 km) and dives are shallower (Loughlin 2002). Females usually go to sea to feed and return to nurse their pups in 24- to 48-hour cycles (NRC 2003a). Steller sea lions tend to make shallow dives of less than 820 ft (250 m) but are capable of deeper dives (NMFS 2003).

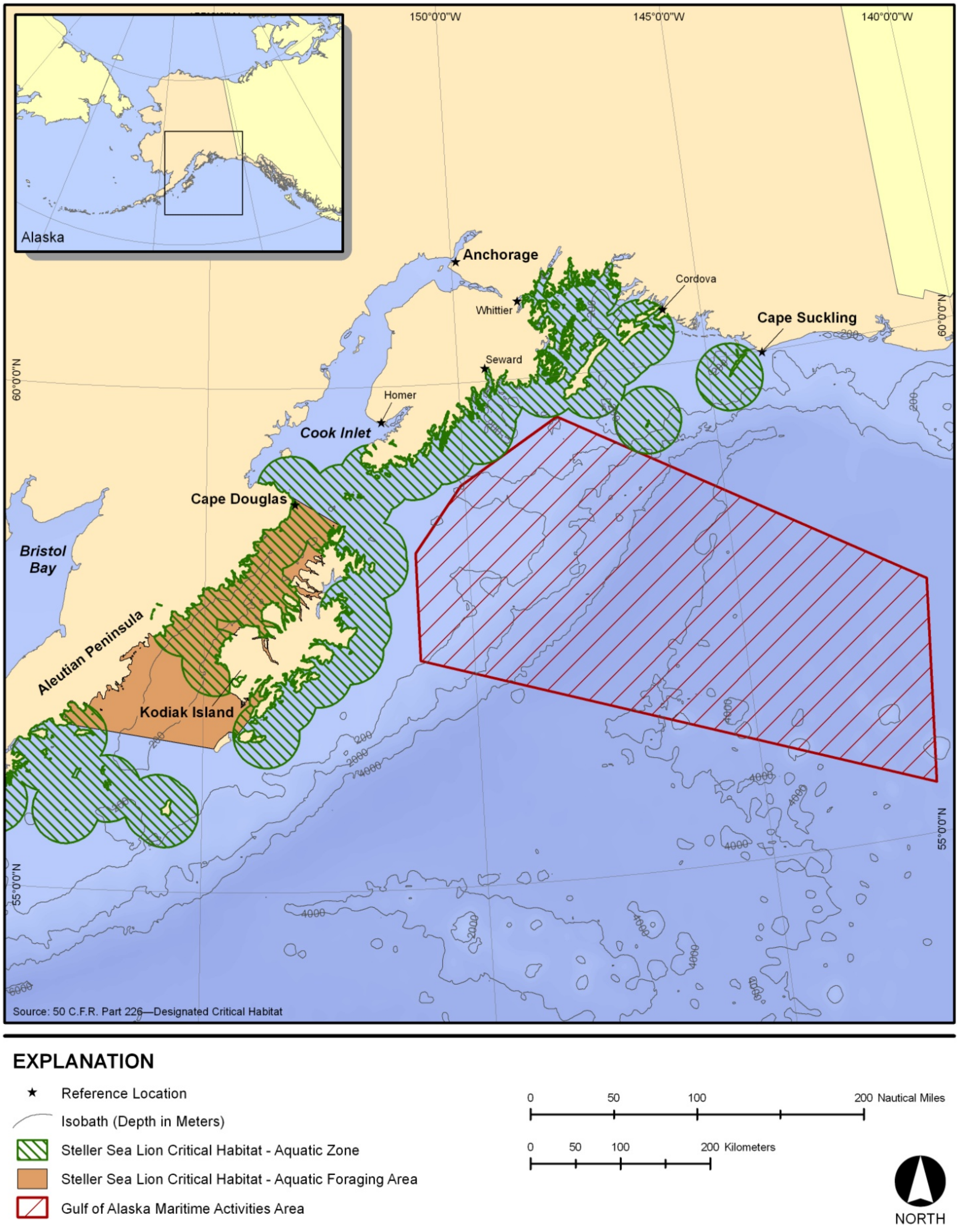


Figure 3.8-2: Steller Sea Lion Western DPS Critical Habitat in the Vicinity of the TMAA

Acoustics

On land, territorial male Steller sea lions usually produce low frequency roars (Schusterman et al. 1970, Loughlin et al. 1987). The calls of females range from 30 Hz to 3 kHz (see Table 3.8-3), with peak frequencies from 150 Hz to 1 kHz; typical duration is 1.0 to 1.5 sec (Campbell et al. 2002). Pups produce bleating sounds. Underwater sounds are similar to those produced on land (Loughlin et al. 1987).

When the underwater hearing sensitivity of two Steller sea lions was tested, the hearing threshold of the male was significantly different from than that of the female. The range of best hearing for the male was from 1 to 16 kHz, with maximum sensitivity (77 dB re 1 µPa @ 1 m) at 1 kHz. The range of best hearing for the female was from 16 kHz to above 25 kHz, with maximum sensitivity (73 dB re 1 µPa @ 1 m) at 25 kHz. However, because of the small number of animals tested, the findings could not be attributed to individual differences in sensitivity or sexual dimorphism (Kastelein et al. 2005).

Impacts of Human Activity

Major sources of induced (anthropogenic) mortality include harvesting by Alaska Natives, fisheries interactions (e.g., entanglements) and food shortages as a result of fishing pressure on prey items, and environmental contamination (NMFS 2008b).

Hunting

Historically, the eastern DPS was subjected to substantial mortality by humans, primarily due to commercial exploitation and both sanctioned and unsanctioned predator control (NMFS 2008b). Alaska Natives are exempted from the MMPA and ESA and continue taking seals for subsistence and/or handicraft purposes. The mean annual harvest of Steller sea lions by Alaska Natives between 2000 and 2004 was estimated approximately 190 animals with the majority of these harvests having involved the western DPS (NMFS 2000). The mean annual take for subsistence harvest between 2002 and 2006 is estimated to have been 198 animals in the western DPS (Angliss and Allen 2009).

State-sanctioned commercial harvest of Steller sea lions ended in 1972 with the advent of the MMPA. Although not well documented, there is little doubt that numbers of Steller sea lions were greatly reduced in many locations by these activities (NMFS 2008b). Commercial hunting and predator control activities have been discontinued and no longer affect the eastern DPS. In contrast to the western DPS, which is experiencing potential human-related threats from competition with fisheries (potentially high), incidental take by fisheries (low), and toxic substances (medium) no threats to continued recovery were identified for the eastern DPS. Although several factors affecting the western DPS also affect the eastern DPS (e.g., environmental variability, killer whale predation, toxic substances, disturbance, shooting), these threats do not appear to be at a level sufficient to keep the eastern DPS from continuing to recover, given the long-term sustained growth of the population as a whole (NMFS 2008b).

Fisheries Interactions

Lethal deterrence of seals from fishing activities ended in 1990 when Steller sea lions were listed under the ESA. Incidental take by fisheries has been assessed as having a low potential threat for the western DPS with an estimated approximate 30 lethal entanglements annually and 3.6 lethal entanglements (estimated in 2005) for the eastern DPS (NMFS 2008b, Angliss and Allen 2009). Entanglement in marine debris is assessed as a minor threat to the Steller sea lions (NMFS 2008b).

Both climate shift and fisheries induced changes in prey communities may have affected the condition of Steller sea lions over the last 40 years, but the relative importance of each is a matter of considerable debate (NMFS 2008b). There are two fishery-related theories about what may have contributed most to decline of Steller sea lions through reductions in prey biomass and quality, which resulted in nutritional stress (proximate cause) and subsequent decreases in vital rates (Trites et al. 2006). In one case, nutritional stress stems from climate-induced changes in the species composition, distribution or nutritional quality of the sea lion prey base. In the other, fishery-induced reductions in localized or overall prey abundance cause nutritional stress (Braham et al. 1980; NMFS 1998a, 2000).

What may have been unusual about the decline in sea lions observed through 2000 is the introduction of large-scale commercial fisheries on sea lion prey. While large-scale groundfish fisheries began in the 1960s, their potential for competitive overlap with Steller sea lions (e.g., catches within what would be designated as critical habitat) increased markedly in the 1980s. Overall and localized fisheries removals of prey could have exacerbated natural changes in carrying capacity, possibly in nonlinear and unpredictable ways (Goodman et al. 2002). Reductions in carrying capacity may have contributed to declines in Steller sea lion fatality that are believed to have occurred at some rookeries through at least 2002 despite shifts to potentially more favorable environmental conditions that may have occurred in 1989 and 1998 (NMFS 2008b).

3.8.4 Non-ESA Cetacean Species

3.8.4.1 Baird's Beaked Whale

Stock

Alaska

Regulatory Status

Baird's beaked whales (*Berardius bairdii*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The Alaska stock of Baird's beaked whales is not classified as strategic.

Habitat Preferences

Baird's beaked whales appear to occur mainly in cold deep waters (3,300 ft [1,000 m] or greater) over the continental slope, oceanic seamounts, and in areas with submarine escarpments. They may also occur occasionally near shore along narrow continental shelves. The range for the Alaska stock of Baird's beaked whale extends from Cape Navarin (63°N) and the central Sea of Okhotsk (57°N) to St. Matthew Island, the Pribilof Islands in the Bering Sea, and the northern GOA (Angliss and Allen 2009, DoN 2006).

Population Size and Trends

There is no reliable population estimate for the Alaska stock of Baird's beaked whale (Angliss and Allen 2009). For purposes of acoustic impact modeling, a density of 0.0005/km^2 was derived for Baird's beaked whales in the TMAA as described in detail in Appendix E.

Distribution

Baird's beaked whales are found only in the North Pacific and the adjacent seas (Bering Sea, Okhotsk Sea, Sea of Japan, and the Gulf of California), mainly north of 34°N in the west and 28°N in the east. The best-known populations occur in the coastal waters around Japan since whaling takes place there. Along the U.S. west coast, Baird's beaked whales are seen primarily along the continental slope from late spring to early fall. British Columbia whalers commented that Baird's beaked whales were most often sighted during May through September, with most catches occurring during August. Baird's beaked whales are seen less frequently and are presumed to be further offshore during the colder water months of November through April (DoN 2006).

Within the GOA, the area of primary occurrence for Baird's beaked whales during both summer and winter is between the depths of 1,640 and 9,842 ft (500 and 3,000 m). There is no evidence of seasonal movements by this species that would affect these predicted occurrence patterns. There is a secondary occurrence between the 656 and 1,640 ft (200 and 500 m) isobaths, as well as seaward of the 9,842 ft (3,000 m) isobath. There is a rare occurrence in waters shallower than the 656 ft (200 m) isobath. In 2003, Waite (2003) reported a group of four Baird's beaked whales was sighted at the shelf break to the east of the TMAA. There were no beaked whales detected acoustically or visually (although two groups of unidentified small whale were sighted) during the April 2009 survey of the TMAA (Rone et al. 2009).

Life History

Baird's beaked whales occur in relatively large groups of 6 to 30, and groups of 50 or more sometimes are seen (Balcomb 1989). Baird's beaked whales in Japan prey primarily on deepwater gadiform fishes and cephalopods, indicating that they feed primarily at depths ranging from 800 to 1,200 m (Walker et al. 2002, Ohizumi et al. 2003). Sexual maturity occurs at about 8 to 10 years, and the calving peak is in March and April (Balcomb 1989).

Reproduction/Breeding

Mating generally occurs in October and November but little else is known of their reproductive behavior (Balcomb 1989). There are no known areas used by Baird's beaked whales for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for Baird's beaked whales is provided in Appendix D. Analysis of stomach contents from captured and stranded individuals suggests that beaked whales are deep-diving animals, feeding by suction (Heyning and Mead 1996). The overall dive behavior of Baird's beaked whales is not known; therefore the diving behavior of a related species, Blainville's beaked whale, is used to provide diving behavior information. Baird et al. (2006) reported on the diving behavior of four Blainville's beaked whales (a similar species) off the west coast of Hawaii. The Blainville's beaked whales foraged in deep ocean areas (2,270-9,855 ft [691-3,003 m]) with a maximum dive to 4,619 ft (1,407 m). Dives ranged from at least 13 min (lost dive recorder during the dive) to a maximum of 68 min (Baird et al. 2006).

Acoustics

Sounds recorded from beaked whales are divided into two categories: whistles and pulsed sounds (clicks), with whistles likely serving a communicative function, and pulsed sounds being important in foraging and/or navigation (Johnson et al. 2004, Madsen et al. 2005, MacLeod and D'Amico 2006). Both whistles and clicks have been recorded from Baird's beaked whales in the eastern north Pacific. Whistles had fundamental frequencies between 4 and 8 kHz, with two to three strong harmonics within the recording bandwidth. Clicks had a dominant frequency around 23 kHz, with a second frequency peak at around 42 kHz (see Table 3.8-3) and, unlike species that echolocate, were most often emitted in irregular series of very few clicks (DoN 2006).

There is no information on the hearing abilities of Baird's beaked whale. In fact, there is no direct information available on the exact hearing abilities of most beaked whales, except for recent information from a live stranded juvenile Gervais' beaked whales (*Mesoplodon europaeus*); another whale in the same taxonomic family. Auditory evoked potential tests on this beaked whale found its hearing to be most sensitive to high-frequency signals between 40 and 80 kHz but it also perceiving mid-frequency sound down to 5 kHz although resulting in smaller evoked potentials (Cook et al. 2006).

It has been previously postulated, based on the occurrence of beaked whale strandings associated with ASW training events, that the species in general may be more sensitive than other cetaceans to sonar (Southall et al. 2007). Recent behavioral response experiments exposing beaked whales to killer whale recordings and sonar sounds in the Bahamas suggested that an anti-predator strategy of flight and fright may pose a greater risk for stranding than a social defense against predation. These preliminary findings are consistent with conclusions reported by Southall et al. (2007) suggesting that, “beaked whales, like porpoises, may be particularly sensitive to anthropogenic sound, but there is no evidence that they have a special sensitivity to sonar compared with other signals” (Tyack 2009). Beaked whales’ reactions to three different sound stimulus in this response study consisted of the animals stopping their clicking, producing fewer foraging buzzes than normal, and ending their dives in a long and unusually slow ascent while moving away from the sound source (Tyack 2009).

Impacts of Human Activity

While beaked whale strandings have been reported since the 1800s, several mass strandings since have been associated with naval operations that may have included mid-frequency sonar (Cox et al. 2006). As Cox et al. (2006) concluded, the state of science can not yet determine if a sound source such as mid-frequency sonar alone causes beaked whale strandings, or if other factors (acoustic, biological, or environmental) must co-occur in conjunction with a sound source. Recent evidence from the experimental sonar exposure to tagged beaked whales seems to suggest there is no general beaked whale sensitivity to Navy sonar (Tyack 2009).

For Alaska waters this is important given that between 27 June and 19 July 2004, five beaked whales were discovered stranded at various locations along 1,600 mi (2,625 km) of the Alaskan coastline and one was found floating (dead) at sea; These whales included three Baird’s beaked whales. As described in Appendix F in greater detail, questions were raised soon after the strandings as to whether they were the result of Navy sonar use, although sonar training events had not been part of an exercise which took place in that general timeframe. While records of Baird’s beaked whale strandings are uncommon in Alaska waters, they are not unknown. Between 1975 and 1987, eight Baird’s beaked whales were found stranded as far north as the area between Cape Pierce and Cape Newenham, to the east near Kodiak, and along the Aleutian Islands (Zimmerman, 1991). In Alaska there has been on average, including more recent data, between zero and three beaked whale strandings documented per year (Jensen 2008).

3.8.4.2 Cuvier’s Beaked Whale

Stock

Alaska

Regulatory Status

Cuvier’s beaked whales (*Ziphius cavirostris*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The Alaska stock of Cuvier’s beaked whales is not classified as strategic.

Habitat Preferences

World-wide, beaked whales normally inhabit continental slope (656-6,562 ft [200-2,000 m]) and deep oceanic waters (>6,562 ft [>2,000 m]), and only rarely stray over the continental shelf (Pitman 2002). Beaked whales are only occasionally reported in waters over the continental shelf. Cuvier’s beaked whales generally are sighted in waters with a bottom depth greater than 656 ft (200 m) and are frequently recorded at depths of 3,280 ft (1,000 m) or more. Forney and Brownell (1996) made one sighting of Cuvier’s beaked whales during surveys in the Aleutian Islands during 1994 in waters with a bottom depth of 13,123 to 16,404 ft (4,000 to 5,000 m). Rice and Wolman (1982) observed a group of six Cuvier’s beaked whales in about 17,716 ft (5,400 m) of water southeast of Kodiak Island. Waite (2003) reported one sighting of a group of four Cuvier’s beaked whales at the shelf break within the TMAA. There were no beaked whales detected acoustically or visually (although two groups of unidentified small whale were sighted) during the April 2009 survey of the TMAA (Rone et al. 2009).

Population Size and Trends

There is no population estimate for the Alaska stock of Cuvier's beaked whales (Angliss and Allen 2009). For purposes of acoustic impact modeling, a density of 0.0022/km^2 was derived for Cuvier's beaked whales in the TMAA as described in detail in Appendix E.

Distribution

The general distribution of Cuvier's beaked whales is primarily derived from strandings, which indicated that they are the most widely distributed of the beaked whales. They occur in all three major oceans and most seas. In the north Pacific, they range north to the northern GOA, the Aleutian Islands, and the Commander Islands and as far south as Hawaii. Cuvier's beaked whales generally are sighted in waters with a bottom depth greater than 656 ft (200 m) and are frequently recorded in areas with depths of 3,281 ft (1,000 m) or more. Occurrence has been linked to physical features such as the continental slope, canyons, escarpments, and oceanic islands (Angliss and Outlaw 2005).

Life History

Little is known of the feeding preferences of Cuvier's beaked whale. They may be mid-water and bottom feeders (Baird et al. 2005b) on cephalopods and, rarely, fish (MacLeod et al. 2003).

Reproduction/Breeding

Little is known of Cuvier's beaked whale reproductive behavior. There are no known areas used by Cuvier's beaked whales for reproduction or calving in the TMAA.

Diving Behavior

Recent research has provided considerable information regarding the complex patterns associated with the diving behavior of this species. Details regarding dive behavior information and how it was used in deriving parameters for input to the acoustic modeling are provided in Appendix D. In general, Cuvier's beaked whales feed on deep sea fish and squid and tend to dive for an hour or more to considerable depths to forage. Tagged Cuvier's beaked whale dive durations have been recorded for as long as 87 min and dive depths of up to 6,529 ft (1,990 m) (Baird et al. 2006).

Acoustics

MacLeod (1999) suggested that beaked whales use frequencies of between 300 Hz and 129 kHz for echolocation, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. Blainville's beaked whales echolocation clicks were recorded at frequencies from 20 to 40 kHz (Johnson et al. 2004) and Cuvier's beaked whales at frequencies from 20 to 70 kHz (Zimmer et al. 2005). Soto et al. (2006) reported changes in vocalizations during diving on close approaches of large cargo ships which may have masked their vocalizations. Cuvier's beaked whales only echolocated below 200 m (656 ft) (Tyack et al. 2006). Echolocation clicks are produced in trains (interclick intervals near 0.4 second) and individual clicks are frequency modulated pulses with durations of 200-300 microsecond; the center frequency was around 40 kHz with no energy below 20 kHz (Tyack et al. 2006).

Impacts of Human Activity

Fisheries Interactions

From 1990 to 2002, six different commercial fisheries operating within the range of the Alaska stock of Cuvier's beaked whales were monitored for incidental take. These fisheries included Bering Sea (and Aleutian Islands) ground fish trawl, longline, and pot fisheries and GOA ground fish trawl, longline, and pot fisheries. No Cuvier's beaked whale mortalities were observed (Angliss and Outlaw 2007).

Strandings

As noted previously for Baird's beaked whales, mass strandings associated with naval training that may have included mid-frequency sonar is a concern for all beaked whales. Between 27 June and 19 July 2004, five beaked whales were discovered stranded at various locations along 1,600 mi (2,575 km) of the Alaskan coastline and one was found floating (dead) at sea. These whales included two Cuvier's beaked whales. As described in Appendix F in greater detail, these strandings were not associated with sonar use by the Navy. Additionally, prior to the Navy conducting the exercise (before 27 June), two Cuvier's beaked whales were discovered stranded at two separate locations along the Alaskan coastline (February 26 at Yakutat and June 1 at Nuka Bay).

Zimmerman (1991) reported that between 1975 and 1987, 19 Cuvier's beaked whales were found stranded from the eastern GOA to the western Aleutians. As noted previously, on average in Alaska there has been on average between zero and three beaked whale strandings documented per year (Jensen 2008).

3.8.4.3 Dall's Porpoise

Stock

Alaska

Regulatory Status

Dall's porpoises (*Phocoenoides dalli*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The Alaska stock of Dall's porpoise is not classified as strategic.

Habitat Preferences

Dall's porpoises are a cool- temperate to subarctic deepwater species found only in the North Pacific and adjacent seas. Cool water temperature (<63 degrees Fahrenheit [°F], 17 degrees Celsius [°C]) is characteristic of their primary habitat. Dall's porpoises are common along the shelf break, slope, and in offshore waters (Consiglieri et al. 1982, Calkins 1986). The waters of the TMAA are an area of primary occurrence.

Population Size and Trends

Numerous studies have documented the occurrence of Dall's porpoises in the Aleutian Islands and western GOA as well as in the Bering Sea. Using a population estimate based on vessel surveys during 1987–1991, and correcting for the tendency of this species to approach vessels, which has been suggested to result in inflated abundance estimates, perhaps by as much as five times, reported a minimum population estimate of 83,400 (CV=0.097) for the Alaska stock of Dall's porpoise. (Angliss and Outlaw 2008) Based on the derived density of 0.1892/km^2 for acoustic impact modeling (Appendix E), Dall's porpoises are the most common cetacean in the TMAA.

Distribution

Dall's porpoises are found from northern Baja California, Mexico, north to the northern Bering Sea and south to southern Japan (Jefferson et al. 1993). The species is only common between 32°N and 62°N in the eastern north Pacific (Morejohn 1979; Houck and Jefferson 1999). Dall's porpoises shift their distribution southward during cooler-water periods (Forney and Barlow 1998). Norris and Prescott (1961) reported finding Dall's porpoises in southern California waters only in the winter, generally when the water temperature was less than 59°F (15°C). Inshore/offshore movements off southern California have also been reported, with individuals remaining inshore in fall and moving offshore in the late spring (Norris and Prescott 1961, Houck and Jefferson 1999, Lagomarsino and Price 2001). Seasonal movements have also been noted off Oregon and Washington, where higher densities of Dall's porpoises were sighted offshore in winter and spring and inshore in summer and fall (Green et al. 1992).

Fiscus et al. (1976) suggested that Dall's porpoise is probably the most common cetacean from the northeast GOA to Kodiak Island. Dall's porpoises are regularly found throughout the GOA year-round. Sightings indicate a general seasonal shift in distribution in the GOA from east in April to west in May and south in June. Dall's porpoises are common along the shelf break, slope, and in offshore waters. Dall's porpoises are primarily found seaward of the 328 ft (100 m) isobaths in the GOA throughout the year. (Angliss and Outlaw 2008, DoN 2006). The April 2009 survey in the TMAA encountered 10 groups of Dall's porpoise totaling 59 individuals in both inshore and offshore strata (Rone et al. 2009).

Life History

Dall's porpoises feed primarily on small fish and squid (Houck and Jefferson 1999). Groups of Dall's porpoises generally include fewer than 10 individuals and are fluid, probably aggregating for feeding (Jefferson 1990, 1991; Houck and Jefferson 1999). There is a strong summer calving peak from June through August, and a smaller peak in March (Jefferson 1989). Animals reach sexual maturity at 3.5 to 8 years (Houck and Jefferson 1999).

Reproduction/Breeding

Calving for Dall's porpoise occurs in the north Pacific from early June through late July (Ferrero and Walker 1999). There are no known areas used by Dall's porpoise for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for Dall's porpoises are provided in Appendix D. Dall's porpoises feed on small fish and squid. In the GOA, Dall's porpoises primarily feed on lanternfish (myctophids). Hanson and Baird (1998) provided the first data on diving behavior for this species: an individual tagged for 41 min dove to a mean depth of 109.6 ft (33.4 m; Standard Deviation [S.D.] = ±23.9 m) for a mean duration of 1.29 min (S.D. = ±0.84 min). (DoN 2006)

Acoustics

Only short-duration pulsed sounds have been recorded from Dall's porpoises; this species apparently does not whistle often. Dall's porpoises produce short-duration (50 to 1,500 microsecond [µs]), high-frequency, narrow-band clicks, with peak energies between 120 and 160 kHz. There are no published data on hearing abilities of this species. However, based on the morphology of the cochlea, it is estimated that the upper hearing threshold is about 170 to 200 kHz (see Table 3.8-3). (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

The Alaska Peninsula and Aleutian Island salmon driftnet fishery was monitored in 1990. One Dall's porpoise mortality was observed which extrapolated to an annual (total) incidental mortality rate of 28 Dall's porpoise. In addition, over a 5-year period (2000-2004), observations of the Bering Sea/Aleutian Islands pollock trawl fishery resulted in a mean annual mortality of 5.9 Dall's porpoises. This results in an estimated annual incidental kill rate in observed fisheries of 33.9 Dall's porpoises per year for the Alaska stock. (Angliss and Outlaw 2008)

3.8.4.4 Gray Whale

Stock

Eastern North Pacific

Regulatory Status

The ENP stock of gray whales was delisted given an increase in population so it was no longer considered "endangered" or "threatened" under the ESA. Subsequent review determined that the stock was neither in danger of extinction, nor likely to become endangered within the foreseeable future. The ENP stock is not classified as a "strategic" stock by NMFS. (Angliss and Allen 2009)

Habitat Preferences

Gray whales primarily occur in shallow waters over the continental shelf. Their feeding grounds are generally less than 223 ft (68 m) deep and most of the ENP stock can be found in summer feeding grounds north of the Aleutian Islands. During migration through the GOA en route from subtropical breeding grounds, gray whales' primary occurrence extends seaward 15 nm (28 km) from the shoreline within a narrow margin of the TMAA's northern boundary. A rare occurrence is expected seaward of the shelf break. (DoN 2006)

Population Size and Trends

Systematic counts of gray whales migrating south along the central California coast have been conducted most years since 1967, documenting the population increasing over the past several decades. The minimum population estimates for the ENP stock of gray whales using the mean of the 2000/01 and 2001/02 abundance estimates is 17,752 and the best estimate of 18,813 whales (CV = 0.07; Angliss and Allen 2009). For purposes of acoustic impact modeling, a density was estimated at 0.0125/km^2, and is applicable only for the farthest north area of the TMAA (2.75 percent of the area) as described in detail in Appendix E.

Distribution

Gray whales are found only in the North Pacific. The ENP population is found from the upper Gulf of California, south to the tip of Baja California, and up the Pacific coast of North America to the Chukchi and Beaufort seas. This stock is known to summer in the shallow waters of the northern Bering Sea, Chukchi Sea, and western Beaufort Sea, but some individuals spend the summer feeding along the Pacific coast from southeastern Alaska to central California. Beginning in October, the whales migrate south to calving and breeding grounds on the west coast of Baja California and the southeastern Gulf of California. Some gray whales are known to deviate from the typical migration path/seasons; for example, gray whale calls have been documented off Barrow, Alaska, in the winter. (DoN 2006, Angliss and Allen 2009)

Gray whales are found along the shore in the northern GOA during migrations between breeding and feeding grounds. Individuals are expected to occur along the northern coast of the GOA between March and November; peak abundance is expected from April through May and in November and December. 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 GOA. The southbound migration continues into the winter season between October and January. Migration of gray whales past Kodiak Island peaks in mid-December. During the northbound migration, the peak of migration in the GOA is in mid-April. Although most gray whales migrate to the Bering Sea to feed, some whales do not complete the migration north but feed in coastal waters in the GOA and the Pacific Northwest. (DoN 2006)

Most gray whales follow the coast during migration and stay within 1.2 mi (2 km) of the shoreline, except when crossing major bays, straits, and inlets from southeastern Alaska to the eastern Bering Sea. However, gray whales are known to move further offshore between the entrance to Prince William Sound and Kodiak Island and between Kodiak Island and the southern part of the Alaska Peninsula. 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 (DoN 2006). The April 2009 survey encountered one group of two gray whales within the western edge of the TMAA and two groups well outside the TMAA nearshore at Kodiak Island (Rone et al. 2009).

Life History

Most of the gray whales in the Eastern North Pacific stock spend the summer feeding in the northern Bering and Chukchi Seas. However, gray whales have been seen feeding in the summer off of Southeast Alaska, British Columbia, Washington, Oregon, and California. Each fall, the whales migrate south from Alaska to Baja California, in Mexico. The stock winters primarily in certain shallow, nearly landlocked lagoons and bays along the west coast of Baja California. Calves are born from early January to mid-February. The northbound migration begins in mid-February and continues through May, with cows and newborn calves migrating northward primarily between March and June along the U.S. west coast. (Angliss and Outlaw 2007)

Reproduction/Breeding

The winter breeding grounds consist of subtropical lagoons that are protected from the open ocean (Jones and Swartz 2002). There are no known areas used by gray whales for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for gray whales are provided in Appendix D. When foraging, gray whales typically dive to 164 to 196 ft (50 to 60 m) for 5 min to about 8 min. When migrating, gray whales may remain submerged near the surface for 7 to 10 min and travel 1,640 ft (500 m) or more before resurfacing to breathe. Migrating gray whales sometimes exhibit a unique “snorkeling” behavior in which they surface cautiously, exposing only the area around the blow hole, exhale quietly without a visible blow, and sink silently beneath the surface. The maximum known dive depth is 557 ft (170 m) (DoN 2006, Jones and Swartz 2002).

Acoustics

Gray whales produce broadband signals ranging from 0.1 to 4 kHz (and up to 12 kHz). The most common sounds on the breeding and feeding grounds are knocks, which are broadband pulses from about 0.1 to 2 kHz (dominant frequency range: 0.327 to 0.825 kHz; see Table 3.8-3). The source level for knocks is approximately 142 dB re 1 µPa @ 1 m. During migration, individuals most often produce low-frequency (predominantly below 1.5 kHz) bonging sounds and moans. (DoN 2006)

The structure of the gray whale ear is evolved for low-frequency hearing. The ability of gray whales to hear frequencies below 2 kHz (as low as 0.8 kHz) has been demonstrated in playback studies and in their responsiveness to underwater noise associated with oil and gas activities. Gray whale responses to noise in these studies include startle responses (i.e., water disturbances, tail-lobbing); changes in swimming speed and direction to move away from the sound source; abrupt behavioral changes from feeding to avoidance, with a resumption of feeding after exposure; changes in calling rates and call structure; and changes in surface behavior, usually from traveling to milling. It was determined the threshold for inducing feeding interruptions from air gun noise was a received level of 173 dB re 1 ìPa @ 1 m, and for continuous industrial noise, the threshold for inducing avoidance was a received level of approximately 120 dB re 1 ìPa @ 1 m. (DoN 2006)

Impacts of Human Activity

Subsistence Interactions

Subsistence hunters in Alaska and Russia have traditionally harvested whales from the ENP stock of gray whales. Based upon reported taking of whales by subsistence hunters from 1995 to 1997 along with an agreement reached between the United States and Russia that the average annual harvest of gray whales would be 124, the annual subsistence take of gray whales averaged 122 whales during a 5-year period from 1999 to 2003. (Angliss and Allen 2009)

Vessel Collisions

The nearshore migration route used by gray whales makes ships strike a potential source of mortality. Between 1999 and 2003, the California stranding network reported four serious injuries or mortalities of gray whales caused by ship strikes. One ship strike was reported in Alaska in 1997. Additional mortality from ship strikes probably goes unreported because the whales either do not strand or do not have obvious signs of trauma. (Angliss and Allen 2009)

3.8.4.5 Harbor Porpoise

Stock

Gulf of Alaska

Regulatory Status

Harbor porpoise (*Phocoena phocoena*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The Gulf of Alaska stock of harbor porpoise is classified as strategic.

Habitat Preferences

Harbor porpoises are generally found in cool temperate to subarctic waters over the continental shelf. This species is seldom found in waters warmer than 62°F (17°C). 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 and in the GOA and Southeast Alaska; they occur most frequently in waters less than 328 ft (100 m) in depth. (DoN 2006, Angliss and Allen 2009) Waite (2003) reports a single sighting (two individuals) 27 nm (50 km) offshore, but within the 328 ft (100 m) isobath. The majority of the TMAA is well offshore of the normal habitat range for harbor porpoise. The April 2009 survey encountered 30 groups of harbor porpoise totaling 89 individuals but only one of these groups was located within the TMAA (Rone et al. 2009).

Population Size and Trends

Two of the nine stocks of harbor porpoises recognized along the U.S. Pacific coast are found near the TMAA: the Gulf of Alaska, and Southeast Alaska stocks. The boundaries of the Gulf of Alaska stock are Cape Suckling to Unimak Pass in the Aleutian Islands. The boundaries of the Southeast Alaska stock are northern border of British Columbia to Cape Suckling, Alaska (Angliss and Outlaw 2008). Given the distance from shore and the depth of the waters, individuals from the Southeast Alaska stock should not be present in the TMAA. Individuals from the Gulf of Alaska stock may rarely occur in the northern portion of the TMAA. There is a minimum population estimate of 41,854 for the Gulf of Alaska stock. There are not sufficient numbers of harbor porpoise present in the TMAA to allow for acoustic impact modeling given they are rare.

To derive an estimate for the number of harbor porpoise that may be exposed to potential MMPA Level B harassment (behavioral disturbance), an analysis of the approximate distribution of harbor porpoise in the Gulf of Alaska stock (occurring from Unimak Pass to Cape Suckling as presented in the stock assessment; Angliss and Outlaw 2006) was undertaken as a first step. The stock assessment information indicates an area for the GOA stock of approximately 69,829 nm^2 (239,597 km^2) with an abundance of 41,854 animals, resulting in the second highest density for a marine mammal species in the GOA (0.5993/nm^2 or 0.1747/km^2). The nearshore portion of the TMAA overlaps this approximate distribution by an area of 4,538 nm^2 (15,565 km^2). If an even distribution of harbor porpoise in the Gulf of Alaska stock is assumed, there would be 2,719 harbor porpoise in the portion of the TMAA that overlaps the distribution as presented in the stock assessment. While this is likely an overestimate for the number of animals present in the area given the TMAA is outside harbor porpoise habitat preferences, it will be assumed for purposes of this analysis that 2,719 harbor porpoise would be exposed to a sound level at or above 120 dB Sound Pressure Level (SPL) resulting in MMPA Level B behavioral harassment during one summer training event.

Distribution

Harbor porpoises are generally found in cool temperate to subarctic waters over the continental shelf in both the North Atlantic and North Pacific. Harbor porpoises regularly occur in the GOA year-round. They are common in nearshore waters of the northeast GOA and south of Kodiak Island on Albatross and Portlock banks. They also regularly occur in Kachemak Bay, Prince William Sound, Yakutat Bay, and southeast Alaska, particularly between April and September. Based on aerial surveys in coastal and offshore waters from Bristol Bay (eastern Bering Sea) to Dixon Entrance (southeast Alaska), harbor porpoises are abundant in Bristol Bay and between Prince William Sound and Dixon Entrance. Lower abundance estimates were calculated for Cook Inlet, Kodiak Island, and the south side of the Alaska Peninsula. (DoN 2006, Angliss and Allen 2009)

Life History

Harbor porpoises are not known to form stable social groupings, which is the typical situation for species in the porpoise family. In most areas, harbor porpoises are found in small groups consisting of just a few individuals. (DoN 2006)

Reproduction/Breeding

They mature at an earlier age, reproduce more frequently, and live for shorter periods than other toothed whales (Read and Hohn 1995). Calves are born in late spring (Read 1990, Read and Hohn 1995). Dall's and harbor porpoises appear to hybridize relatively frequently in the Puget Sound area (Willis et al. 2004). There are no known areas used by Harbor porpoises for reproduction or calving in the TMAA.

Diving Behavior

Harbor porpoises make brief dives, generally lasting less than 5 min. Tagged harbor porpoise individuals spend 3 to 7 percent of their time at the surface and 33 to 60 percent in the upper 7 ft (2 m) of the water column. Average dive depths range from 46 to 135 ft (14 to 41 m), with a maximum known dive of 741 ft (226 m), and average dive durations ranging from 44 to 103 sec. (DoN 2006)

Acoustics

Harbor porpoise vocalizations include clicks and pulses, as well as whistle-like signals. The dominant frequency range is 110 to 150 kHz, with source levels of 135 to 177 dB re 1 µPa @ 1 m. Echolocation signals include one or two low-frequency components in the 1.4 to 2.5 kHz range. (DoN 2006)

A behavioral audiogram of a harbor porpoise indicated the range of best sensitivity is 8 to 32 kHz at levels between 45 and 50 dB re 1 µPa @ 1 m; however, auditory-evoked potential studies showed a much higher frequency of approximately 125 to 130 kHz with two frequency ranges of best sensitivity. More recent psycho-acoustic studies found the range of best hearing to be 16 to 140 kHz (see Table 3.8-3), with a reduced sensitivity around 64 kHz and maximum sensitivity between 100 and 140 kHz. (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

The Pacific cod longline, Pacific halibut longline, rockfish longline, and sablefish longline fisheries were monitored for incidental mortality by fishery observers from 2000 to 2004. No mortalities were observed for the Southeast Alaska or Gulf of Alaska stock of the harbor porpoise. However, monitoring in Prince William Sound (1990-1991), Cook Inlet (1999 and 2000), and Kodiak Island (2002) of salmon drift and set gillnet fisheries resulted in the observation of incidental mortalities. These mortalities extrapolated to an estimated mortality level of 71 animals per year for the Gulf of Alaska stock of harbor porpoise.

3.8.4.6 Killer Whale

There are at least three killer whale (*Orcinus orca*) ecotypes in the eastern north Pacific: "residents," "transients," and "offshore" killer whales. Resident animals often differ from both transient and offshore individuals by having a dorsal fin that is more curved and rounded at the tip, especially among mature females. Residents also exhibit five patterns of saddle patch pigmentation, two of which are shared with transients. Transients have more pointed dorsal fins, and closed saddle patches that extend further forward. Offshores are thought to be slightly smaller in body size than residents and transients and have dorsal fins and saddle patches resembling those of residents. (DoN 2006)

Stock

Eastern North Pacific Alaska Resident, Eastern North Pacific Northern Resident, Eastern North Pacific Offshore, Gulf of Alaska, Aleutian Island, and Bering Sea Transient, AT1 Transient; and West Coast Transient

Regulatory Status

The ENP Alaska Resident, ENP Northern Resident, ENP Offshore, GOA, Aleutian Islands, and Bering Sea transient, and West Coast Transient stocks of killer whales are not listed as threatened or endangered under the ESA or classified as depleted or strategic under the MMPA. In June 2004, NMFS designated the AT1 Transient stock of killer whales as a "depleted" stock under the MMPA and therefore classified as strategic. (Angliss and Allen 2009). In the past, the AT1 Transient stock was one of the most frequently encountered and was sighted year-round in Prince William Sound in the 1980s. However, since the 1989 Exxon Valdez oil spill, the size of the AT1 Transient stock has been reduced by half. The AT1 Transient stock is not currently listed as threatened or endangered.

Habitat Preferences

Killer whales have the most ubiquitous distribution of any species of marine mammal, observed in virtually every marine habitat from the tropics to the poles and from shallow, inshore waters (and even rivers) to deep, oceanic regions. Although reported in tropical and offshore waters, killer whales occur in higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes. In the eastern north Pacific, including Alaskan waters, killer whales are found in protected inshore waters, as well as offshore waters. (DoN 2006)

Population Size and Trends

Killer whales are segregated socially, genetically, and ecologically into three distinct eco-type groups: residents, transients, and offshore animals. Resident killer whales primarily feed on fish. "Transient" stocks of killer whales feed on other marine mammals, including other whales, pinnipeds (e.g., London 2006) and sea otters (e.g., Estes et al. 1998) and do not have known schedules and locations as resident whales do. Offshore whales do not appear to mix with the other types of killer whales (Black et al. 1997, Dahlheim et al. 1997). Most cetacean taxonomists agree that multiple killer whale species or subspecies occur worldwide (DoN 2006).

ENP Alaskan Resident stock individuals are found from southeastern Alaska to the Aleutian Islands and Bering Sea; intermixing has been documented among these three areas (Angliss and Outlaw 2007). The ENP Northern Resident stock occurs from British Columbia through part of southeastern Alaska. There are about 656 and 216 photoidentified individuals in the ENP Alaska Resident and ENP Northern Resident stocks, respectively (Angliss and Allen 2009).

The minimum population estimate for the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock is 314 individuals based on photoidentification work. There is a minimum population estimate of 320 individuals in the West Coast Transient stock including about 225 in Washington State and British Columbia, and southeastern Alaska, and 105 off California. The population estimate for the ENP Stock of transient killer whales is 346. The minimum population estimate for the AT1 Transient stock is seven individuals based on photographs from recent years. (Angliss and Allen 2009)

The minimum population estimate for the ENP Offshore stock of killer whales is 1,214 individuals (Carretta et al. 2007). The total number of known Offshore killer whales is 211 individuals, but the proportion of time this transboundary stock spends in U.S. waters is unknown (Carretta et al. 2006). For purposes of acoustic impact modeling, a density of 0.010/km^2 was derived as representative for all killer whales in the TMAA as described in detail in Appendix E.

Distribution

Movement data on ENP Alaska Resident stock individuals have been documented based on photographic matches. Southeast Alaskan killer whale pods have been seen in Prince William Sound and in the GOA. Prince William Sound pods have been seen near Kodiak Island, but have never been observed in southeastern Alaska. Recent studies have documented very limited movements between the Bering Sea and GOA. (Angliss and Allen 2009, DoN 2006)

Transient killer whales in the eastern north Pacific spend most of their time along the outer coast, but visit Hood Canal and Puget Sound in search of harbor seals, sea lions, and other prey. Transient occurrence in inland waters appears to peak during August and September, which is the peak time for harbor seal pupping, weaning, and post-weaning. Offshore killer whales usually occur 9 mi (15 km) or more offshore but also visit coastal waters and occasionally enter protected inshore waters. Along the Pacific coast of North America, killer whales are found along the entire Alaskan coast, and are seen frequently in southeast Alaska and the area between Prince William Sound and Kodiak Island. (Angliss and Allen 2009; DoN 2006)

GOA, Aleutian Islands, and Bering Sea transients are seen throughout the GOA, including occasional sightings in Prince William Sound. Wade et al. (2003) noted that transients were more frequently seen from Shumagin Islands to the eastern Aleutian Islands. The AT1 Transient stock is primarily seen in Prince William Sound and in the Kenai Fjords region. At present, there is no information available to determine if this group regularly uses the TMAA. West coast transients are found from California to northern southeast Alaska. Some individual killer whales have been documented to move between the waters of southeast Alaska and central California. (Angliss and Allen 2009, DoN 2006)

The known range of the ENP Northern Resident stock includes Canadian waters from approximately Mid-Vancouver Island and throughout most of southeastern Alaskan waters. They have also been frequently seen in Washington state waters. (Angliss and Allen 2009, DoN 2006)

In Alaska, sightings of killer whales are widely distributed, mostly occurring in waters over the continental shelf, but also quite frequently in offshore waters. The Resident population is suspected to pass through the TMAA regularly during the summer based on limited satellite tagging data. The sympatric Gulf of Alaska, Aleutian Island, and Bering Sea transient population is suspected to spend considerable time in offshore waters, due to the infrequency of nearshore sightings; however, it is not certain how much time these killer whales spend in the TMAA. Members of the Offshore population have been seen only irregularly adjacent to the TMAA, and although it is likely they pass through it there is not data to document this. (Angliss and Allen 2009, DoN 2006)

There is no known seasonal component to the killer whale's occurrence in the TMAA. Resident, AT1 transient, and Gulf of Alaska, Aleutian Island, and Bering Sea transient populations all remain in the general area during the winter, however, there is no data that specifically places these whales in the TMAA due to lack of substantial research effort offshore and in winter. (Angliss and Allen 2009, DoN 2006)

The April 2009 GOALS survey visually detected six groups of killer whales totaling 119 individuals within the TMAA although there were additional acoustic detections as well (Rone et al. 2009). Analysis of photos taken for identification has not yet been completed and, at present, the specific eco-types for some of these detected killer whales have not been determined.

Life History

Diet in the eastern North Pacific is specific to the type of killer whale. The offshore ecotype appears to eat mostly fish (Bigg 1982, Morton 1990, Heise et al. 2003, Herman et al. 2005). Few details are known about the biology of offshore killer whales, but they commonly occur in groups of 20 to 75 individuals (Wiles 2004).

Transient killer whales show greater variability in habitat use, with some groups spending most of their time foraging in shallow waters close to shore while others hunt almost entirely in open water (Heimlich-Boran 1988, Felleman et al. 1991, Baird and Dill 1995, Matkin and Saulitis 1997). Transient killer whales feed on marine mammals and some seabirds, but apparently no fish (Morton 1990, Baird and Dill 1996, Ford et al. 1998, Ford and Ellis 1999, Ford et al. 2005). Transient killer whales travel in small, matrilineal groups, but they typically contain fewer than 10 animals and their social organization generally is more flexible than in residents (Morton 1990, Ford and Ellis 1999). These differences in social organization probably relate to differences in foraging (Baird and Whitehead 2000).

Reproduction/Breeding

There is no information on the reproductive behavior of killer whales in this area. Among resident killer whales in the northeastern Pacific, births occur largely from October to March, although births can occur year-round (Olesiuk et al. 1990, Stacey and Baird 1997).

While there is a lack of data on the reproduction/breeding activities of transient killer whales, it is thought that calving occurs year-round, but tends to peak in fall through spring. (Angliss and Outlaw 2007) There are no known areas used by killer whales for reproduction or calving in the TMAA.

Diving Behavior

The maximum depth recorded for free-ranging killer whales diving off British Columbia is 866 ft (264 m) (Baird et al. 2005a). On average, however, for seven tagged individuals, less than one percent of all dives examined were to depths greater than 98 ft (30 m). A trained killer whale dove to a maximum of 853 ft (260 m) (Baird et al. 2003). The longest duration of a recorded dive from a radio-tagged killer whale was 17 min (DoN 2006). Details regarding the diving behavior as characterized for acoustic modeling input are provided in Appendix D.

Acoustics

Killer whales produce a wide-variety of clicks and whistles, but most of this species' social sounds are pulsed, with frequencies ranging from 0.5 to 25 kHz (dominant frequency range: 1 to 6 kHz). Echolocation clicks recorded for this species indicate source levels ranging from 195 to 224 dB re: 1 ìPa @ 1 m peak-to-peak (see Table 3.8-3), dominant frequencies ranging from 20 to 60 kHz, and durations of 80 to 120 microseconds (ìsec). Source levels associated with social sounds have been calculated to range from 131 to 168 dB re 1 ìPa @ 1 m and have been demonstrated to vary with vocalization type (e.g., whistles: average source level of 140.2 dB re 1 ìPa @ 1 m, variable calls: average source level of 146.6 dB re 1 ìPa @ 1 m, and stereotyped calls: average source level 152.6 dB re 1 ìPa @ 1 m). Additionally, killer whales modify their vocalizations depending on social context or ecological function (i.e., short-range vocalizations [<5.4 nm {10 km} range]) are typically associated with social and resting behaviors and long-range vocalizations [5.4 to 8.6 nm {10 to 16 km} range] associated with travel and foraging). (DoN 2006)

Resident killer whales are very vocal, making calls during all types of behavioral states. Acoustic studies of resident killer whales in the Pacific Northwest have found that there are dialects in their highly stereotyped, repetitive discrete calls, which are group-specific and shared by all group members. These dialects likely are used to maintain group identity and cohesion, and may serve as indicators of relatedness that help in the avoidance of inbreeding between closely related whales. Dialects have been documented in northern Norway and southern Alaskan killer whale populations and are likely to occur in other regions as well. Residents do not need to alter their sounds (i.e., frequency or amplitude) when hunting fishes, since most of their prey (i.e., salmonids) are not capable of hearing in this frequency range (i.e., >20 kHz).

Transient killer whales, conversely, appear to use passive listening as a primary means of locating prey, call less often, and frequently vocalize or use high-amplitude vocalizations only when socializing (i.e., not hunting), trying to communicate over long distances, or after a successful attack, as a result of their prey's ability (i.e., primarily other marine mammal species) to hear or "eavesdrop" on their sounds. Discrete pulsed calls were recently identified in the vocal repertoire of the AT1 transients and for transients off southern Alaska, indicating that transients may maintain reproductive and socially isolated subpopulations using distinct vocalizations as well. (DoN 2006)

Both behavioral and auditory brainstem response (ABR) techniques indicate killer whales can hear a frequency range of 1 to 100 kHz and are most sensitive at 20 kHz, which is one the lowest maximum-sensitivity frequency known among toothed whales (DoN 2006).

Impacts of Human Activity

Fisheries Interactions

Three commercial fisheries in Alaska have caused serious injuries or mortalities of killer whales (any stock) between 2000 and 2004: the Bering Sea and Aleutian Islands flatfish trawl, the Bering Sea and Aleutian Islands pollock trawl and the Bering Sea and Aleutian Islands pacific cod longline. Recently observers have collected tissue samples of many of the killer whales which were killed incidental to commercial fisheries. Genetics analysis have indicated that the mortalities incidental to the Bering Sea and Aleutian Islands flatfish trawl and the Bering Sea and Aleutian Islands Pacific cod fisheries are of the "resident" type, and mortalities incidental to the Bering Sea and Aleutian Islands pollock trawl fisheries are of the "transient" type. The estimated minimum mortality rate for resident killer whales incidental to U.S. commercial fisheries recently monitored is 1.5 animals per year, based completed on observer data. The estimated minimum mortality rate for transient killer whales incidental to U.S. commercial fisheries recently monitored is 0.4 animals per year, based completely on observer data. (Angliss and Allen 2009)

Other Mortality

During the 1992 killer whale surveys conducted in the Bering Sea and western GOA, 9 of 182 individual whales in 7 of the 12 pods encountered had evidence of bullet wounds. The relationship between wounding due to shooting and survival is unknown. There have been no obvious bullet wounds observed on killer whales during recent surveys in the Bering Sea and western GOA. However, researchers have reported that killer whale pods in certain areas exhibit vessel avoidance behavior, which may indicate that shootings occur in some places. (Angliss and Allen 2009)

3.8.4.7 Minke Whale

Stock

Alaska

Regulatory Status

Minke whales (*Balaenoptera acutorostrata*) are not listed as threatened or endangered under the ESA or designated as depleted under the MMPA. Because minke whales are considered common in the waters off Alaska and the number of human-related removals are currently thought to be minimal, the Alaska stock is not considered a strategic stock.

Habitat Preferences

Minke whales typically occupy waters over the continental shelf, including inshore bays and some estuaries. In the eastern north Pacific, minke whales are found feeding off California and Washington State in waters over the continental shelf. Based on whaling catches and surveys worldwide, there is also a deep-ocean component to the minke whale's distribution. In the western North Pacific, minke whales occur extensively in deep waters. Most sightings of minke whales in the central-eastern Bering Sea occur along the upper slope in waters with a bottom depth of 328 to 656 ft (100 to 200 m). Minke whales are relatively common in the Bering and Chukchi Seas and in the inshore areas of the GOA. (DoN 2006)

Population Size and Trends

The NMFS recognizes three stocks of minke whales within the Pacific U.S. EEZ: a California/Oregon/Washington stock, an Alaskan stock, and a Hawaiian stock (Carretta et al. 2006). There are no current estimates of abundance are available for minke whales in Alaskan waters (Angliss and Allen 2009). For purposes of acoustic impact modeling, a density of 0.0006/km^2 was derived for minke whales in the TMAA as described in detail in Appendix E.

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 are present in the North Pacific from near the equator to the Arctic. The number of sightings of minke whales in the GOA is generally sparse. The summer range extends to the Chukchi Sea. In the winter, minke whales are found south to within 2° of the equator. The distribution of minke whale vocalizations (specifically, "boings") suggests that the winter breeding grounds are the offshore tropical waters of the North Pacific Ocean. In the northern part of their range, minke whales are believed to be migratory, although there is no obvious migration from low-latitude, winter breeding grounds to high-latitude, summer feeding locations in the western North Pacific as there is in the North Atlantic. However, there are some monthly changes in densities in both high and low latitudes. Minke whales are seen in several locations year-round in the eastern north Pacific. (Angliss and Allen 2009)

It is believed that minke whales are more abundant in the nearshore waters of the Aleutian Islands than in the waters of the TMAA. Minke whales are known to be a migratory species; however, the patterns are not as well-known or defined as for some other species, such as gray and humpback whales. There are no winter sightings of this species in this area. (DoN 2006)

The number of sightings of minke whales in the GOA is generally sparse (DoN 2006). Large numbers of minke whales were reported at Portlock Bank (in the TMAA) and Albatross bank (west of the TMAA) during May 1976; however, subsequent NMFS surveys encountered none at those locations (Fiscus et al. 1976). Six sightings in shallow water (<656 ft [200 m]) and two in deep water (>3,281 ft [1,000 m]) were reported in 1987. Waite (2003) reported three sightings at or inshore of the shelf break in the northern margin of the TMAA. Two encounters totaling three individual minke whales occurred on the shelf during the April 2009 survey although only one of these encounters (at Portlock Bank) was within the TMAA (Rone et al. 2009).

Life History

Although minke whales are distributed in polar, temperate, and tropical waters (Jefferson et al. 1993), there is no obvious migration from low-latitude, winter breeding grounds to high-latitude, summer feeding locations in the western North Pacific (Horwood 1990).

Reproduction/Breeding

Stewart and Leatherwood (1985) suggested that mating occurs in winter or early spring although it had never been observed. There are no known areas used by minke whales for reproduction or calving in the TMAA.

Diving Behavior

Details of minke whale dive behavior as characterized for acoustic modeling are provided in Appendix D. A general surfacing pattern of minke whales consisting of about four surfacings interspersed by short-duration dives averaging 38 sec have been recorded. After the fourth surfacing, there was a longer duration dive ranging from approximately 2 to 6 min. Minke whales are lunge-feeding "gulpers," like most other rorquals. (DoN 2006)

Acoustics

Recordings of minke whale sounds indicate the production of both high- and low-frequency sounds (range: 0.06 to 20 kHz, see Table 3.8-3). Minke whale sounds have a dominant frequency range of 0.06 kHz to greater than 12 kHz, depending on sound type. There are two basic forms of pulse trains: a "speed-up" pulse train (dominant frequency range: 0.2 to 0.4 kHz) with individual pulses lasting 40 to 60 milliseconds (ms), and a less common "slow-down" pulse train (dominant frequency range: 50 to 0.35 kHz) lasting for 70 to 140 ms. Source levels for this species have been estimated to range from 151 to 175 dB re 1 ìPa @ 1 m. Source levels for some minke whale sounds have been calculated to range from 150 to 165 dB re 1 ìPa @ 1 m. In the Southern Hemisphere a complex and stereotyped sound sequence ("star-wars vocalization") was recorded. This sound sequence spanned a frequency range of 50 Hz to 9.4 kHz. Broadband source levels between 150 and 165 dB re 1 ìPa @ 1 m were calculated. "Boings" recorded in the North Pacific have many striking similarities to the star-wars vocalization in both structure and acoustic behavior. “Boings,” recently confirmed to be produced by minke whales and suggested to be a breeding display, consist of a brief pulse at 1.3 kHz followed by an amplitude-modulated call with greatest energy at 1.4 kHz, with slight frequency modulation over a duration of 2.5 sec. (DoN 2006) While no empirical data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes are most adapted to hear low to infrasonic frequencies.

Impacts of Human Activity

Fisheries Interactions

Six different commercial fisheries operating in Alaska waters within the range of the Alaska minke whale stock were monitored for incidental take by NMFS observers during 2000-2004: Bering Sea and Aleutian Islands groundfish trawl, longline and pot fisheries, and GOA groundfish trawl, longline, and pot fisheries. The Bering Sea/Aleutian Islands groundfish trawl fisheries caused one mortality of a minke whale in 2000. The total estimated mortality and serious injury incurred by this stock as a result of interactions with U.S. commercial fisheries is 0.32 minke whales annually.

3.8.4.8 Pacific White-sided Dolphin

Stock

North Pacific

Regulatory Status

Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The North Pacific stock is not classified as strategic.

Habitat Preferences

Pacific white-sided dolphins occur in temperate North Pacific waters over the outer continental shelf and slope, and in the open ocean. In the eastern north Pacific, the species occurs from the southern Gulf of California, north to the GOA, west to Amchitka in the Aleutian Islands, and is rarely encountered in the southern Bering Sea. The species is commonly found on both the high seas and along the continental margins, and animals are known to enter the inshore passes of Alaska, British Columbia, and Washington. (Angliss and Allen 2009, DoN 2006)

Population Size and Trends

The minimum population estimate for the North Pacific stock is 26,880 (CV=0.90) individuals (Angliss and Allen 2009). For purposes of acoustic impact modeling, a density of 0.0208/km^2 was derived for Pacific white-sided dolphins in the TMAA as described in detail in Appendix E.

Distribution

Pacific white-sided dolphins occur across the central North Pacific waters to latitudes as low as (or lower than) 38°N and northward to the Bering Sea and coastal areas of southern Alaska. Surveys suggest a seasonal north-south movement of Pacific white-sided dolphins in the eastern north Pacific, with animals found primarily off California during the colder water months and highest densities shifting northward into Oregon and Washington State as water temperatures increase during late spring and summer. (Angliss and Allen 2009; DoN 2006)

Pacific white-sided dolphins occur regularly year-round throughout the GOA. They are widely distributed along the shelf break, continental slope, and in offshore waters. Inshore movements of Pacific white-sided dolphins are not common, but instances have been documented in Washington State, British Columbia, and southeast Alaska. In Alaska, peak abundance is between July and August, when Pacific white-sided dolphins tend to congregate near the Fairweather Grounds in the southeastern GOA and Portlock Bank in the northeast part of the TMAA. (Angliss and Allen 2009; DoN 2006)

Previous survey data did not indicate the potential for a large number of Pacific white-sided dolphins in the vicinity of the TMAA (DoN 2006). Waite (2003), however, reported sighting two large groups (an average group size 56) just off Kenai Peninsula. This was previously characterized as an area of rare occurrence (relatively shallow waters) (DoN 2006). As a result of this new information, for purposes of acoustic impact modeling Pacific white-sided dolphins are analyzed as having the second highest density for cetaceans in the TMAA. The GOALS survey encountered Pacific white-sided dolphins only once (a group of 60 individuals) although this was outside the TMAA inside the shelfbreak to the southeast of Kodiak Island (Rone et al. 2009).

Life History

The diet in the eastern North Pacific includes cephalopods and fish (Schwartz et al. 1992, Black 1994, Heise 1997, Brownell et al. 1999, Morton 2000), and includes salmonids off Washington (Stroud et al. 1981). In this gregarious species, group sizes range from tens to thousands of dolphins (Leatherwood et al. 1984). They frequently aggregate with Risso's and northern right whale dolphins (Brownell et al. 1999).

Reproduction/Breeding

Calving occurs from June through August (Heise 1997). There are no known areas used by pacific white-sided dolphins for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for Pacific white-sided dolphins are provided in Appendix D. Pacific white-sided dolphins in the eastern north Pacific feed primarily on epipelagic fishes and cephalopods. This does not appear to be a deep-diving species. Based on feeding habits, it has been inferred that Pacific white-sided dolphins dive to at least 120 m. The majority of foraging dives last less than 15 to 25 sec. (DoN 2006)

Acoustics

Vocalizations produced by Pacific white-sided dolphins include whistles and echolocation clicks. Whistles are in the frequency range of 2 to 20 Hz. Echolocation clicks range in frequency from 50 to 80 kHz (see Table 3.8-3); the peak amplitude is 170 dB re 1 µPa @ 1 m. (DoN 2006)

Tremel et al. (1998) measured the underwater hearing sensitivity of Pacific white-sided dolphins from 0.075 kHz through 150 kHz. The greatest sensitivities were from 2 to 128 kHz, while the lowest measurable sensitivities were 145 dB at 100 Hz and 131 dB at 140 kHz. Below 8 Hz and above 100 kHz, this dolphin's hearing was similar to that of other toothed whales. (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

As a result in changes in fishery practices, there were no serious injuries or mortalities incidental to observed commercial fisheries between 2000 and 2004 for this species. (Angliss and Allen 2009)

3.8.4.9 Stejneger's Beaked Whale

Stock

Alaska

Regulatory Status

Stejneger's beaked whales (*Mesoplodon stejnegeri*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The Alaska stock is not classified as strategic.

Habitat Preferences

Stejneger's beaked whales (also called Bering Sea beaked whales) appear to prefer cold-temperate and subpolar waters, although strandings have been reported as far south as Monterey, California (Reeves et al. 2002). World-wide, beaked whales normally inhabit continental slope and deep oceanic waters (>656 ft [200 m]). In many locales, occurrence patterns have been linked to physical features, in particular, the continental slope, canyons, and escarpments, and oceanic islands. Off Alaska, this species has been observed in waters ranging in bottom depth from 2,395 to 5,118 ft (730 to 1,560 m) on the steep slope of the continental shelf as it drops off into the Aleutian Basin which exceeds 11,483 ft (3,500 m) in bottom depth. (DoN 2006)

Population Size and Trends

No current estimates of abundance are available for Stejneger's beaked whales in Alaskan waters (Angliss and Allen 2009). Groups of 3 to 15 Stejneger's beaked whales were sighted on a number of occasions in the 1980s near the central Aleutian Islands (Rice 1986). There were no beaked whales detected acoustically or visually (although two groups of unidentified small whale were sighted) during the April 2009 survey of the TMAA (Rone et al. 2009). It has been suggested, however, that Stejneger's beaked whales are probably the most common beaked whales in these Alaskan waters (DoN 2006). For that reason, analysis of impacts for Stejneger's beaked whales will be considered using the results of acoustic impact modeling from Cuvier's beaked whales as a surrogate, given that sufficient information exists for Cuvier's beaked whales, they are in the same taxonomic family, and the predicted density of Cuvier's beaked whale in GOA is higher than that of Baird's beaked whales and therefore presumably errs on the side of overestimation.

Distribution

Stejneger's beaked whales (also called Bering Sea beaked whales) appear to prefer cold-temperate and subpolar waters and are found only in the North Pacific. The Alaska stock is recognized as separate from the species off California (Angliss and Outlaw 2007). Off Alaska, this species has been observed in waters ranging in bottom depth from 730 to 1,560 m (2,395 to 5,118 ft) on the steep slope of the continental shelf as it drops off into the Aleutian Basin (which exceeds 3,500 m [11,482 ft] in bottom depth) (DoN, 2006). Stejneger's beaked whales are found only in the North Pacific. The species range from the waters off southern California, north to the Bering Sea, and south to the Sea of Japan (Reeves et al. 2003).

Life History

Observed group sizes for beaked whales are typically small. Stejneger's beaked whales have been observed in groups of 5 to 15 individuals, often containing individuals of mixed sizes (Jefferson et al. 1993). Most sightings of beaked whales are brief since these whales are often difficult to approach and they actively avoid aircraft and vessels (e.g., Würsig et al. 1998).

Reproduction/Breeding

There is no available information on the reproduction or breeding of this species. There are no known areas used by Stejneger's beaked whales for reproduction or calving in the TMAA.

Diving Behavior

Most sightings of beaked whales are brief since these whales are often difficult to approach, and they actively avoid aircraft and vessels. Stejneger's beaked whale stomach contents include squids and pelagic fish. Until recently, it was thought that all beaked whales probably feed at or close to the bottom in deep oceanic waters, taking whatever suitable prey was encountered or was locally abundant, by suction-feeding. However, based on recent tagging data from Cuvier's and Blainville's beaked whales, it is suggested that feeding might actually occur at midwater rather than only at or near the bottom. Durations of long dives for *Mesoplodon* species are over 20 min. (DoN 2006)

Acoustics

There is no information available for Stejneger's beaked whale vocalizations. Sounds recorded from beaked whales are, in general, divided into two categories: whistles and pulsed sounds (clicks), with whistles likely serving a communicative function, and pulsed sounds being important in foraging and/or navigation. Whistle frequencies are about 2 to 12 kHz, while pulsed sounds range in frequency from 300 Hz to 135 kHz, however, higher frequencies may not be recorded due to equipment limitations. (DoN 2006)

There is no empirical information available on the hearing abilities of Stejneger's beaked whales. (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

From 1990 to 2002, six different commercial fisheries operating within the range of the Alaska stock of Stejneger's beaked whale were monitored for incidental take. These fisheries included Bering Sea (and Aleutian Islands) ground fish trawl, longline, and pot fisheries and GOA groundfish trawl, longline, and pot fisheries. No Stejneger's beaked whale mortalities were observed. (Angliss and Outlaw 2007)

3.8.5 Non-ESA Pinniped Species

3.8.5.1 California Sea Lion

Stock

United States

Regulatory Status

California sea lions (*Zalophus californianus*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The U.S. stock is not classified as strategic.

Habitat Preferences

Alaska waters are north of the main breeding and feeding range located in California. California sea lions congregate near rookery islands in California waters and typically feed over the continental shelf staying within approximately 27 nm (50 km) of rookery islands although are occasionally sighted up to several hundred kilometers offshore (DoN 2006). California sea lions recorded in Alaska usually are observed at Steller sea lion rookeries and haulout sites and are present throughout the year (DoN 2006).

Population Size and Trends

The U.S. stock of California sea lions can be found in the GOA. The estimated stock is 238,000 individuals (Carretta et al. 2007). This number is from counts during the 2001 breeding season of animals that were ashore at the four major rookeries in Southern California and at haulout sites north to the Oregon/California border. Sea lions that were at sea or were hauled out at other locations were not counted (Carretta et al. 2007). The general trend for this stock is that the population is growing (Carretta et al. 2007). There are not sufficient numbers of individuals of this species present in the TMAA to allow for acoustic impact modeling given they are rare.

Distribution

The primary rookeries for California sea lions are located on the California Channel Islands. 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). The first recorded account of a California sea lion in Alaska was in 1973 at Point Elrington in the northern GOA (Maniscalco et al. 2004). Since then, 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 in recent years (Maniscalco 2002, DoN 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 GOA throughout the year. (Maniscalco et al. 2004, DoN 2006).

Life History

Survey data from 1975 to 1978 were analyzed to describe the seasonal shifts in the offshore distribution of California sea lions (Bonnell and Ford 1987). During summer, the highest densities were found immediately west of San Miguel Island. During autumn, peak densities of sea lions were centered on Santa Cruz Island. During winter and spring, peak densities occurred just north of San Clemente Island. The seasonal changes in the center of distribution were attributed to changes in the distribution of the prey species. If California sea lion distribution is determined primarily by prey abundance, these same areas might not be the center of sea lion distribution every year.

The distribution and habitat use of California sea lions vary with the sex of the animals and their reproductive phase. Adult males haul out on land to defend territories and breed from mid-to-late May until late July. Individual males remain on territories for 27–45 days without going to sea to feed. During August and September, after the mating season, the adult males migrate northward to feeding areas as far away as the GOA (Lowry et al. 1991). They remain there until spring (March–May), when they migrate back to the breeding colonies. Distribution of immature California sea lions is less well known, but some make northward migrations that are shorter in length than the migrations of adult males (Huber 1991). However, most immature seals are presumed to remain near the rookeries (Lowry et al. 1991). Adult females remain near the rookeries throughout the year.

Reproduction/Breeding

Most sea lion births occur from mid-June to mid-July (peak in late June) on the island rookeries in California and Mexico. GOA is outside the known breeding range for California sea lion. There are no known areas used by California sea lions for reproduction or calving in the TMAA.

Diving Behavior

California sea lions usually do not need to dive very deeply, since most of their food is found in shallow waters, about 85 to 243 ft (26 to 74 m) deep. They can, however, dive to depths of about 900 ft (274 m).

California sea lions typically stay submerged 3 min or less; however, they can remain submerged for as long as 10 min. (Carretta et al. 2007)

Acoustics

In air, California sea lions make incessant, raucous barking sounds; these have most of their energy at less than 2 kHz. The male barks have most of their energy at less than 1 kHz. Males vary both the number and rhythm of their barks depending on the social context; the barks appear to control the movements and other behavior patterns of nearby conspecifics. Females produce barks, squeals, belches, and growls in the frequency range of 0.25 to 5 kHz, while pups make bleating sounds at 0.25 to 6 kHz (see Table 3.8-3). California sea lions produce two types of underwater sounds: clicks (or short-duration sound pulses) and barks. All underwater sounds have most of their energy below 4 kHz. (DoN 2006)

The range of maximal sensitivity underwater is between 1 and 28 kHz. Functional underwater high frequency hearing limits are between 35 and 40 kHz, with peak sensitivities from 15 to 30 kHz. California sea lions show relatively poor hearing at frequencies below 1,000 Hz. Peak sensitivities in air are shifted to lower frequencies; the effective upper hearing limit is approximately 36 kHz. The best range of sound detection is from 2 to 16 kHz. Older sea lions (22 to 25 years of age) show in-air and underwater hearing losses that range from 10 dB at lower frequencies to 50 dB near the upper frequency limit. It has been determined that hearing sensitivity generally worsens with depth—hearing thresholds were lower in shallow water, except at the highest frequency tested (35 kHz), where this trend was reversed. (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

Between 2000 and 2004, the mean annual serious injury and mortality to California sea lions from fisheries in California was 159 individuals. Other mortalities (boat collisions, power plant intake entrapment, shootings, marine debris, and unknown) added an additional 74 sea lions annually (NMFS 2007).

3.8.5.2 Harbor Seal

Stock

Three separate stocks of harbor seals are currently recognized in Alaska waters although there is substantial evidence that the population is more finely divided and may consist of a minimum of 12 stocks (DoN 2006, Angliss and Allen 2009). The three currently recognized stocks under MMPA are: Southeast Alaska stock (the Alaska/British Columbia border to Cape Suckling, Alaska), the Bering Sea stock (including all waters north of Unimak Pass), and the Gulf of Alaska stock (Cape Suckling, Alaska to Unimak Pass and throughout the Aleutian Islands). Animals from the Gulf of Alaska stock may be found in the TMAA.

Regulatory Status

Harbor Seal (*Phoca vitulina richardsi*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The U.S. stock is not classified as strategic.

Habitat Preferences

Harbor seals are coastal animals that primarily occur within 11 nm (20 km) from shore (Baird 2001, Lowery et al. 2001, Small et al. 2005). Harbor seals are considered abundant throughout most of their range which extends from Baja California to the eastern Aleutian Islands. In Alaska, they range from the Dixon Entrance to Kuskokwim Bay, are widely distributed along the coastal GOA (Angliss and Outlaw

2007), and are also found on offshore islands (Hoover 1988). There are over 300 coastal haulout sites for harbor seals in the GOA (Boveng et al. 2003). Harbor seals are abundant in fjords with tidewater glaciers, Prince William Sound, in several areas in the Kodiak Archipelago, and in major estuaries, particularly along the north side of the Alaska Peninsula (Hoover 1988, Lowrey et al. 2001, Boveng et al. 2003). There are haul outs along the shoreline of southeast Alaska, the south side of the Alaska Peninsula, the Aleutian Islands, and Middleton and Montague Islands (Hoover 1988, Lowrey et al. 2001). There is none of the harbor seal's preferred coastal habitat within the waters of the TMAA.

Population Size and Trends

Minimum population estimates for the Gulf of Alaska stock is 45,975 (CV=0.04) (Angliss and Allen 2009).

Distribution

The harbor seal is one of the most widespread of the pinniped species distributed from the eastern Baltic Sea, west across the Atlantic and Pacific Oceans to southern Japan, along the coast and offshore islands of Gulf of Alaska (DoN 2006). The harbor seal's preferred coastal habitat does not extend into the waters of the TMAA. Studies using satellite tags have documented the movements and home range of harbor seals in the vicinity of the TMAA (Lowry et al. 2001, Small et al. 2005). Although these tagging studies have documented harbor seal movement into deep water (beyond the shelf break) in the GOA, these movements are the exception. With few exceptions, harbor seals will be located in shallow nearshore areas and not at sea in the TMAA. Harbor seals, therefore, should be very rare in the small section of the TMAA nearest Kenai Peninsula, Montague Island, and Middleton Island. No harbor seals were encountered within the TMAA during the April 2009 GOALS survey (Rone et al. 2009).

Life History

On land, harbor seals tend to congregate in small groups of about 30 to 80 individuals, although larger groups are found in areas where food is plentiful. In Alaska, group size at haulouts ranges from 25 animals to more than 1,000 in some areas. (DoN 2006)

Information from tagged seals has indicated movement from haulouts to sea was age dependent with 3-5 nm (5-10 km) for adults and 5-14 nm (10-25 km) for juveniles (Lowry et al. 2001). Although some harbor seal pups made extensive movements, approximately 97% of pups were located less than 25 km from their haulouts (Small et al. 2005).

Reproduction/Breeding

In the Gulf of Alaska, male harbor seals attain sexual maturity around 5 to 6 years of age, while females are usually sexually mature at 5 years. Pups are typically born from late May through June. In general, the pupping season lasts up to 10 weeks with a two-week peak. Suckling harbor seal pups spend as much as 40% of their time in the water. The nursing period is approximately four to six weeks and after the pups are weaned, mating, which takes place in the water, may take place shortly thereafter. In the Gulf of Alaska, mating takes place from late June through July. Delayed implantation occurs for about 11 weeks after mating. (Don 2006)

Diving Behavior

Harbor seals are generally shallow divers. About 50% of their diving is shallower than 40 m, and 95% is shallower than 250 m. Dive durations are typically shorter than 10 min, with about 90% lasting less than 7 min. A tagged harbor seal in Monterey Bay dove as deep as 481 m. Harbor seal pups swim and dive with their mothers, although they dive for short periods compared with their mothers. Recorded dive durations for older individuals may be as long as 32 min. (DoN 2006)

Acoustics

Harbor seal males produce a variety of low-frequency (<4 kHz) in-air vocalizations including snorts, grunts, and growls, while pups make individually unique calls for mother recognition (contain multiple harmonics with main energy below 0.35 kHz). Adult males also produce several underwater sounds during the breeding season that typically range from 0.025 to 4 kHz (duration range: 0.1 s to multiple seconds) with individual variation in the dominant frequency range of sounds between different males. (DoN 2006)

Harbor seals hear nearly as well in air as underwater (Kastak and Schusterman 1998). Harbor seals hear frequencies from 1 to 180 kHz (most sensitive at frequencies below 50 kHz; above 60 kHz sensitivity rapidly decreases) in water and from 0.25 kHz to 30 kHz in air (most sensitive from 6 to 16 kHz using behavior and auditory brainstem response testing). (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

Harbor seals often become caught in from gillnets when attempting to salmon that have been caught. For the Gulf of Alaska stock, the estimated minimum annual mortality rate incidental to commercial fisheries is 24 animals (Angliss and Allen 2009).

Subsistence Interactions

The MMPA restricts the hunting of harbor seals to Alaska Natives. In some areas, harbor seals are an important part of the subsistence economy. Angliss and Allen (2008) report that based on data from Alaska Department of Fish and Game for the years 2000 to 2004, the annual number of harbor seal taken from the Gulf of Alaska stock is 795 animals.

3.8.5.3 Northern Elephant Seal

Stock

California Breeding

Regulatory Status

Northern elephant seals (*Mirounga angustirostris*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The California Breeding stock is not classified as strategic.

Habitat Preferences

Breeding and molting habitats for northern elephant seals are characterized by sandy beaches, mostly on offshore islands, but also in some mainland locations, along the coast. When on shore, seals will also use small coves and sand dunes behind and adjacent to breeding beaches. They rarely enter the water during the breeding season, but some seals will spend short periods in tide pools and alongshore; these are most commonly weaned pups that are learning to swim. Feeding habitat is mostly in deep, offshore waters of warm temperate to subpolar zones. Some seals will move into subtropical or tropical waters while foraging. (DoN 2006)

Population Size and Trends

The California Breeding stock of the northern elephant seal has recovered from near extinction in the early 1900s to an estimated 124,000 (Carretta et al., 2007). Current census data suggest an increasing population trend. Although movement and genetic exchange continue between rookeries, most elephant seals return to their natal rookeries to breed. The California and Mexican Breeding groups may be demographically isolated and are currently considered two separate stocks. Individuals from the

California Breeding stock do occur in the GOA, typically only sub-adult and adult male elephant seals forage in the GOA (Le Boeuf et al. 2000). The population size has to be estimated since all age classes are not ashore at any one time of the year. There are now at least 101,000 elephant seals in the California Breeding stock (Carretta et al. 2007), Numbers in this stock are increasing by around 6 percent annually (Stewart et al. 1994, Carretta et al. 2007). For purposes of acoustic impact modeling, a density of 0.0022/km^2 was derived for elephant seals in the TMAA as described in detail in Appendix E.

Distribution

Northern elephant seals are endemic to the North Pacific Ocean, occurring almost exclusively in the eastern and central North Pacific. Adult males range further north into the GOA and along the Aleutian Islands. Vagrant individuals do sometimes range to the western North Pacific. The most far-ranging known individual appeared on Nijima Island, off the Pacific coast of Japan in 1989 demonstrating the great distances these animals are capable of covering. (DoN 2006)

Adult males and females segregate while foraging and migrating (Stewart and DeLong 1995, Stewart 1997). 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 TMAA. In contrast, adult males range further north and east into the GOA and along the Aleutian Islands to between 47°N and 58°N (Stewart and Huber 1993, Stewart and DeLong 1995, Le Boeuf et. al. 2000). Northern elephant seal males regularly occur in the GOA year-round (Calkins 1986). Adults stay offshore during migration, while juveniles and subadults are often seen along the coasts of Oregon, Washington State, and British Columbia (Condit and Le Boeuf 1984, Stewart and Huber 1993). Females may cover over 18,000 km (11,185 mi) and males over 21,000 km (13049 mi) during these postbreeding migrations (Stewart and DeLong 1995). There are few records of northern elephant seals being present in southeast Alaska. (DoN 2006)

Life History

Northern elephant seals haul out on land to give birth and breed from December through March, and pups remain hauled out through April. After spending time at sea to feed (post-breeding migration), they generally return to the same areas to molt (Odell 1974, Stewart and Yochem 1984, Stewart and DeLong 1995). However, they do not necessarily return to the same beach. Adult males tend to haul out to molt between June and August (peaking in July), whereas females and juveniles haul out to most between March and May (peaking in April). Sub-adult and adult male northern elephant seals are found in the MAA predominately in the spring and fall (Le Boeuf et al. 2000). For much of the year, northern elephant seals feed mostly in deep, offshore waters, and their foraging range extends thousands of kilometers offshore from the breeding range into the eastern and central North Pacific (Stewart and DeLong 1995, Stewart 1997, Le Boeuf et al. 2000). Adult males and females segregate while foraging and migrating; females mostly range west to about 173°W, between the latitudes of 40°N and 45°N, whereas males range further north into the GOA and along the Aleutian Islands, to between 47°N and 58°N (Stewart and Huber 1993, Stewart and DeLong 1995, Le Boeuf et al. 2000).

Reproduction/Breeding

The elephant seal pupping/breeding season occurs from December through March on the rookeries in California and Mexico. There are no known areas used by elephant seals for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for elephant seals are provided in Appendix D. Elephant seals are probably the deepest and longest diving pinnipeds; few other mammals can match their abilities. Adults dive continuously, day and night, during their feeding migrations. Elephant seals may spend as much as 90 percent of their time submerged; this year-round pattern of continuous, long, deep dives explains why northern elephant seals are rarely seen at sea and why their oceanic whereabouts and migrations have long been unknown. The average diving cycle consists of a 23-min dive, followed by a 2- to 4-min surface interval. The longest known dive is 106 min. Dives average between 1,148 and 1,805 ft (350 and 550 m) in depth and can reach as deep as 5,121 ft (1,561 m; females) and 5,200 ft (1,585 m; males). (DoN 2006)

Acoustics

Northern elephant seals produce loud, low-frequency in-air vocalizations. The mean fundamental frequencies are in the range of 147 to 334 Hz for adult males. The mean source level of the male produced vocalizations during the breeding season is 110 dB re 20 ìPa. In-air calls made by aggressive males include (1) snoring, which is a low-intensity threat; (2) a snort (0.2 to 0.6 kHz) made by a dominant male when approached by a subdominant male; and (3) a clap threat (<2.5 kHz) which may contain signature information at the individual level. Seismic (low frequency) vibrations accompany these in-air vocalizations; they are produced as males move about and vocalize on sand beaches. These sounds appear to be important social cues. The mean fundamental frequency of airborne calls for adult females is 500 to 1,000 Hz. In-air sounds produced by females include a <0.7 kHz belch roar used in aggressive situations and a 0.5 to 1 kHz bark used to attract the pup. Pups use a <1.4 kHz call to maintain contact with the mother. Evidence for underwater sound production by this species is scant. Except for one unsubstantiated report, none have been definitively identified. (DoN 2006)

The audiogram of northern elephant seals indicates that this species is well-adapted for underwater hearing; sensitivity is best between 3.2 and 45 kHz (see Table 3.8-3), with greatest sensitivity at 6.4 kHz and an upper frequency cutoff of approximately 55 kHz. Elephant seals exhibit the greatest sensitivity to low frequency (<1 kHz) sound among seals in which hearing has been tested. In-air hearing is generally poor, but is best for frequencies between 3.2 and 15 kHz, with greatest sensitivity at 6.3 kHz. The upper frequency limit in air is approximately 20 kHz. Elephant seals are relatively good at detecting tonal signals over masking noise. (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

Stranding data reported to the California, Oregon, and Washington Marine Mammal stranding Networks in 2000-2004 include elephant seal injuries caused by hook-and-line fisheries (two injuries) and gillnet fisheries (one injury). The estimated mortality and serious injury of northern elephant seals (California Breeding stock) in commercial fisheries that might take this species is less than 8.8 animals per year. (Carretta et al. 2007)

Other Interactions

Stranding databases for California, Oregon, and Washington states that are maintained by NMFS contain the following records of human-related elephant seal mortalities and injuries in 2000-2004: (1) boat collisions (3 mortalities), (2) power plant entrainment (1 mortality), (3) shootings (4 mortalities), and (4) entanglement in marine debris (10 mortalities). This results in a minimum annual average of 1.6 nonfishery related mortalities for 2000-2004. (Carretta et al. 2007)

3.8.5.4 Northern Fur Seal

Stock

Eastern Pacific

Regulatory Status

The northern fur seal is not listed as threatened or endangered under the ESA. The Eastern Pacific stock of northern fur seal is classified as a strategic stock because it is designated as depleted under the MMPA.

Habitat Preferences

Northern fur seals are a highly oceanic species spending all but 35 to 45 days per year at sea. They are usually sighted 38 to 70 nm (70 to 130 km) from land along the continental shelf and slope, seamounts, submarine canyons, and sea valleys, where there are upwellings of nutrient-rich water. The Pribilof Islands in the Bering Sea are the rookery location for most of the worldwide population during the summer breeding season (Angliss and Allen 2009). Following the breeding season, most females and juveniles migrate south to waters off British Columbia, Washington, Oregon, and California, and most adult males remain in the GOA (DoN 2006).

Population Size and Trends

Two stocks of northern fur seals are recognized in U.S. waters: an Eastern Pacific stock and a San Miguel Island stock. The Eastern Pacific stock includes the Pribilof Island breeding group in the Bering Sea. The most recent population estimate for the Eastern Pacific stock is 665,550 (Angliss and Allen, 2008). The population of fur seals in the Pribilof Islands is declining for unknown reasons. The northern fur seal is a "strategic" stock because it is considered "depleted" under the MMPA because the population has declined from the 1.8 million animals estimated in the 1950s (Angliss and Outlaw 2006). For purposes of acoustic impact modeling, a density of 0.1180/km^2 was derived for northern fur seals in the TMAA as described in detail in Appendix E.

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. 2006). They are a coldwater species and when at sea they are usually sighted in forage areas along the continental shelf and slope 38 to 70 nm (70 to 130 km) from land and along the continental shelf and slope where they typically forage (Kajimura 1984). The Eastern Pacific stock spends May–November in northern waters and at northern breeding colonies (north of the GOA). 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 GOA (Kajimura 1984). Maximum numbers are found in the southern extent of their range in waters from 42ºN to 34ºN during February–April. By early June, most seals of the Eastern Pacific stock have migrated back to northern waters (Antonelis and Fiscus 1980).

Peak abundance in the TMAA should occur between March and June during the annual migration north to the Pribilof Islands breeding grounds (Fiscus et al. 1976, Consiglieri et al. 1982). Tagging data presented by Ream et al. (2005) indicate the main foraging areas and the main migration route through the GOA are located far to the west of the TMAA. There are no rookeries or haulout sites in the vicinity of the TMAA. Some northern fur seals, particularly juvenile males and nonpregnant females, remain in the GOA throughout the summer and have been documented in the nearshore waters of Southeastern Alaska, Prince William Sound, Portlock Bank, and the middle of the GOA (Calkins 1986, Fiscus et al. 1976). (DoN 2006) The 2009 GOALS survey (Rone et al. 2009) did not encounter any northern fur seals in the TMAA although the acoustic analysis assumes they are the second-most abundant marine mammal in the area. It is likely, therefore, that effects from Navy activities on this species in this analysis are an overestimate.

Life History

Northern fur seals are solitary at sea but tend to congregate in food-rich areas where as many as 100 individuals have been sighted (Antonelis and Fiscus 1980, Kajimura 1984). Northern fur seals feed opportunistically on a variety of fish and squids species throughout their range (Kajimura, 1984).

Northern fur seals are gregarious during the breeding season and maintain a complex social structure on the rookeries. The largest rookery is on St. Paul and St. George Islands in the Pribilof Islands Archipelago in Alaska. Smaller breeding colonies are located on the Kuril Islands, Robben Island, and the Commander Islands in Russia; Bogoslof Island in the southeastern Bering Sea; and San Miguel and the Farallon Islands in California (Pyle et al. 2001, Robson 2002).

Reproduction/Breeding

Pupping and breeding occur between June and August on the Pribilof Islands (York, 1987). Pups are weaned at around 4 months (Gentry, 1998). There are no known areas used by Northern fur seals for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for northern fur seals are provided in Appendix D. Northern fur seals are solitary at sea but tend to congregate in food-rich areas where as many as 100 individuals have been sighted. The average dive time for northern fur seals is 2.6 min, with a maximum between 5 and 7 min. The deepest recorded dive is 679 ft (207 m), but most are between 66 and 459 ft (20 and 140 m) and are probably associated with feeding. (DoN 2006)

Acoustics

Northern fur seals produce underwater clicks, and in-air bleating, barking, coughing, and roaring sounds. Males vocalize (roar) almost continuously at rookeries. Females and pups produce airborne sounds (bawls) to reunite after separation. The hearing ability of this species has been measured in air and underwater by behavioral methods. (DoN 2006)

Of all the pinniped species for which hearing information is available, northern fur seals are the most sensitive to airborne sound. In air, this species can hear sounds ranging from 0.1 to 36 kHz, with best sensitivity from 2 to 16 kHz. There is an anomalous in-air hearing loss at around 4 or 5 kHz, which is attributed to a middle specialization. The underwater hearing range of northern fur seals ranges from 0.5 Hz to 40 kHz (most sensitive from 2 to 32 kHz). The underwater hearing sensitivity of this species is 15 to 20 dB better than in the air. (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

The estimated mortality and serious injury of northern fur seals in commercial fisheries that might take this species is approximately 1.9 animals per year. (Angliss and Allen 2009)

Subsistence Interactions

Alaska Natives residing on the Pribilof Islands are allowed an annual subsistence harvest of northern fur seals, with a take range determined from annual household surveys. Between 2001 and 2006, there was an annual average of 667 seals harvested per year. (Angliss and Allen 2009)

Other Interactions

Mortality resulting from entanglement in marine debris has been implicated as a contributing factor in the previous decline of Eastern Pacific stock of northern fur seal. The average entanglement rate for adult males from 1998 to 2002 was 0.27 percent (Angliss and Allen 2009), and if that rate was sustained, the result would be approximately 1,900 mortalities to male fur seals based on the current minimum population estimate.

3.8.6 Current Requirements and Practices

As presented in Section 5.1.7, a comprehensive suite of protective measures and standard operating procedures (SOPs) is implemented by the Navy to avoid and reduce impacts to marine mammals. In particular, the following categories of measures all serve to reduce or eliminate potential impacts of Navy activities on marine mammals that may be present in the vicinity of training activities:

- Training personnel and watchstander to identify and locate nearby marine mammals;
- Maintaining minimum buffer zones for surface vessel approach to marine mammals;
- Maintaining minimum aircraft overflight buffer zones of critical habitat and pinniped rookeries and haulout sites;
- Maneuvering to avoid interactions and collisions with marine species;
- Reducing mid-frequency active sound from sonar when marine mammals are in the proximity of training activities; and
- Establishing marine mammal-free exclusion zones for activities involving at-sea explosions.

3.8.7 Environmental Consequences

As described previously in Section 3.8.1, the ROI for marine mammals is the TMAA, which is more than 12 nm (22 km) from the closest point of land. As such, this section distinguishes between U. S. territorial seas (shoreline to 12 nm [22 km]) and nonterritorial seas, (seaward of 12 nm [22 km]) for the purposes of applying the appropriate regulations (National Environmental Policy Act [NEPA] or Executive Order [EO] 12114) to analyze potential environmental effects. There are no activities in the Proposed Action taking place in U.S. territorial seas.

3.8.7.1 Regulatory Framework

The MMPA and ESA prohibit the unauthorized harassment of marine mammals and endangered species, and provide the regulatory processes for authorizing any such harassment that might occur incidental to an otherwise lawful activity. These two acts also establish the context for determining potentially adverse impacts to marine mammals from military activities.

Marine Mammal Protection Act

The MMPA of 1972 established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The act further regulates "takes" of marine mammals in the global commons (that is, the high seas) by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 (16 U.S.C. 1362) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of harassment, Level A (potential injury) and Level B (potential behavioral disturbance).

The National Defense Authorization Act of Fiscal Year 2004 (Public Law 108-136) amended the definition of harassment as applied to military readiness activities or scientific research activities conducted by or on behalf of the federal government, consistent with Section 104(c)(3) [16 U.S.C. 1374 (c)(3)]. The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (Public Law 107-314). Military training activities within the TMAA constitute military readiness activities as that term is defined in Public Law 107-314 because training activities constitute "training and operations of the

Armed Forces that relate to combat" and constitute "adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use."

For military readiness activities, the relevant definition of harassment is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment").
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") [16 U.S.C. 1362 (18)(B)(i) and (ii)].

Section 101(a)(5) of the MMPA directs the Secretary of the Department of Commerce to allow, upon request, the incidental (but not intentional) taking of marine mammals by U.S. citizens who engage in a specified activity (exclusive of commercial fishing), if certain findings are made and regulations are issued. Permission will be granted by the Secretary for the incidental take of marine mammals if the taking will have a negligible impact on the species or stock and will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses.

In support of the Proposed Action for the Preferred Alternative, the Navy is requesting a Letter of Authorization (LOA) pursuant to Section 101(a)(5)(A) of the MMPA. After the application was reviewed by NMFS, a Notice of Receipt of Application was published in the Federal Register on February 3, 2010 (75 FR 5575). Publication of the Notice of Receipt of Application initiated the 30-day public comment period, during which time anyone could obtain a copy of the application by contacting NMFS. In addition, the MMPA requires NMFS to develop regulations governing the issuance of an LOA and to publish these regulations in the Federal Register. Specifically, the regulations for each allowed activity establish (1) permissible methods of taking, and other means of affecting the least practicable adverse impact on such species or stock and its habitat, and on the availability of such species or stock for subsistence, and (2) requirements for monitoring and reporting of such taking. For military readiness activities (as described in the National Defense Authorization Act), a determination of "least practicable adverse impacts" on a species or stock that includes consideration, in consultation with the Department of Defense (DoD), of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

Several species of marine mammals occur in the TMAA. Accordingly, the Navy has initiated the MMPA compliance process with NMFS, by submission of a request for a LOA.

Endangered Species Act

The ESA of 1973 established protection over and conservation of threatened and endangered species and the ecosystems upon which they depend. An "endangered" species is a species that is in danger of extinction throughout all or a significant portion of its range, while a "threatened" species is one that is likely to become endangered within the foreseeable future throughout all or in a significant portion of its range. The USFWS and NMFS jointly administer the ESA and are also responsible for the listing of species (designating a species as either threatened or endangered). The USFWS has primary management responsibility for management of terrestrial and freshwater species, while NMFS has primary responsibility for marine species and anadromous fish species (species that migrate from saltwater to freshwater to spawn). The ESA allows the designation of geographic areas as critical habitat for threatened or endangered species.

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Section

7(a)(2) requires each federal agency to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" a protected species, that agency is required to consult formally with the NMFS or the USFWS, depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR 402.14(a)). Under the terms of Section 7(b)(4) and Section 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of an Incidental Take Statement.

Seven marine mammal species that are listed as endangered under the ESA could potentially occur in the TMAA. Critical habitat for North Pacific right whales and Steller sea lions has been designated under the ESA; however, these areas are outside the action area of the TMAA. Accordingly, the Navy has initiated the ESA Section 7 consultation process with NMFS.

Executive Order 12114

EO 12114 directs federal agencies to provide for informed decision making for major federal actions outside the United States, including the global commons, the environment of a nonparticipating foreign nation, or impacts on protected global resources. An OEIS is required when an action has the potential to significantly harm the environment of the global commons. “Global commons” are defined as “geographical areas that are outside of the jurisdiction of any nation, and include the oceans outside territorial limits (outside 12 nm [22 km] from the coast) and Antarctica. Global commons do not include contiguous zones and fisheries zones of foreign nations” (32 C.F.R. 187.3). The Navy has published procedures for implementing EO 12114 in 32 C.F.R. 187, Environmental Effects Abroad of Major Department of Defense Actions, as well as the October 2007 Office of the Chief of Naval Operations Instruction (OPNAVINST) 5090.1C.

Unlike NEPA, EO 12114 does not require a scoping process. However, the EIS and OEIS have been combined into one document, as permitted under NEPA and EO 12114, in order to reduce duplication. Therefore, the scoping requirements found in NEPA were implemented with respect to actions occurring seaward of U.S. territorial seas (outside 12 nm [22 km]), and discussions regarding scoping requirements will reference the combined GOA Draft EIS/OEIS.

3.8.7.2 Approach to Analysis

This section describes potential environmental effects associated with conducting naval training activities for three proposed alternatives in the TMAA. These activities are configured in various combinations to define specific warfare areas. The activities under Alternatives 1 and 2 include use of active sonar; surface vessel, submarine, and aircraft warfare training activities; weapons firing and non-explosives ordnance use; electronic combat; and discharges of expendable materials.

This section distinguishes between U.S. territorial seas (shoreline to 12 nm [22 km]) and nonterritorial seas, (seaward of 12 nm [22 km]) for the purposes of applying the appropriate regulation (EO 12114) to analyze potential environmental effects.

Data Sources

A comprehensive and systematic review of relevant literature and data was conducted to complete this analysis. Of the available scientific and technical literature (both published and unpublished), the following types of documents were utilized: journals, books, periodicals, bulletins, DoD operations reports, theses, dissertations, endangered species recovery plans, species management plans, stock assessment reports, environmental impact statements, range complex management plans, and other technical reports published by government agencies, private businesses, or consulting firms. Scientific and technical literature was also consulted during the search for geographic location data (geographic coordinates) on the occurrence of marine resources within the GOA.

Information was collected from the following sources to summarize the occurrence of and to evaluate the impacts to marine mammal species in the Study Area:

- Marine Resource Assessment (MRA) for the TMAA and marine mammal density estimates for the GOA;
- On-line databases: Ingenta, Web of Science; Aquatic Sciences and Fisheries Abstracts, Science Direct, Synergy, BIOSIS previews;
- The Internet, including various databases and related websites: National Oceanic and Atmospheric Administration (NOAA)-Coastal Services Center, NMFS, Ocean Biogeographic Information System, U.S. Geological Survey, WhaleNet, Blackwell-Science, FishBase, Food and Agriculture Organization, Federal Register, Pacific and North Pacific Fishery Management Councils;
- Federal and state agencies: the DoN, Pacific Fishery Management Council, NMFS Highly Migratory Species Division, NMFS Northwest Fisheries Science Center, NMFS Southwest Fisheries Science Center, NMFS Alaska Fisheries Science Center, NMFS Northwest Regional Office, NMFS Office of Habitat Protection, NMFS Office of Protected Resources, NOAA: Marine Managed Areas Inventory, USFWS Ecological Services Field Offices, U.S. Environmental Protection Agency, U.S. Geological Survey: Sirenia Project, Bureau of Land Management, Minerals Management Service, California Department of Fish and Game, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife; and
- Marine resource experts and specialists.

Assessment Methods

Each alternative analyzed in this EIS/OEIS includes several warfare areas (for example, Anti-Surface Warfare [ASUW] and Anti-Submarine Warfare [ASW]). Most warfare areas include multiple types of training activities (for example, ASW Tracking Exercise [TRACKEX]). Likewise, many activities (for example, vessel movements, aircraft overflights, and weapons firing) are common to many training scenarios. Accordingly, the analysis of the consequences to marine mammals is organized by specific activity and/or stressors associated with that activity, rather than warfare area.

The following general steps were used to analyze the potential environmental consequences of the alternatives to marine mammals:

- Identify those aspects of the Proposed Action that are likely to act as stressors to marine mammals by having a direct or indirect effect on the physical, chemical, and biotic environment. As part of this step, the spatial extent of these stressors, including changes in that spatial extent over time, were identified. The results of this step identified those aspects of the Proposed Action that required detailed analysis in this EIS/OEIS.
- Identify marine mammal resources that may occur in the action area.
- Identify the marine mammal resources that are likely to co-occur with the stressors in space and time, and the nature of that co-occurrence (exposure analysis).
- Determine whether and how marine mammals are likely to respond given their exposure to the proposed activities based on available scientific knowledge of their probable responses.

- Estimate the effectiveness of proposed mitigation measures in avoiding, offsetting, and reducing the intensity of any potential adverse impacts to marine mammals.
- Determine implications of the estimated risks under the ESA and MMPA.

Warfare Areas and Associated Environmental Stressors

Navy subject matter experts, in consultation with NMFS, identified the warfare areas and activities included in the Proposed Action to identify specific activities that could act as stressors to marine mammals. Public and agency scoping comments, previous environmental analyses, previous agency consultations, laws, regulations, executive orders, and resource-specific information were also evaluated. This process was used to organize the information presented and analyzed in the affected environment and environmental consequences sections of this EIS/OEIS. Potential stressors and the type of effect to marine mammals include:

- Vessel movements;
- Aircraft overflights;
- Non-explosive practice ordnance;
- High explosive ordnance (at-sea explosions);
- Active sonar; and
- Expended materials (ordnance related materials, targets, flares, chaff, sonobuoys, and marine dye markers).

As discussed in Section 3.2 (Expended Materials) and Section 3.4 (Acoustic Environment) of this EIS/OEIS, some water and air pollutants would be released into the environment as a result of the proposed action. Those sections indicated that any increases in water or air pollutant concentrations resulting from Navy training would be negligible and localized. Impacts to water and air quality would be less than significant. Thus, water and air quality changes would have no effect on marine mammals. Accordingly, the effects of water and air quality changes on marine mammals are not addressed further in this EIS/OEIS.

3.8.7.3 Acoustic Effects

Assessing Marine Mammal Responses to Sound

As summarized by the National Academies of Science (NAS), the possibility that human-generated sound could harm marine mammals or significantly interfere with their "normal" activities has been an issue of concern (National Research Council [NRC] 2005). This section evaluates the potential quantification for specific Navy acoustic sources proposed for use in the TMAA to result in harassment of or injury to marine mammals.

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 (NRC 2003b, NRC 2005), there are many unknowns in assessing the effects and significance of marine mammals responses to sound exposures related to the context for the exposure and the disposition of the marine mammal (Southall et al. 2007). For this reason, the Navy enlisted the expertise of NMFS as a cooperating agency. Their input assisted the Navy in developing a conceptual analytical framework for evaluating what sound levels marine mammals might receive as a result of Navy training actions, whether marine mammals might respond to these exposures, and whether that response might have a mode of action on the biology or ecology of marine mammals such that the response should be considered a potential harassment. From this framework of evaluating the potential for harassment incidents to occur, an assessment of whether acoustic sources might impact populations, stocks or species of marine mammals can be conducted.

The flow chart in Figure 3.8-3 is a representation of the general analytical framework utilized in applying the specific thresholds discussed in this section. The framework presented in the flow chart is organized from left to right and is compartmentalized according to the phenomena that occur within each. These include the physics of sound propagation (Physics), the potential physiological processes associated with sound exposure (Physiology), the potential behavioral processes that might be affected as a function of sound exposure (Behavior), and the immediate effects these changes may have on functions the animal is engaged in at the time of exposure (Life Function – Proximate). These compartmentalized effects are extended to longer term life functions (Life Function – Ultimate) and into population and species effects ("life functions" are the basic processes organisms undergo to survive and reproduce such as feeding and breeding).

Throughout the flow chart, dotted and solid lines are used to connect related events. Solid lines designate those effects that "will" happen; dotted lines designate those that "might" happen but must be considered (including those hypothesized to occur but for which there is no direct evidence).

Some boxes contained within the flow chart are colored according to how they relate to the definitions of harassment in the MMPA. Red boxes correspond to events that are injurious. By prior ruling and usage, these events would be considered as Level A harassment under the MMPA. Yellow boxes correspond to events that have the potential to qualify as Level B harassment under the MMPA. Based on prior ruling, the specific instance of Temporary Threshold Shift (TTS) is considered as part of Level B harassment (Level B harassment includes TTS, non-TTS, and sub-TTS). Boxes that are shaded from red to yellow have the potential for injury (Level A harassment) and behavioral disturbance (Level B harassment).

The analytical framework outlined within the flow chart acknowledges that physiological responses must always precede behavioral responses (i.e., there can be no behavioral response without first some physiological effect of the sound) and an organization where each functional block only occurs once and all relevant inputs/outputs flow to/from a single instance.

Physics

Starting with a sound source, the attenuation of an emitted sound due to propagation loss is determined. Uniform animal distribution is overlaid onto the calculated sound fields to assess if animals are physically present at sufficient received sound levels to be considered "exposed" to the sound. If the animal is determined to be exposed, two possible scenarios must be considered with respect to the animal's physiology – effects on the auditory system and effects on nonauditory system tissues. These are not independent pathways and both must be considered since the same sound could affect both auditory and nonauditory tissues. Note that the model does not account for any animal response; rather the animals are considered stationary, accumulating energy until the threshold is tripped.

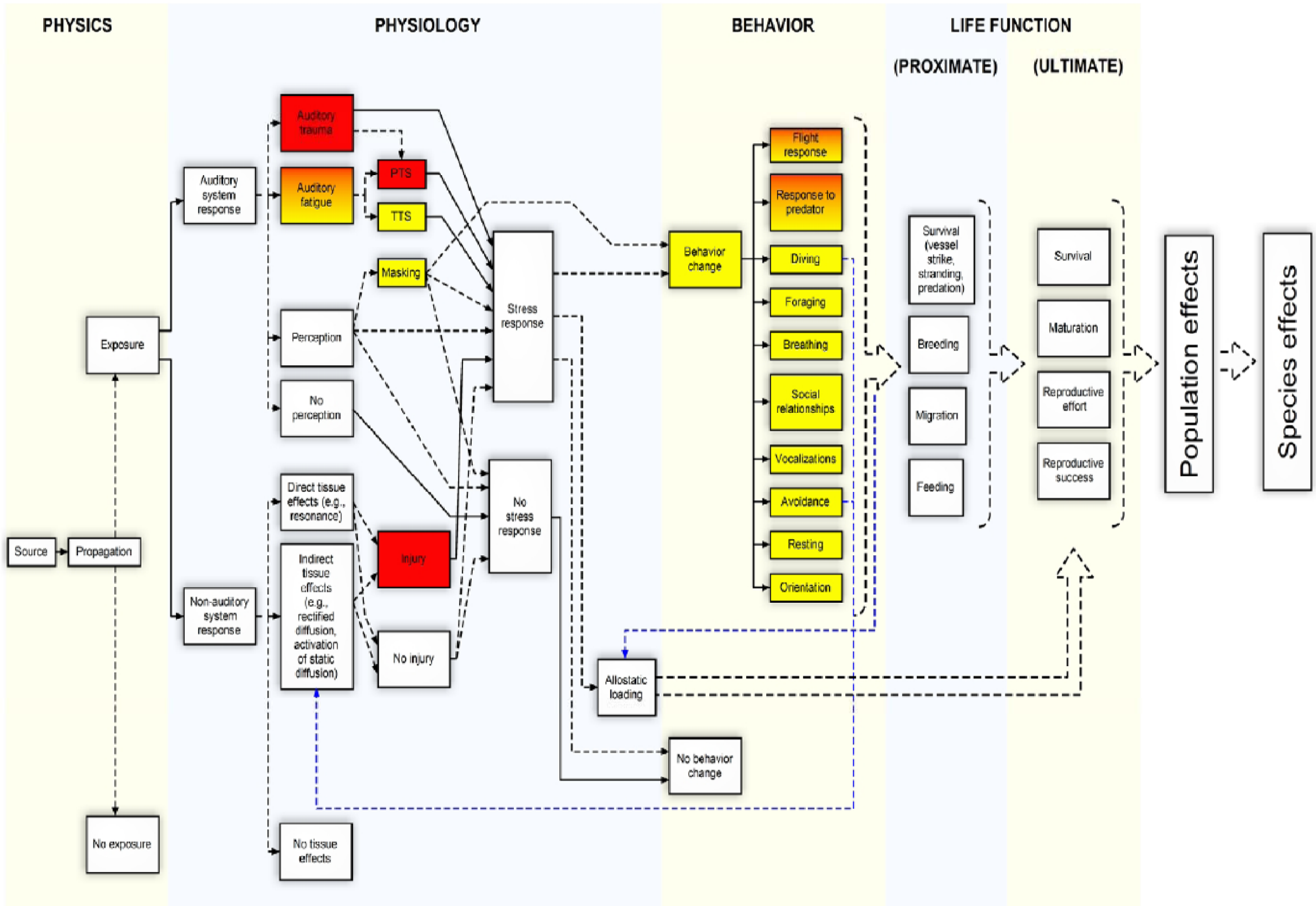


Figure 3.8-3: Analytical Framework for Evaluating Sonar Effects to Marine Mammals

Physiology

Potential impacts to the auditory system are assessed by considering the characteristics of the received sound (e.g., amplitude, frequency, duration) and the sensitivity of the exposed animals. Some of these assessments can be numerically based (e.g., TTS, Permanent Threshold Shift [PTS], perception). Others will be necessarily qualitative, due to lack of information, or will need to be extrapolated from other species for which information exists. Potential physiological responses to the sound exposure are ranked in descending order, with the most severe impact (auditory trauma) occurring at the top and the least severe impact occurring at the bottom (the sound is not perceived).

1. Auditory trauma represents direct mechanical injury to hearing related structures, including tympanic membrane rupture, disarticulation of the middle ear ossicles, and trauma to the inner ear structures such as the organ of Corti and the associated hair cells. Auditory trauma is always injurious but could be temporary and not result in PTS. Auditory trauma is always assumed to result in a stress response.

2. Auditory fatigue refers to a loss of hearing sensitivity after sound stimulation. The loss of sensitivity persists after, sometimes long after, the cessation of the sound. The mechanisms responsible for auditory fatigue differ from auditory trauma and would primarily consist of metabolic exhaustion of the hair cells and cochlear tissues. The features of the exposure (e.g., amplitude, frequency, duration, temporal pattern) and the individual animal's susceptibility would determine the severity of fatigue and whether the effects were temporary (TTS) or permanent (PTS). Auditory fatigue (PTS or TTS) is always assumed to result in a stress response.

3. Sounds with sufficient amplitude and duration to be detected among the background ambient noise are considered to be perceived. This category includes sounds from the threshold of audibility through the normal dynamic range of hearing (i.e., not capable of producing fatigue). To determine whether an animal perceives the sound, the received level, frequency, and duration of the sound are compared to what is known of the species' hearing sensitivity.

Since audible sounds may interfere with an animal's ability to detect other sounds at the same time, perceived sounds have the potential to result in auditory masking. Unlike auditory fatigue, which always results in a stress response because the sensory tissues are being stimulated beyond their normal physiological range, masking may or may not result in a stress response, depending on the degree and duration of the masking effect. Masking may also result in a unique circumstance where an animal's ability to detect other sounds is compromised without the animal's knowledge. This could conceivably result in sensory impairment and subsequent behavior change; in this case, the change in behavior is the *lack of a response* that would normally be made if sensory impairment did not occur. For this reason, masking also may lead directly to behavior change without first causing a stress response.

The features of perceived sound (e.g., amplitude, duration, temporal pattern) are also used to judge whether the sound exposure is capable of producing a stress response. Factors to consider in this decision include the probability of the animal being naïve or experienced with the sound (i.e., what are the known/unknown consequences of the exposure).

The received level is not of sufficient amplitude, frequency, and duration to be perceptible by the animal. By extension, this does not result in a stress response (not perceived).

Potential impacts to tissues other than those related to the auditory system are assessed by considering the characteristics of the sound (e.g., amplitude, frequency, duration) and the known or estimated response characteristics of nonauditory tissues. Some of these assessments can be numerically based (e.g., exposure required for rectified diffusion). Others will be necessarily qualitative, due to lack of information. Each of the potential responses may or may not result in a stress response.

1. Direct tissue effects – Direct tissue responses to sound stimulation may range from tissue shearing (injury) to mechanical vibration with no resulting injury. Any tissue injury would produce a stress response, whereas noninjurious stimulation may or may not.

2. Indirect tissue effects – Based on the amplitude, frequency, and duration of the sound, it must be assessed whether exposure is sufficient to indirectly affect tissues. For example, the hypothesis that rectified diffusion occurs is based on the idea that bubbles that naturally exist in biological tissues can be stimulated to grow by an acoustic field. Under this hypothesis, one of three things could happen: (1) bubbles grow to the extent that tissue hemorrhage occurs (injury); (2) bubbles develop to the extent that a complement immune response is triggered or nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs (a stress response without injury); or (3) the bubbles are cleared by the lung without negative consequence to the animal. The probability of rectified diffusion, or any other indirect tissue effect, will necessarily be based on what is known about the specific process involved.

3. No tissue effects – The received sound is insufficient to cause either direct mechanical) or indirect effects to tissues. No stress response occurs.

The Stress Response

The acoustic source is considered a potential stressor if, by its action on the animal, via auditory or nonauditory means, it may produce a stress response in the animal. The term "stress" has taken on an ambiguous meaning in the scientific literature, but with respect to the discussions of allostasis and allostatic loading, the stress response will refer to an increase in energetic expenditure that results from exposure to the stressor and which is predominantly characterized by either the stimulation of the sympathetic nervous system (SNS) or the hypothalamic-pituitary-adrenal (HPA) axis (Reeder and Kramer 2005).

The presence and magnitude of a stress response in an animal depends on a number of factors. These include the animal's life history stage (e.g., neonate, juvenile, adult), the environmental conditions, reproductive or developmental state, and experience with the stressor.

Not only will these factors be subject to individual variation, but they will also vary within an individual over time. 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). In considering potential stress responses of marine mammals to acoustic stressors, each of these should be considered. For example, is the acoustic stressor in an area where animals engage in breeding activity? Are animals in the region resident and likely to have experience with the stressor (i.e., repeated exposures)? Is the region a foraging ground or are the animals passing through as transients? What is the ratio of young (naïve) to old (experienced) animals in the population? It is unlikely that all such questions can be answered from empirical data; however, they should be addressed in any qualitative assessment of a potential stress response as based on the available literature.

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 conspecifics, 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. Potential stressors resulting from anthropogenic activities must be considered not only as to their direct impact on the animal but also as to their cumulative impact with environmental stressors already experienced by the animal.

Studies on the stress response of odontocete cetaceans to acute acoustic stimuli were previously discussed Thomas et al. 1990, Miksis et al. 2001, Romano et al. 2004). 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. Pursuit, capture and short-term holding of belugas has 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 (St. Aubin et al. 1996, Ortiz and Worthy 2000, St. Aubin 2002). 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). With respect to anthropogenic sound as a stressor, the current limited body of knowledge will require extrapolation from species for which information exists to those for which no information exists.

The stress response may or may not result in a behavioral change, depending on the characteristics of the exposed animal. However, provided a stress response occurs, we assume that some contribution is made to the animal's allostatic load. Allostasis is the ability of an animal to maintain stability through change by adjusting its physiology in response to both predictable and unpredictable events (McEwen and Wingfield 2003). The same hormones associated with the stress response vary naturally throughout an animal's life, providing support for particular life history events (e.g., pregnancy) and predictable environmental conditions (e.g., seasonal changes). The allostatic load is the cumulative cost of allostasis incurred by an animal and is generally characterized with respect to an animal's energetic expenditure. Perturbations to an animal that may occur with the presence of a stressor, either biological (e.g., predator) or anthropogenic (e.g., construction), can contribute to the allostatic load (McEwen and Wingfield 2003). Additional costs are cumulative and additions to the allostatic load over time may contribute to reductions in the probability of achieving ultimate life history functions (e.g., survival, maturation, reproductive effort and success) by producing pathophysiological states. The contribution to the allostatic load from a stressor requires estimating the magnitude and duration of the stress response, as well as any secondary contributions that might result from a change in behavior.

If the acoustic source does not produce tissue effects, is not perceived by the animal, or does not produce a stress response by any other means, Figure 3.8-3 assumes that the exposure does not contribute to the allostatic load. Additionally, without a stress response or auditory masking, it is assumed that there can be no behavioral change. Conversely, any immediate effect of exposure that produces an injury (i.e., red boxes on the flow chart in Figure 3.8-3) is assumed to also produce a stress response and contribute to the allostatic load.

Behavior

Acute stress responses may or may not cause a behavioral reaction. However, all changes in behavior are expected to result from an acute stress response. This expectation is based on the idea that some sort of physiological trigger must exist to change any behavior that is already being performed. The exception to this rule is the case of masking. The presence of a masking sound may not produce a stress response, but may interfere with the animal's ability to detect and discriminate biologically relevant signals. The inability to detect and discriminate biologically relevant signals hinders the potential for normal behavioral responses to auditory cues and is thus considered a behavioral change.

Numerous behavioral changes can occur as a result of stress response, and Figure 3.8-3 lists only those that might be considered the most common types of response for a marine animal. For each potential behavioral change, the magnitude in the change and the severity of the response needs to be estimated. Certain conditions, such as stampeding (i.e., flight response) or a response to a predator, might have a probability of resulting in injury. For example, a flight response, if significant enough, could produce a stranding event. Under the MMPA, such an event would be considered a MMPA Level A harassment. Each altered behavior may also have the potential to disrupt biologically significant events (e.g., breeding or nursing) and may need to be qualified as MMPA Level B harassment. Exposures to sonar resulting in non-TTS behavioral disturbance and exposure to at-sea explosions resulting in sub-TTS behavioral disturbance are quantified as MMPA Level B harassment. All behavioral disruptions have the potential to contribute to the allostatic load. This secondary potential is signified by the feedback from the collective behaviors to allostatic loading (physiology block).

The response of a marine mammal to an anthropogenic sound source will depend on the frequency content, 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 direction of the responses can vary, with some changes resulting in either increases or decreases from baseline (e.g., decreased dive times and increased respiration rate). Responses can also 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.

A review of marine mammal responses to anthropogenic sound was first conducted by Richardson and others in 1995. A more recent review (Nowacek et al. 2007) addresses studies conducted since 1995 and focuses on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. The following sections provide a very brief overview of the state of knowledge of behavioral responses. The overviews focus on studies conducted since 2000 but are not meant to be comprehensive; rather, they provide an idea of the variability in behavioral responses that would be expected given the differential sensitivities of marine mammal species to sound and the wide range of potential acoustic sources to which a marine mammal may be exposed. Estimates of the types of behavioral responses that could occur for a given sound exposure should be determined from the literature that is available for each species or extrapolated from closely related species when no information exists.

Flight Response

A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. Relatively little information on flight responses of marine mammals to anthropogenic signals exists, although observations of flight responses to the presence of predators have occurred (Connor and Heithaus 1996). Flight responses have been speculated as being a component of marine mammal strandings associated with sonar activities (Evans and England 2001).

Response to Predators

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.

Diving

Changes in dive behavior can vary widely. They may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive. Variations in dive behavior may reflect interruptions in biologically significant activities (e.g., foraging) or they may be of little biological significance. Variations in dive behavior may also expose an animal to potentially harmful conditions (e.g., increasing the chance of ship-strike) or may serve as an avoidance response that enhances survivorship. The impact of a variation in diving resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response.

Nowacek et al. (2004) reported disruptions of dive behaviors in foraging North Atlantic right whales when exposed to an alerting stimulus, an action, they noted, that could lead to an increased likelihood of ship strike. However, the whales did not respond to playbacks of either right whale social sounds or vessel noise, highlighting the importance of the sound characteristics in producing a behavioral reaction. Conversely, Indo-Pacific humpback dolphins have been observed to dive for longer periods of time in areas where vessels were present and/or approaching (Ng and Leung 2003). In both of these studies, the influence of the sound exposure cannot be decoupled from the physical presence of a surface vessel, thus complicating interpretations of the relative contribution of each stimulus to the response. Indeed, the presence of surface vessels, their approach and speed of approach, seemed to be significant factors in the response of the Indo-Pacific humpback dolphins (Ng and Leung 2003). Low frequency signals of the Acoustic Thermometry of Ocean Climate (ATOC) 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 (Costa et al. 2003). They did, however, produce subtle effects that varied in direction and degree among the individual seals, illustrating the equivocal nature of behavioral effects and consequent difficulty in defining and predicting them.

Due to past incidents of beaked whale strandings associated with sonar operations, feedback paths are provided between avoidance and diving and indirect tissue effects. This feedback accounts for the hypothesis that variations in diving behavior and/or avoidance responses can possibly result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular bubble formation (Jepson et al. 2003). Although hypothetical, the potential process is being debated within the scientific community.

Foraging

Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (e.g., bubble nets or sediment plumes), or changes in dive behavior. Noise from seismic surveys was not found to impact the feeding behavior in western gray whales off the coast of Russia (Yazvenko et al. 2007) and sperm whales engaged in foraging dives did not abandon dives when exposed to distant signatures of seismic airguns (Madsen et al. 2006). Balaenopterid whales exposed to moderate low-frequency signals similar to the ATOC sound source demonstrated no variation in foraging activity (Croll et al. 2001), whereas five out of six North Atlantic right whales exposed to an acoustic alarm interrupted their foraging dives (Nowacek et al. 2004). Although the received sound pressure level at the animals was similar in the latter two studies, the frequency, duration, and temporal pattern of signal presentation were different. These factors, as well as differences in species sensitivity, are likely contributing factors to the differential response. A determination of whether foraging disruptions incur fitness consequences will require information on or estimates of the energetic requirements of the individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal.

Breathing

Variations in respiration naturally vary with different behaviors and variations in respiration rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Mean exhalation rates of gray whales at rest and while diving were found to be unaffected by seismic surveys conducted adjacent to the whale feeding grounds (Gailey et al. 2007). Studies with captive harbor porpoises showed increased respiration rates upon introduction of acoustic alarms (Kastelein et al. 2000, Kastelein et al. 2006) and emissions for underwater data transmission (Kastelein et al. 2005). 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 when determining the potential for impacts resulting from anthropogenic sound exposure.

Social relationships

Social interactions between mammals can be affected by noise via the disruption of communication signals or by the displacement of individuals. Disruption of social relationships therefore depends on the disruption of other behaviors (e.g., caused avoidance, masking, etc.) and no specific overview is provided here. However, social disruptions must be considered in context of the relationships that are affected. Long-term disruptions of mother/calf pairs or mating displays have the potential to affect the growth and survival or reproductive effort/success of individuals, respectively.

Vocalizations

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 may result in response to a need to compete with an increase in background noise or may reflect an increased vigilance or startle response. For example, in the presence of low-frequency active sonar, humpback whales have been observed to increase the length of their ”songs” (Miller et al. 2000, Fristrup et al. 2003), possibly due to the overlap in frequencies between the whale song and the low-frequency active sonar. A similar compensatory effect for the presence of low frequency vessel noise has been suggested for right whales; 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 (Parks et al. 2007). Killer whales off the northwestern coast of the United States have been observed to increase the duration of primary calls once a threshold in observing vessel density (e.g., whale watching) was reached, which has been suggested as a response to increased masking noise produced by the vessels (Foote et al. 2004). 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.

Avoidance

Avoidance is the displacement of an individual from an area as a result of the presence of a sound. It is qualitatively different from the flight response in its magnitude (i.e., directed movement, rate of travel, etc.). Oftentimes avoidance is temporary, and animals return to the area once the noise has ceased. Longer term displacement is possible, however, which 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 (Blackwell et al. 2004, Bejder et al. 2006, Teilmann et al. 2006). Acute avoidance responses have been observed in captive porpoises and pinnipeds exposed to a number of different sound sources (Kastelein et al. 2000, Finneran et al. 2003, Kastelein et al. 2006). Short term avoidance of seismic surveys, low frequency emissions, and acoustic deterrents has also been noted in wild populations of odontocetes

(Bowles et al. 1994; Goold 1996, 1998; Stone et al. 2000; Morton and Symonds 2002) and to some extent in mysticetes (Gailey et al. 2007), while longer term or repetitive/chronic displacement for some dolphin groups and for manatees has been suggested to be due to the presence of chronic vessel noise (Haviland-Howell et al. 2007, Miksis-Olds et al. 2007).

Orientation

A shift in an animal's resting state or an attentional change via an orienting response represent behaviors that would be considered mild disruptions if occurring alone, and thus are placed at the bottom of the framework behavior list. As previously mentioned, the responses may co-occur with other behaviors; for instance, an animal may initially orient toward a sound source, and then move away from it. Thus, any orienting response should be considered in context of other reactions that may occur.

Life Functions

Proximate Life Functions

Proximate life history functions are the functions that the animal is engaged in at the time of acoustic exposure. The disruption of these functions, and the magnitude of the disruption, is something that must be considered in determining how the ultimate life history functions are affected. Consideration of the magnitude of the effect to each of the proximate life history functions is dependent upon the life stage of the animal. For example, an animal on a breeding ground which is sexually immature will suffer relatively little consequence to disruption of breeding behavior when compared to an actively displaying adult of prime reproductive age.

Ultimate Life Functions

The ultimate life functions are those that enable an animal to contribute to the population (or stock, or species, etc.). The impact to ultimate life functions will depend on the nature and magnitude of the perturbation to proximate life history functions. Depending on the severity of the response to the stressor, acute perturbations may have nominal to profound impacts on ultimate life functions. For example, unit-level use of sonar by a vessel transiting through an area that is utilized for foraging, but not for breeding, may disrupt feeding by exposed animals for a brief period of time. Because of the brevity of the perturbation, the impact to ultimate life functions may be negligible. By contrast, weekly training over a period of years may have a more substantial impact because the stressor is chronic. Assessment of the magnitude of the stress response from the chronic perturbation would require an understanding of how and whether animals acclimate to a specific, repeated stressor and whether chronic elevations in the stress response (e.g., cortisol levels) produce fitness deficits.

The proximate life functions are loosely ordered in decreasing severity of impact. Mortality (survival) has an immediate effect, in that no future reproductive success is feasible and there is no further addition to the population resulting from reproduction. Severe injuries may also lead to reduced survivorship (longevity) and prolonged alterations in behavior. The latter may further affect an animal's overall reproductive success and reproductive effort. Disruptions of breeding have an immediate impact on reproductive effort and may impact reproductive success. The magnitude of the effect will depend on the duration of the disruption and the type of behavior change that was provoked. Disruptions to feeding and migration can affect all of the ultimate life functions; however, the impacts to reproductive effort and success are not likely to be as severe or immediate as those incurred by mortality and breeding disruptions. Taking into account these considerations, it was determined if there were population and species effects.

Regulatory Framework

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.

The model for estimating potential acoustic effects from ASW training activities on cetacean species makes use of the methodology that was developed in cooperation with the NOAA for the Navy's Draft EIS/OEIS (DoN 2005). Via response comment letter to Undersea Warfare Training Range (USWTR) received from NMFS dated January 30, 2006, NMFS concurred with the use of Energy Flux Density Level (EL) for the determination of physiological effects to marine mammals. Therefore, this methodology is used to estimate the annual exposure of marine mammals that may be considered MMPA Level A harassment or MMPA Level B harassment as a result of temporary, recoverable physiological effects.

In addition, the approach for estimating potential effects from training activities on marine mammal makes use of the comments received and documents associated with previous Navy NEPA documents analyzing Navy training activities (DoN 2008a,b). As a result of these analyses and in consultation with NMFS, this analysis uses a risk function approach to evaluate the potential for non-TTS MMPA Level B harassment from behavioral effects. The risk function is further explained in Section 3.8.6.3.

A number of Navy actions and NOAA rulings have helped to qualify possible events deemed as "harassment" under the MMPA (e.g. DoN 2008a,b). As stated previously, "harassment" under the MMPA includes both potential injury (Level A), and disruptions of natural behavioral patterns to a point where they are abandoned or significantly altered (Level B). NMFS also includes mortality as a possible outcome to consider in addition to MMPA Level A and MMPA Level B harassment. The acoustic effects analysis and exposure calculations are based on the following premises:

Harassment that may result from Navy training activities described in this EIS/OEIS is unintentional and incidental to those activities.

The acoustic effects analysis is based on primary exposures only. Secondary, or indirect, effects, such as susceptibility to predation following injury and injury resulting from disrupted behavior, while possible, can only be reliably predicted in circumstances where the responses have been well documented. Consideration of secondary effects would result in much MMPA Level A harassment being considered MMPA Level B harassment, and vice versa, since much injury (Level A harassment) has the potential to disrupt behavior (Level B harassment), and much temporary physiological or behavioral disruption (Level B) could be conjectured to have the potential for injury (Level A). Consideration of secondary effects would lead to circular definitions of harassment. However, consistent with prior ruling (NOAA 2001a, 2006b), this analysis assumes that MMPA Level A and MMPA Level B do not overlap so as to preclude circular definitions of harassment.

An individual animal predicted to experience simultaneous multiple injuries, multiple disruptions, or both, is counted as a single take (NOAA 2001, 2006b, 2009). NMFS has defined a 24-hour "refresh rate," or amount of time in which an individual can be harassed no more than once. Behavioral harassment, under the risk function presented in this request, uses received SPL over a 24-hour period as the metric for determining the probability of harassment. The Navy has determined that all proposed sonar activities would be shorter than a 24-hour period. Additional model assumptions account for ship movement, make adjustments for multiple ships and make adjustments for the presence of land shadows.

Integration of Regulatory and Biological Frameworks

This section presents a biological framework within which potential effects can be categorized and then related to the existing regulatory framework of injury (MMPA Level A harassment) and behavioral disruption (MMPA Level B harassment). The information presented in this section was used to develop specific numerical exposure thresholds and risk function exposure estimations. Exposure thresholds are combined with sound propagation models and species distribution data to estimate the potential exposures.

Physiological and Behavioral Effects

Sound exposure may affect multiple biological traits of a marine animal; however, the MMPA as amended directs which traits should be used when determining effects. Effects that address injury are considered Level A harassment under MMPA. Effects that address behavioral disruption are considered Level B harassment under MMPA.

The biological framework proposed here is structured according to potential physiological and behavioral effects resulting from sound exposure. The range of effects may then be assessed to determine which qualify as injury or behavioral disturbance under MMPA regulations. Physiology and behavior are chosen over other biological traits because:

- They are consistent with regulatory statements defining harassment by injury and harassment by disturbance.
- They are components of other biological traits that may be relevant.
- They are a more sensitive and immediate indicator of effect.

For example, ecology is not used as the basis of the framework because the ecology of an animal is dependent on the interaction of an animal with the environment. The animal's interaction with the environment is driven both by its physiological function and its behavior, and an ecological impact may not be observable over short periods of observation. Ecological information is considered in the analysis of the effects of individual species.

A "physiological effect" is defined here as one in which the "normal" physiological function of the animal is altered in response to sound exposure. Physiological function is any of a collection of processes ranging from biochemical reactions to mechanical interaction and operation of organs and tissues within an animal. A physiological effect may range from the most significant of impacts (i.e., mortality and serious injury) to lesser effects that would define the lower end of the physiological impact range, such as the noninjurious distortion of auditory tissues. This latter physiological effect is important to the integration of the biological and regulatory frameworks and will receive additional attention in later sections.

A "behavioral effect" is one in which the "normal" behavior or patterns of behavior of an animal are overtly disrupted in response to an acoustic exposure. Examples of behaviors of concern can be derived from the harassment definitions in the MMPA.

In this EIS/OEIS the term "normal" is used to qualify distinctions between physiological and behavioral effects. Its use follows the convention of normal daily variation in physiological and behavioral function without the influence of anthropogenic acoustic sources. As a result, this EIS/OEIS uses the following definitions:

- A **physiological effect** is a variation in an animal's respiratory, endocrine, hormonal, circulatory, neurological, or reproductive activity and processes, beyond the animal's normal range of variability, in response to human activity or to an exposure to a stimulus such as active sonar.
- A **behavioral effect** is a variation in the pattern of an animal's breathing, feeding, resting, migratory, intraspecific behavior (such as reproduction, mating, territorial, rearing, and agonistic behavior), and interspecific beyond the animal's normal pattern of variability in response to human activity or to an exposure to a stimulus such as active sonar.

The definitions of physiological effect and behavioral effect used within this document should not be confused with more global definitions applied to the field of biology or to existing federal law. It is reasonable to expect some physiological effects to result in subsequent behavioral effects. For example, a marine mammal that suffers a severe injury may be expected to alter diving or foraging to the degree that its variation in these behaviors is outside that which is considered normal for the species. If a physiological effect is accompanied by a behavioral effect, the overall effect is characterized as a physiological effect; physiological effects take precedence over behavioral effects with regard to their ordering. This approach provides the most conservative ordering of effects with respect to severity, provides a rational approach to dealing with the overlap of the definitions, and avoids circular arguments.

The severity of physiological effects generally decreases with decreasing sound exposure and/or increasing distance from the sound source. The same generalization does not consistently hold for behavioral effects because they do not depend solely on the received sound level. Behavioral responses also depend on an animal's learned responses, innate response tendencies, motivational state, the pattern of the sound exposure, and the context in which the sound is presented. However, to provide a tractable approach to predicting acoustic effects that is relevant to the terms of behavioral disruption described in the MMPA, it is assumed here that the severities of behavioral effects also decrease with decreasing sound exposure and/or increasing distance from the sound source. Figure 3.8-4 shows the relationship between severity of effects, source distance, and exposure level, as defined in this EIS/OEIS.

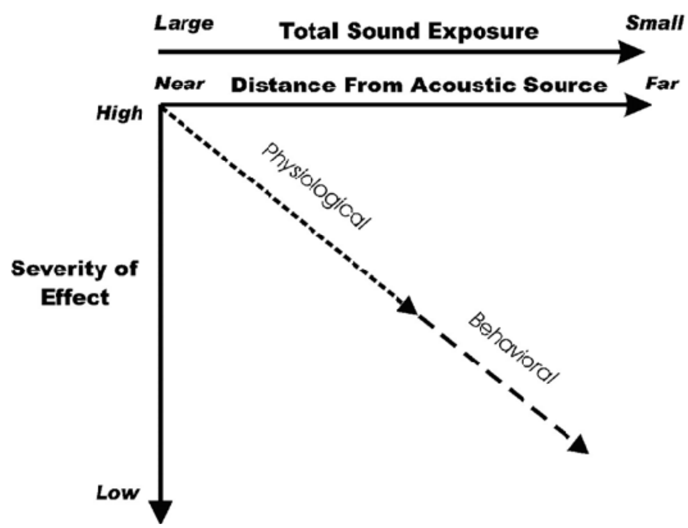


Figure 3.8-4: Relationship between Severity of Effects, Source Distance, and Exposure Level

MMPA Level A Harassment and MMPA Level B Harassment

Categorizing potential effects as either physiological or behavioral effects allows them to be related to the harassment definitions. For military readiness activities, 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 EIS/OEIS and previous rulings (NOAA 2001a, 2002, 2008b, 2008c), is the destruction or loss of biological tissue from a species. The destruction or loss of biological tissue will result in an alteration of physiological function that exceeds the normal daily physiological variation of the intact tissue. For example, increased localized histamine production, edema, production of scar tissue, activation of clotting factors, white blood cell response, etc., may be expected following injury. Therefore, this EIS/OEIS assumes that all injury is qualified as a physiological effect and, to be consistent with prior actions and rulings (NOAA 2001a, 2008b, 2008c), all injuries (slight to severe) are considered MMPA Level A harassment.

Public Law 108-136 (2004) amended the MMPA definitions of Level B harassment for military readiness activities, which applies to this action. For military readiness activities, MMPA Level B harassment is defined as "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behaviors are abandoned or significantly altered." Unlike MMPA Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause MMPA Level B harassment.

For example, some physiological effects (such as TTS) can occur that are non-injurious but that can potentially disrupt the behavior of a marine mammal. These include temporary distortions in sensory tissue that alter physiological function, but that are fully recoverable without the requirement for tissue replacement or regeneration. For example, an animal that experiences a temporary reduction in hearing sensitivity suffers no injury to its auditory system, but may not perceive some sounds due to the reduction in sensitivity. As a result, the animal may not respond to sounds that would normally produce a behavioral reaction. This lack of response qualifies as a temporary disruption of normal behavioral patterns – the animal is impeded from responding in a normal manner to an acoustic stimulus.

The harassment status of slight behavior disruption has been addressed in workshops, previous actions, and rulings (NOAA 2001a, 2008b, 2008c; DoN 2001a). 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. A more general conclusion, that MMPA Level B harassment occurs only when there is "a potential for a significant behavioral change or response in a biologically important behavior or activity," is found in recent rulings (NOAA 2002, 2008b, 2008c). Public Law 108-136 (2004) amended the definition of MMPA Level B harassment for military readiness activities, which applies to this action. For military readiness activities, MMPA Level B harassment is defined as "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns…to a point where such behaviors are abandoned or significantly altered."

Although the temporary lack of response discussed above may not result in abandonment or significant alteration of natural behavioral patterns, the acoustic effect inputs used in the acoustic model assume that temporary hearing impairment (slight to severe) is considered MMPA Level B harassment. Although modes of action are appropriately considered, as outlined in Figure 3.8-5, the conservative assumption used here is to consider all hearing impairment as harassment from TTS. As a result, the actual incidental harassment of marine mammals associated with this action may be less than predicted via the analytical framework.

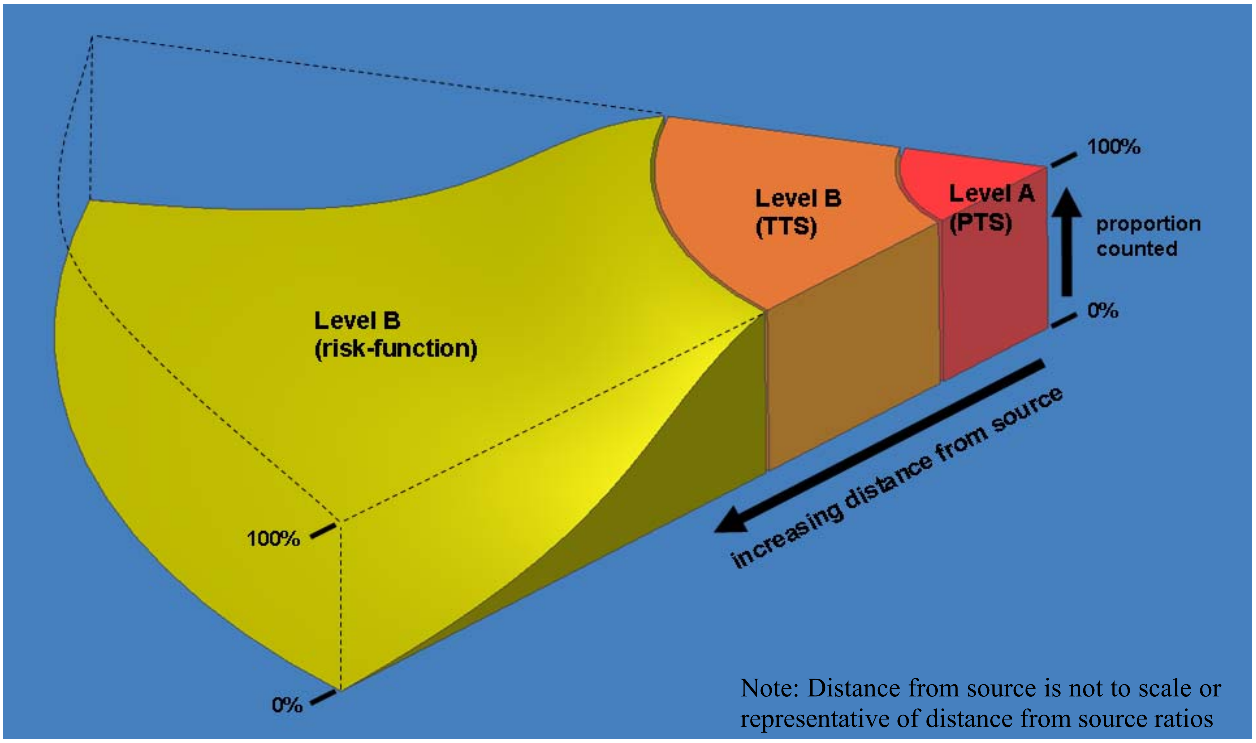


Figure 3.8-5: Exposure Zones Extending from a Hypothetical, Directional Sound Source

MMPA Exposure Zones

Two acoustic modeling approaches are used to account for both physiological and behavioral effects to marine mammals. When using a threshold of accumulated energy (EL) the volumes of ocean in which MMPA Level A and MMPA Level B harassment from a Threshold Shift (TS) are predicted to occur are described as exposure zones. As a conservative estimate, all marine mammals predicted to be in a zone are considered exposed to accumulated sound levels that may result in harassment within the applicable MMPA Level A (PTS) or MMPA Level B (TTS) harassment categories. MMPA non-TTS Level B (risk-function) is not derived from EL, but is an estimate of the probability of non-TTS behavioral responses that NMFS would classify as harassment. See Section 3.8.6.3 for a thorough description of the risk function methodology. Figure 3.8-5 illustrates harassment zones extending from a hypothetical, directional sound source and is for illustrative purposes only and does not represent the sizes or shapes of the actual exposure zones.

As depicted in Figure 3.8-5, the red MMPA Level A (PTS) exposure zone extends from the source out to the distance and exposure at which the slightest amount of injury is predicted to occur (a distance of approximately 33 ft [10 m] from a SQS-53 sonar in the TMAA). The acoustic exposure that produces the slightest degree of injury is therefore the threshold value defining the outermost limit of the MMPA Level A exposure zone. Use of the threshold associated with the onset of slight injury as the most distant point and least injurious exposure takes account of all more serious injuries by inclusion within the MMPA Level A harassment zone.

The orange MMPA Level B (TTS) exposure zone begins just beyond the point of slightest injury (33 ft [10 m]) and extends outward from that point to include all animals that may possibly experience MMPA Level B harassment from TTS (a distance of approximately 584 ft [178 m] from an SQS-53 sonar in the TMAA). Physiological effects extend beyond the range of slightest injury to a point where slight temporary distortion of the most sensitive tissue occurs, but without destruction or loss of that tissue (such as occurs with inner ear hair cells subjected to TTS). The animals predicted to be in this zone are assumed to experience MMPA Level B harassment from TTS by virtue of temporary impairment of sensory function (altered physiological function) that can disrupt behavior. The criterion and threshold used to define the outer limit of the MMPA Level B exposure zone for the on-set of certain physiological effects are given in Figure 3.8-5.

On Figure 3.8-5 in the yellow non-TTS MMPA Level B harassment exposure zone, varying percentages of exposed animals would be included under MMPA Level B harassment from behavioral reactions (to a distance of approximately 105 km [57 nm] from a SQS-53 in the TMAA).

Auditory Tissues as Indicators of Physiological Effects

Exposure to continuous-type sound may cause a variety of physiological effects in mammals. For example, exposure to very high sound levels may affect the function of the visual system, vestibular system, and internal organs (Ward, 1997). Exposure to high-intensity, continuous type sounds of sufficient duration may cause injury to the lungs and intestines (e.g., Dalecki et al. 2002). Sudden, intense sounds may elicit a "startle" response and may be followed by an orienting reflex (Ward 1997, Jansen 1998). The primary physiological effects of sound, however, are on the auditory system (Ward 1997).

The mammalian auditory system consists of the outer ear, middle ear, inner ear, and central nervous system. Sound waves are transmitted through the middle ears to fluids within the inner ear except cetaceans. The inner ear contains delicate electromechanical hair cells that convert the fluid motions into neural impulses that are sent to the brain. The hair cells within the inner ear are the most vulnerable to over-stimulation by sound exposure (Yost 1994).

Very high sound levels may rupture the eardrum or damage the small bones in the middle ear (Yost 1994). Lower level exposures of sufficient duration may cause permanent or temporary hearing loss; such an effect is called a noise-induced threshold shift, or simply a TS (Miller 1974). A TS may be either permanent, in which case it is called a PTS, or temporary, in which case it is called a TTS. Still lower levels of sound may result in auditory masking (described in Section 3.8.6.2), which may interfere with an animal's ability to hear other concurrent sounds.

Because the tissues of the ear appear to be the most susceptible to the physiological effects of sound and TSs tend to occur at lower exposures than other more serious auditory effects, PTS and TTS are used here as the biological indicators of physiological effects. TTS is the first indication of physiological noninjurious change and is not physical injury. The remainder of this section is, therefore, focused on TSs, including PTSs and TTSs. Since masking (without a resulting TS) is not associated with abnormal physiological function, it is not considered a physiological effect in this EIS/OEIS, but rather a potential behavioral effect. Descriptions of other potential physiological effects, including acoustically mediated bubble growth and air cavity resonance, are described in the Appendix F.

Noise-Induced Threshold Shifts

The amount of TS depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al. 1966, Ward 1997).

The magnitude of a TS normally decreases with the amount of time post-exposure (Miller, 1974). The amount of TS just after exposure is called the initial TS. If the TS eventually returns to zero (the threshold returns to the pre-exposure value), the TS is a TTS. Since the amount of TTS depends on the time post-exposure, it is common to use a subscript to indicate the time in min after exposure (Quaranta et al. 1998). For example, TTS_2 means a TTS measured 2 min after exposure. If the TS does not return to zero but leaves some finite amount of TS, then that remaining TS is a PTS. The distinction between PTS and TTS is based on whether there is a complete recovery of a TS following a sound exposure. Figure 3.8-6 shows two hypothetical TSs: one that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.

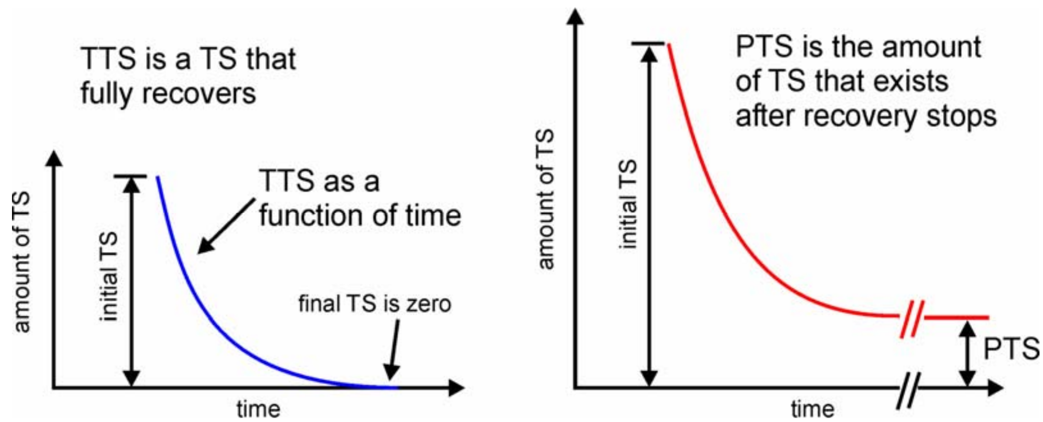


Figure 3.8-6: Hypothetical Temporary and Permanent Threshold Shifts

PTS, TTS, and Exposure Zones

PTS is non-recoverable and, by definition, must result from the destruction of tissues within the auditory system. PTS therefore qualifies as an injury and is classified as Level A harassment under the wording of the MMPA. In the TMAA, 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.

TTS is recoverable and, as in recent rulings (NOAA 2001a, 2002a, 2009), is considered to result from the temporary, non-injurious distortion of hearing-related tissues. In the TMAA, 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. This follows from the concept that hearing loss potentially affects an animal’s ability to react normally to the sounds around it. Therefore, in the TMAA, the potential for TTS is considered as a MMPA Level B harassment that is mediated by physiological effects on the auditory system.

Criteria and Thresholds for Physiological Effects (Sensory Impairment)

This section presents the effect criteria and thresholds for physiological effects of sound leading to injury and behavioral disturbance as a result of sensory impairment. Tissues of the ear are the most susceptible to physiological effects of underwater sound. PTS and TTS were determined to be the most appropriate biological indicators of physiological effects that equate to the onset of injury (Level A harassment) and behavioral disturbance (Level B harassment from TTS), respectively. This section is, therefore, focused on criteria and thresholds to predict PTS and TTS in marine mammals.

Marine mammal ears are functionally and structurally similar to terrestrial mammal ears; however, there are important differences (Ketten 1998). The most appropriate information from which to develop

PTS/TTS criteria for marine mammals would be experimental measurements of PTS and TTS from marine mammal species of interest. TTS data exist for several marine mammal species and may be used to develop meaningful TTS criteria and thresholds. Because of the ethical issues presented, PTS data do not exist for marine mammals and are unlikely to be obtained. Therefore, PTS criteria must be extrapolated using TTS criteria and estimates of the relationship between TTS and PTS.

This section begins with a review of the existing marine mammal TTS data. The review is followed by a discussion of the relationship between TTS and PTS. The specific criteria and thresholds for TTS and PTS used in this EIS/OEIS are then presented. This is followed by discussions of sound energy flux density level (EL), the relationship between EL and SPL, and the use of SPL and EL in previous environmental compliance documents.

EL and SPL

EL is measure of the sound energy flow per unit area expressed in dB. EL is stated in dB re 1 μPa^2-s for underwater sound and dB re $(20\ \mu Pa)^2$-s for airborne sound.

SPL is a measure of the root-mean square (rms), or "effective," sound pressure in decibels. SPL is expressed in dB re 1 μPa for underwater sound and dB re 20 μPa for airborne sound.

TTS in Marine Mammals

A number of investigators have measured TTS in marine mammals. These studies measured hearing thresholds in trained marine mammals before and after exposure to intense sounds. Some of the more important data obtained from these studies are onset-TTS levels – exposure levels sufficient to cause a just-measurable amount of TTS, often defined as 6 dB of TTS (for example, Schlundt et al. 2000). The existing cetacean and pinniped underwater TTS data are summarized in the following bullets.

- Schlundt et al. (2000) reported the results of TTS experiments conducted with bottlenose dolphins and white whales exposed to 1-second tones. This paper also includes a reanalysis of preliminary TTS data released in a technical report by Ridgway et al. (1997). At frequencies of 3, 10, and 20 kHz, SPLs necessary to induce measurable amounts (6 dB or more) of TTS were between 192 and 201 dB re 1 μPa (EL = 192 to 201 dB re 1 μPa^2-s). The mean exposure SPL and EL for onset-TTS were 195 dB re 1 μPa and 195 dB re 1 μPa^2-s, respectively. The sound exposure stimuli (tones) and relatively large number of test subjects (five dolphins and two white whales) make the Schlundt et al. (2000) data the most directly relevant TTS information for the scenarios described in this EIS/OEIS.

- Finneran et al. (2001, 2003, 2005) described TTS experiments conducted with bottlenose dolphins exposed to 3-kHz tones with durations of 1, 2, 4, and 8 seconds. Small amounts of TTS (3 to 6 dB) were observed in one dolphin after exposure to ELs between 190 and 204 dB re 1 μPa^2-s. These results were consistent with the data of Schlundt et al. (2000) and showed that the Schlundt et al. (2000) data were not significantly affected by the masking sound used. These results also confirmed that, for tones with different durations, the amount of TTS is best correlated with the exposure EL rather than the exposure SPL.

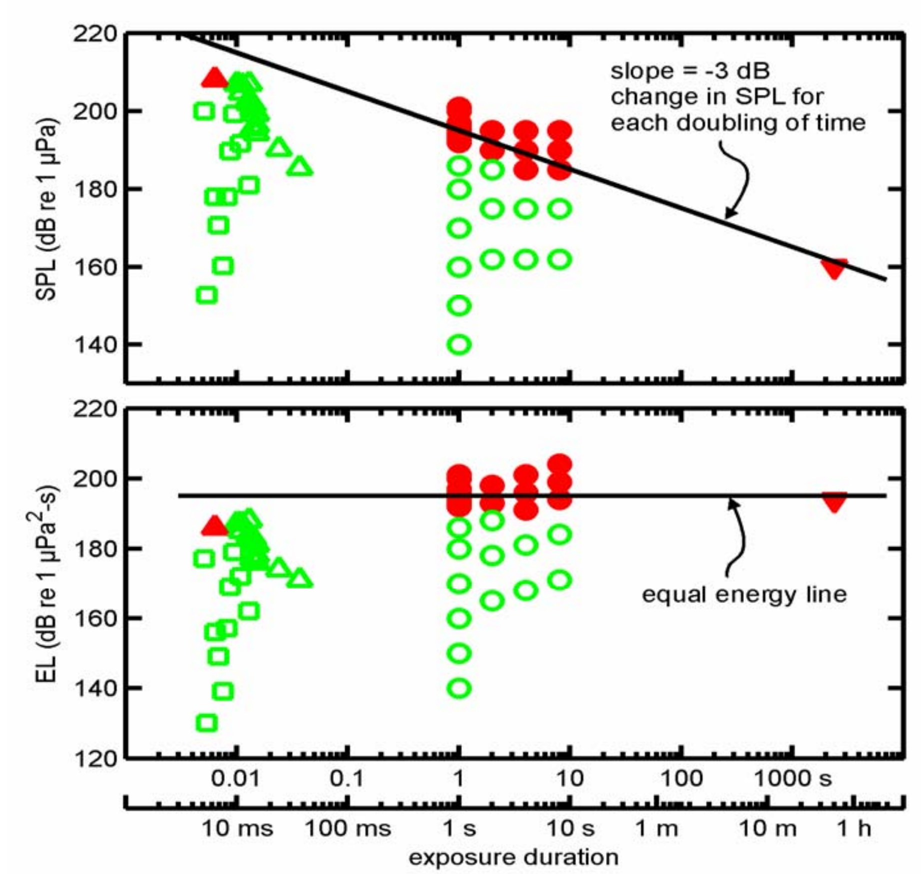
- Finneran et al. (2007) conducted TTS experiments with bottlenose dolphins exposed to intense 20 kHz fatiquing tone. Behavioral and auditory evoked potentials (using sinusoidal amplitude modulated tones creating auditory steady state response [AASR]) were used to measure TTS. The fatiguing tone was either 16 (mean = 193 re 1μPa, SD = 0.8) or 64 seconds (185-186 re 1μPa) in duration. TTS ranged from 19-33db from behavioral measurements and 40-45dB from ASSR measurements.

- Nachtigall et al. (2003) measured TTS in a bottlenose dolphin exposed to octave-band sound centered at 7.5 kHz. Nachtigall et al. (2003) reported TTSs of about 11 dB measured 10 to 15 min after exposure to 30 to 50 min of sound with SPL 179 dB re 1 μPa (EL about 213 dB re μPa^2-s). No TTS was observed after exposure to the same sound at 165 and 171 dB re 1 μPa. Nachtigall et al. (2003) reported TTSs of around 4 to 8 dB 5 min after exposure to 30 to 50 min of sound with SPL 160 dB re 1 μPa (EL about 193 to 195 dB re 1 μPa^2-s). The difference in results was attributed to faster post-exposure threshold measurement—TTS may have recovered before being detected by Nachtigall et al. (2003). These studies showed that, for long-duration exposures, lower sound pressures are required to induce TTS than are required for short-duration tones. These data also confirmed that, for the cetaceans studied, EL is the most appropriate predictor for onset-TTS.
- Finneran et al. (2000, 2002) conducted TTS experiments with dolphins and white whales exposed to impulsive sounds similar to those produced by distant at-sea explosions and seismic water guns. These studies showed that, for very short-duration impulsive sounds, higher sound pressures were required to induce TTS than for longer-duration tones.
- Kastak et al. (1999, 2005) conducted TTS experiments with three species of pinnipeds, California sea lion, northern elephant seal and a Pacific harbor seal, exposed to continuous underwater sounds at levels of 80 and 95 dB Sensation Level (referenced to the animal's absolute auditory threshold at the center frequency) at 2.5 and 3.5 kHz for up to 50 min. Mean TTS shifts of up to 12.2 dB occurred with the harbor seals showing the largest shift of 28.1 dB. Increasing the sound duration had a greater effect on TTS than increasing the sound level from 80 to 95 dB.

Figure 3.8-7 shows the existing TTS data for cetaceans (dolphins and white whales). Individual exposures are shown in terms of SPL versus exposure duration (upper panel) and EL versus exposure duration (lower panel). Exposures that produced TTS are shown as filled symbols. Exposures that did not produce TTS are represented by open symbols. The squares and triangles represent impulsive test results from Finneran et al. 2000 and 2002, respectively. The circles show the 3-, 10-, and 20-kHz data from Schlundt et al. (2000) and the results of Finneran et al. (2003). The inverted triangle represents data from Nachtigall et al. (2003).

Figure 3.8-7 illustrates that the effects of the different sound exposures depend on the SPL and duration. As the duration decreases, higher SPLs are required to cause TTS. In contrast, the ELs required for TTS do not show the same type of variation with exposure duration. At this time the raw data for pinnipeds is not available to construct a similar graph of TTS in pinnipeds as there is for cetaceans in Figure 3.8-7.

The solid line in the upper panel of Figure 3.8-7 has a slope of -3 dB per doubling of time. This line passes through the point where the SPL is 195 dB re 1 μPa and the exposure duration is 1 second. Since EL = SPL + 10log10 (duration), doubling the duration increases the EL by 3 dB. Subtracting 3 dB from the SPL decreases the EL by 3 dB. The line with a slope of -3 dB per doubling of time, therefore, represents an equal energy line – all points on the line have the same EL, which is, in this case, 195 dB re 1 μPa^2-s. This line appears in the lower panel as a horizontal line at 195 dB re 1 μPa^2-s. The equal energy line at 195 dB re 1 μPa^2-s fits the tonal and sound data (the nonimpulsive data) very well, despite differences in exposure duration, SPL, experimental methods, and subjects.



Legend: Filled symbol: Exposure that produced TTS, Open symbol: Exposure that did not produce TTS Squares: Impulsive test results from Finneran et al. 2000, Triangles: Impulsive test results from Finneran et al. 2002, Circles: 3, 10, and 20-kHz data from Schlundt et al. (2000) and results of Finneran et al. (2003), and Inverted triangle: Data from Nachtigall et al. 2004.

Figure 3.8-7: Existing TTS Data for Cetaceans

In summary, the existing cetacean TTS data show that, for the species studied and sounds (nonimpulsive) of interest, the following is true:

- The growth and recovery of TTS are analogous to those in land mammals. This means that, as in land mammals, cetacean TSs depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al. 1966, Ward 1997).
- SPL by itself is not a good predictor of onset-TTS, since the amount of TTS depends on both SPL and duration.
- Exposure EL is correlated with the amount of TTS and is a good predictor for onset-TTS for single, continuous exposures with different durations. This agrees with human TTS data presented by Ward et al. (1958, 1959).
- An energy flux density level of 195 dB re 1 µPa^2-s is the most appropriate predictor for onset-TTS from a single, continuous exposure.

- For the purposes of this EIS/OEIS a measurable amount of 6 dB is considered the onset of TTS.

Relationship between TTS and PTS

Since marine mammal PTS data do not exist, onset-PTS levels for these animals must be estimated using TTS data and relationships between TTS and PTS. Much of the early human TTS work was directed towards relating TTS_2 after 8 hours of sound exposure to the amount of PTS that would exist after years of similar daily exposures (e.g., Kryter et al. 1966). Although it is now acknowledged that susceptibility to PTS cannot be reliably predicted from TTS measurements, TTS data do provide insight into the amount of TS that may be induced without a PTS. Experimental studies of the growth of TTS may also be used to relate changes in exposure level to changes in the amount of TTS induced. Onset-PTS exposure levels may therefore be predicted by:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
- Estimating the additional exposure, above the onset-TTS exposure, necessary to reach the maximum allowable amount of TTS that, again, may be induced without PTS. This is equivalent to estimating the growth rate of TTS – how much additional TTS is produced by an increase in exposure level.

Experimentally induced TTSs, from short duration sounds 1-8 seconds in the range of 3.5-20 kHz, in marine mammals have generally been limited to around 2 to 10 dB, well below TSs that result in some PTS. Experiments with terrestrial mammals have used much larger TSs and provide more guidance on how high a TS may rise before some PTS results. Early human TTS studies reported complete recovery of TTSs as high as 50 dB after exposure to broadband sound (Ward 1960; Ward et al. 1958, 1959). Ward et al. (1959) also reported slower recovery times when TTS_2 approached and exceeded 50 dB, suggesting that 50 dB of TTS_2 may represent a “critical” TTS. Miller et al. (1963) found PTS in cats after exposures that were only slightly longer in duration than those causing 40 dB of TTS. Kryter et al. (1966) stated: “A TTS_2 that approaches or exceeds 40 dB can be taken as a signal that danger to hearing is imminent.” These data indicate that TSs up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for TS to prevent PTS.

The small amounts of TTS produced in marine mammal studies also limit the applicability of these data to estimates of the growth rate of TTS. Fortunately, data do exist for the growth of TTS in terrestrial mammals. For moderate exposure durations (a few min to hours), TTS_2 varies with the logarithm of exposure time (Ward et al. 1958, 1959; Quaranta et al. 1998). For shorter exposure durations the growth of TTS with exposure time appears to be less rapid (Miller 1974, Keeler 1976). For very long-duration exposures, increasing the exposure time may fail to produce any additional TTS, a condition known as asymptotic threshold shift (Saunders et al. 1977, Mills et al. 1979).

Ward et al. (1958, 1959) provided detailed information on the growth of TTS in humans. Ward et al. (1958, 1959) presented the amount of TTS measured after exposure to specific SPLs and durations of broadband sound. Since the relationship between EL, SPL, and duration is known, these same data could be presented in terms of the amount of TTS produced by exposures with different ELs.

Figure 3.8-8 shows results from Ward et al. (1958, 1959) plotted as the amount of TTS_2 versus the exposure EL. The data in Figure 3.8-8 (a) are from broadband (75 Hz to 10 kHz) sound exposures with durations of 12 to 102 min (Ward et al. 1958). The symbols represent mean TTS_2 for 13 individuals exposed to continuous sound. The solid line is a linear regression fit to all but the two data points at the lowest exposure EL. The experimental data are fit well by the regression line (R2 = 0.95). These data are important for two reasons: (1) they confirm that the amount of TTS is correlated with the exposure EL; and (2) the slope of the line allows one to estimate the in additional amount of TTS produced by an increase in exposure. For example, the slope of the line in Figure 3.8-8 (a) is approximately 1.5 dB TTS_2 per dB of EL. This means that each additional dB of EL produces 1.5 dB of additional TTS_2.

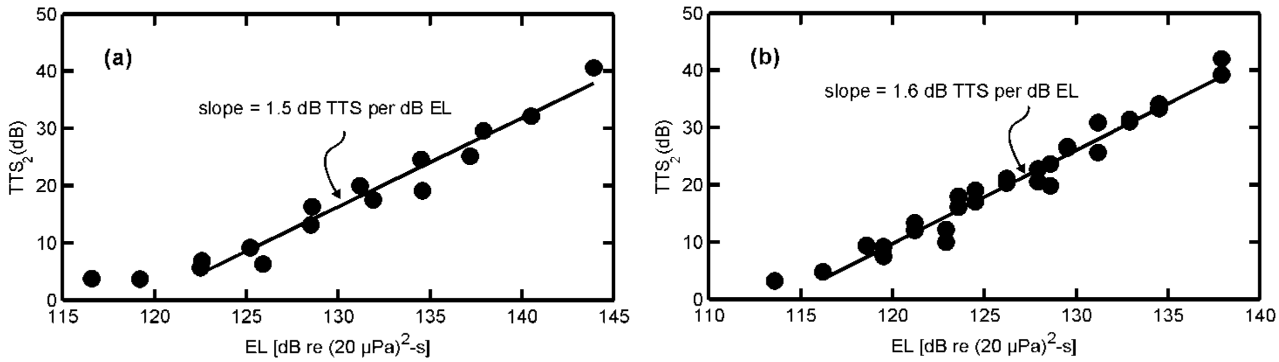


Figure 3.8-8: Growth of TTS versus the Exposure EL (from Ward et al. [1958, 1959])

The data in Figure 3.8-8 (b) are from octave-band sound exposures (2.4 to 4.8 kHz) with durations of 12 to 102 min (Ward et al. 1959). The symbols represent mean TTS for 13 individuals exposed to continuous sound. The linear regression was fit to all but the two data points at the lowest exposure EL. The slope of the regression line fit to the mean TTS data was 1.6 dB TTS_2/dB EL. A similar procedure was carried out for the remaining data from Ward et al. (1959), with comparable results. Regression lines fit to the TTS versus EL data had slopes ranging from 0.76 to 1.6 dB TTS_2/dB EL, depending on the frequencies of the sound exposure and hearing test.

An estimate of 1.6 dB TTS2 per dB increase in exposure EL is the upper range of values from Ward et al. (1958, 1959) and gives the most conservative estimate – it predicts a larger amount of TTS from the same exposure compared to the lines with smaller slopes. The difference between onset-TTS (6 dB) and the upper limit of TTS before PTS (40 dB) is 34 dB. To move from onset-TTS to onset-PTS, therefore, requires an increase in EL of 34 dB divided by 1.6 dB/dB, or approximately 21 dB. An estimate of 20 dB between exposures sufficient to cause onset-TTS and those capable of causing onset-PTS is a reasonable approximation.

To summarize:

In the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated from marine mammal TTS data and PTS/TTS relationships observed in terrestrial mammals. This involves:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
- Estimating the growth rate of TTS – how much additional TTS is produced by an increase in exposure level.
- A variety of terrestrial mammal data sources point toward 40 dB as a reasonable estimate of the largest amount of TS that may be induced without PTS. A conservative is that continuous-type exposures producing TSs of 40 dB or more always result in some amount of PTS.
- Data from Ward et al. (1958, 1959) reveal a linear relationship between TTS_2 and exposure EL. A value of 1.6 dB TTS_2 per dB increase in EL is a conservative estimate of how much additional TTS is produced by an increase in exposure level for continuous- type sounds.

- There is a 34 dB TS difference between onset-TTS (6 dB) and onset-PTS (40 dB). The additional exposure above onset-TTS that is required to reach PTS is therefore 34 dB divided by 1.6 dB/dB, or approximately 21 dB.
- Exposures with ELs 20 dB above those producing TTS may be assumed to produce a PTS. This number is used as a conservative simplification of the 21 dB number derived above.

Threshold Levels for Harassment from Physiological Effects

For this specified action, sound exposure thresholds for modeling TTS and PTS exposures are as presented in Table 3.8-4.

Table 3.8-4: Summary of the Physiological Effects Thresholds for TTS and PTS for Cetaceans and Pinnipeds in the TMAA

Species	Criteria	Threshold (dB re 1μPa^2-s)	MMPA Harassment
Cetaceans All species	TTS PTS	195 215	Level B Level A
Pinniped			
California Sea Lion	TTS PTS	206 226	Level B Level A
Northern Elephant Seal	TTS PTS	204 224	Level B Level A
Northern Fur Seal	TTS PTS	206 226	Level B Level A
Steller Sea Lion	TTS PTS	206 226	Level B Level A

Notes: dB re 1µPa^2-s = decibels referenced to 1 micropascal squared per second, MMPA = Marine Mammal Protection Act, PTS = Permanent Threshold Shift, TTS = Temporary Threshold Shift

Cetaceans predicted to receive a sound exposure with EL of 215 dB re 1 µPa^2-s or greater are assumed to experience PTS and are counted as MMPA Level A harassment. Cetaceans predicted to receive a sound exposure with EL greater than or equal to 195 dB re 1 µPa^2-s but less than 215 dB re 1 µPa^2-s are assumed to experience TTS and are counted as MMPA Level B harassment from TTS.

The TTS and PTS thresholds for pinnipeds vary with species. A threshold of 206 dB re 1 µPa^2-s for TTS and 226 dB re 1 µPa^2-s for PTS is used for otariids (California sea lion, Steller sea lion, and Northern fur seal). Although this criteria is based on data from studies on California sea lions (Kastak et al. 1999, 2005), all three species are morphologically related (e.g., similar body structure and anatomy), and have similar breeding and foraging behaviors. Northern elephant seals are similar to otariids and use thresholds of TTS = 204 dB re 1 µPa^2-s, PTS = 224 dB re 1 µPa^2-s. A lower threshold is used for harbor seals (TTS = 183 dB re 1 µPa^2-s, PTS = 203 dB re 1 µPa^2-s).

Derivation of Effect Threshold

Cetacean Threshold

The TTS threshold is primarily based on the cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The mean exposure EL required to produce onset-TTS in these tests was 195 dB re 1 µPa^2-s. This result is corroborated by the short-duration tone data of Finneran et al. (2001, 2003, 2005) and the long-duration sound data from Nachtigall et al. (2003). Together, these data demonstrate that TTS in cetaceans is correlated with the received EL and that onset-TTS exposures are fit well by an equal-energy line passing through 195 dB re 1 μPa^2-s.

The PTS threshold is based on a 20-dB increase in exposure EL over that required for onset-TTS. The 20-dB value is based on estimates from terrestrial mammal data of PTS occurring at 40 dB or more of TS, and on TS growth occurring at a rate of 1.6 dB/dB increase in exposure EL. This is conservative because: (1) 40 dB of TS is actually an upper limit for TTS used to approximate onset-PTS, and (2) the 1.6 dB/dB growth rate is the highest observed in the data from Ward et al. (1958, 1959).

Pinniped Threshold

The TTS threshold for pinnipeds is based on TTS data from Kastak et al. (1999, 2005). Although their data is from continuous noise rather than short duration tones, pinniped TTS can be extrapolated using equal energy curves. Continuous sound at a lower intensity level can produce TTS similar to short duration but higher intensity sounds such as sonar pings.

Use of EL for Physiological Effect Thresholds

Effect thresholds are expressed in terms of total received EL. Energy flux density is a measure of the flow of sound energy through an area. Marine and terrestrial mammal data show that, for continuous-type sounds of interest, TTS and PTS are more closely related to the energy in the sound exposure than to the exposure SPL.

The EL for each individual ping is calculated from the following equation:

$$EL = SPL + 10\log_{10}(\text{duration})$$

The EL includes both the ping SPL and duration. Longer-duration pings and/or higher-SPL pings will have a higher EL.

If an animal is exposed to multiple pings, the energy flux density in each individual ping is summed to calculate the total EL. Since mammalian TS data show less effect from intermittent exposures compared to continuous exposures with the same energy (Ward 1997), basing the effect thresholds on the total received EL is a conservative approach for treating multiple pings; in reality, some recovery will occur between pings and lessen the effect of a particular exposure.

Therefore, estimates are conservative because recovery is not taken into account – intermittent exposures are considered comparable to continuous exposures.

The total EL depends on the SPL, duration, and number of pings received. The TTS and PTS thresholds do not imply any specific SPL, duration, or number of pings. The SPL and duration of each received ping are used to calculate the total EL and determine whether the received EL meets or exceeds the effect thresholds. For example, the TTS threshold would be reached through any of the following exposures:

- A single ping with SPL = 195 dB re 1 μPa and duration = 1 second.
- A single ping with SPL = 192 dB re 1 μPa and duration = 2 seconds.
- Two pings with SPL = 192 dB re 1 μPa and duration = 1 second.
- Two pings with SPL = 189 dB re 1 μPa and duration = 2 seconds.

Previous Use of EL for Physiological Effects

Originally for effects criteria from at-sea (underwater) explosions, energy measures were part of dual criteria for cetacean auditory effects in ship shock trials, which only involve impulsive-type sounds (DoN 1997, 2001a). These previous actions used 192 dB re 1 μPa^2-s as a reference point to derive a TTS threshold in terms of EL. A second TTS threshold, based on peak pressure, was also used. If either threshold was exceeded, effect was assumed.

The 192 dB re 1 μPa^2-s reference point differs from the threshold of 195 dB re 1 μPa^2-s used in this EIS/OEIS. The 192 dB re 1 μPa^2-s value was based on the minimum observed by Ridgway et al. (1997) and Schlundt et al. (2000) during TTS measurements with bottlenose dolphins exposed to 1-second tones. At the time, no impulsive test data for marine mammals were available and the 1-second tonal data were considered to be the best available. The minimum value of the observed range of 192 to 201 dB re 1 μPa^2-s was used to protect against misinterpretation of the sparse data set available. The 192 dB re 1 μPa^2-s value was reduced to 182 dB re 1 μPa^2-s to accommodate the potential effects of pressure peaks in impulsive waveforms.

The additional data now available for onset-TTS in small cetaceans confirm the original range of values and increase confidence in it (Finneran et al. 2001, 2003; Nachtigall et al. 2003). This EIS/OEIS therefore, uses the more complete data available and the mean value of the entire Schlundt et al. (2000) data set (195 dB re 1 μPa^2-s), instead of the minimum of 192 dB re 1 μPa^2-s. Use of the data in this manner has been established as standard by NMFS for these types of actions in other Navy training locations in the Pacific (NOAA 2009). From the standpoint of statistical sampling and prediction theory, the mean is the most appropriate predictor—the "best unbiased estimator"—of the EL at which onset-TTS should occur; predicting the number of exposures in future actions relies (in part) on using the EL at which onset-TTS will most likely occur. When that EL is applied over many pings in each of many sonar exercises, that value will provide the most accurate prediction of the actual number of exposures by onset-TTS over all of those exercises. Use of the minimum value would overestimate the number of exposures because many animals counted would not have experienced onset-TTS. Further, there is no logical limiting minimum value of the distribution that would be obtained from continued successive testing. Continued testing and use of the minimum would produce more and more erroneous estimates.

Criteria and Thresholds for Level B Harassment from Non-TTS

This Section presents the effect criterion and threshold for non-TTS behavioral effects of sound leading to behavioral disturbance without accompanying physiological effects as has been established by NMFS (NOAA 2009). Since TTS is used as the biological indicator for a physiological effect leading to behavioral disturbance, the non-TTS behavioral effects discussed in this section may be thought of as behavioral disturbance occurring at exposure levels below those causing TTS.

A large body of research on terrestrial animal and human response to airborne sound exists, but results from those studies are not readily extendible to the development of effect criteria and thresholds for marine mammals. For example, "annoyance" is one of several criteria used to define impact to humans from exposure to industrial sound sources. Comparable criteria cannot be developed for marine mammals because there is no acceptable method for determining whether a nonverbal animal is annoyed. Further, differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (e.g., human data tend to focus on 8-hour-long exposures) make extrapolation of human sound exposure standards inappropriate.

Behavioral observations of marine mammals exposed to anthropogenic sound sources exist; however, there are few observations and no controlled measurements of behavioral disruption of cetaceans caused by sound sources with frequencies, waveforms, durations, and repetition rates comparable to those employed by the tactical sonars to be used in the TMAA. At the present time there is no consensus on how to account for behavioral effects on marine mammals exposed to continuous-type sounds (NRC, 2003b).

3.8.7.4 Assessing MMPA Level B Non-TTS Behavioral Harassment Using Risk Function

Background

Based on available evidence, marine animals are likely to exhibit any of a suite of potential behavioral responses or combinations of behavioral responses upon exposure to sonar transmissions. Potential behavioral responses include, but are not limited to: avoiding exposure or continued exposure; behavioral disturbance (including distress or disruption of social or foraging activity); habituation to the sound; becoming sensitized to the sound; or not responding to the sound.

Existing studies of behavioral effects of human-made sounds in marine environments remain inconclusive, partly because many of those studies have lacked adequate controls, applied only to certain kinds of exposures (which are often different from the exposures being analyzed in the study), and had limited ability to detect behavioral changes that may be significant to the biology of the animals that were being observed. These studies are further complicated by the wide variety of behavioral responses marine mammals exhibit and the fact that those responses can vary significantly by species, individual, and the context of an exposure. In some circumstances, some individuals will continue normal behavioral activities in the presence of high levels of human-made noise. In other circumstances, the same individual or other individuals may avoid an acoustic source at much lower received levels (Richardson et al. 1995, Wartzok et al. 2003). These differences within and between individuals appear to result from a complex interaction of experience, motivation, and learning that are difficult to quantify and predict.

It is possible that some marine mammal behavioral reactions to anthropogenic sound may result in strandings. As detailed in Appendix F, 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 training activities, seismic surveys, and other anthropogenic activities that introduced sound into the marine environment. Based on the results of recent experiments with tagged beaked whales, it has been suggested that that beaked whales may be “particularly sensitive to anthropogenic sounds, but there is no evidence that they have a special sensitivity to sonar compared with other signals” (Tyack 2009). Sonar exposure has, however, been identified as a contributing cause or factor in five specific mass stranding events: Greece in 1996; the Bahamas in March 2000; Madeira, Portugal in 2000; the Canary Islands in 2002, and Spain in 2006 (Advisory Committee on Acoustic Impacts on Marine Mammals 2006).

In these five events, exposure to acoustic energy has been considered a potential indirect cause of the death of marine mammals (Cox et al. 2006). A popular hypothesis regarding a potential cause of the strandings is that tissue damage results from a “gas and fat embolic syndrome” (Fernandez et al. 2005; Jepson et al. 2003, 2005). 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. 2001, 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 of the strandings (e.g., overheating, decomposition, or internal hemorrhaging from being on shore) were the result of the stranding and not the direct result of exposure to sonar (Cox et al. 2006).

Non-TTS Risk Function Adapted from Feller (1968)

To assess the potential effects on marine mammals associated with active sonar used during training activity, the Navy and NMFS as cooperating agencies in previous analysis (NOAA 2008b, 2008c) applied a risk function that estimates the probability of behavioral responses that NMFS would classify as harassment for the purposes of the MMPA given exposure to specific received levels of MFA sonar. The mathematical function is derived from a solution in Feller (1968) as defined in the SURTASS LFA Sonar Final OEIS/EIS (DoN 2001), and relied on in the Supplemental SURTASS LFA Sonar EIS (DoN 2007a) for the probability of MFA sonar risk for MMPA Level B non-TTS behavioral harassment with input parameters modified by NMFS for MFA sonar for mysticetes, odontocetes (except harbor porpoises), and pinnipeds (NMFS 2008a, NOAA 2009). The same risk function and input parameters will be applied to high frequency active (HFA) (>10 kHz) sources until applicable data becomes available for high frequency sources.

In order to represent a probability of risk, the function should have a value near zero at very low exposures, and a value near one for very high exposures. One class of functions that satisfies this criterion is cumulative probability distributions, a type of cumulative distribution function. In selecting a particular functional expression for risk, several criteria were identified:

- The function must use parameters to focus discussion on areas of uncertainty;
- The function should contain a limited number of parameters;
- The function should be capable of accurately fitting experimental data; and
- The function should be reasonably convenient for algebraic manipulations.

As described in DoN (2001), the mathematical function below is adapted from a solution in Feller (1968).

$$R = \frac{1 - \left(\frac{L-B}{K}\right)^{-A}}{1 - \left(\frac{L-B}{K}\right)^{-2A}}$$

Where: R = risk (0 – 1.0);

L = Received Level (RL) in dB;

B = basement RL in dB; (120 dB);

K = the RL increment above basement in dB at which there is 50 percent risk;

A = risk transition sharpness parameter (10 for odontocetes, 8 for mysticetes).

In order to use this function, the values of the three parameters (B, K, and A) need to be established. The values used in this EIS/OEIS analysis are based on three sources of data: TTS experiments conducted at SSC and documented in Finneran, et al. (2001, 2003, and 2005; Finneran and Schlundt 2004); reconstruction of sound fields produced by the USS SHOUP associated with the behavioral responses of killer whales observed in Haro Strait and documented in Department of Commerce, NMFS (2005), DoN (2004), and Fromm (2004a, 2004b); and observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components documented in Nowacek et al.

(2004). The input parameters, as defined by NMFS, are based on very limited data that represent the best available science at this time.

Data Sources Used For Risk Function

There is widespread consensus that cetacean response to MFA sound signals needs to be better defined using controlled experiments. Navy is contributing to an ongoing behavioral response study in the Bahamas that has provided some initial information on beaked whales, the species identified as potentially the most sensitive to MFA sonar. NMFS is leading this international effort with scientists from various academic institutions and research organizations to conduct studies on how marine mammals respond to underwater sound exposures. Field experiments in 2007 and 2008 with tagged beaked whales found reactions to all introduced sound stimulus consisted of the animals stopping their clicking, producing fewer foraging buzzes than normal, and ending their dive in a long and an unusually slow ascent moving away from the sound source (Tyack 2009). This suggested that beaked whales may be "particularly sensitive to anthropogenic sounds, but there is no evidence that they have a special sensitivity to sonar compared with other signals" (Tyack 2009). These initial findings are not in conflict with the current risk function. Until additional data beyond the three recently completed experimental exposures are available, NMFS and the Navy will continue use of the risk function established for recent Final Rules under MMPA for Navy training activities (e.g., NOAA 2009). NMFS and the Navy have determined that the following three data sets remain the most applicable for the direct use in developing risk function parameters for MFA/HFA sonar. These data sets represent the only known data that specifically relate altered behavioral responses to exposure to MFA sound sources.

Data from SSC's Controlled Experiments

Most of the observations of the behavioral responses of toothed whales resulted from a series of controlled experiments on bottlenose dolphins and beluga whales conducted by researchers at SSC's facility in San Diego, California (Finneran et al. 2001, 2003, 2005; Finneran and Schlundt 2004; Schlundt et al. 2000). In experimental trials with marine mammals trained to perform tasks when prompted, scientists evaluated whether the marine mammals performed these tasks when exposed to mid-frequency tones. Altered behavior during experimental trials usually involved refusal of animals to return to the site of the sound stimulus. This refusal included what appeared to be deliberate attempts to avoid a sound exposure or to avoid the location of the exposure site during subsequent tests. (Schlundt et al. 2000, Finneran et al. 2002) Bottlenose dolphins exposed to 1-sec intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 micropascal (ìPa) root mean square (rms), and beluga whales did so at received levels of 180 to 196 dB and above. Test animals sometimes vocalized after an exposure to impulsive sound from a seismic watergun (Finneran et al. 2002). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway et al. 1997, Schlundt et al. 2000).

Finneran and Schlundt (2004) examined behavioral observations recorded by the trainers or test coordinators during the Schlundt et al. (2000) and Finneran et al. (2001, 2003, 2005) experiments featuring 1-second (sec) tones. These included observations from 193 exposure sessions (fatiguing stimulus level > 141 dB re 1μPa) conducted by Schlundt et al. (2000) and 21 exposure sessions conducted by Finneran et al. (2001, 2003, 2005). The observations were made during exposures to sound sources at 0.4 kHz, 3 kHz, 10 kHz, 20 kHz, and 75 kHz. The TTS experiments that supported Finneran and Schlundt (2004) are further explained below:

Schlundt et al. (2000) provided a detailed summary of the behavioral responses of trained marine mammals during TTS tests conducted at SSC San Diego with 1-sec tones. Schlundt et al. (2000) reported eight individual TTS experiments. Fatiguing stimuli durations were 1-sec; exposure frequencies were 0.4 kHz, 3 kHz, 10 kHz, 20 kHz and 75 kHz. The experiments were conducted in San Diego Bay. Because of the variable ambient noise in the bay, low-level broadband masking noise was used to keep hearing thresholds consistent despite fluctuations in the ambient noise. Schlundt et al. (2000) reported that “behavioral alterations,” or deviations from the behaviors the animals being tested had been trained to exhibit, occurred as the animals were exposed to increasing fatiguing stimulus levels.

Finneran et al. (2001, 2003, 2005) conducted TTS experiments using tones at 3 kHz. The test method was similar to that of Schlundt et al. (2000) except the tests were conducted in a pool with very low ambient noise level (below 50 dB re 1 µPa/Hz), and no masking noise was used. Two separate experiments were conducted using 1-sec tones. In the first, fatiguing sound levels were increased from 160 to 201 dB SPL. In the second experiment, fatiguing sound levels between 180 and 200 dB re 1 µPa were randomly presented.

Data from Studies of Baleen (Mysticetes) Whale Responses

The only mysticete data available resulted from a field experiments in which baleen whales (mysticetes) were exposed to a range frequency sound sources from 120 Hz to 4500 Hz (Nowacek et al. 2004). An alert stimulus, with a mid-frequency component, was the only portion of the study used to support the risk function input parameters.

Nowacek et al. (2004) documented observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components. To assess risk factors involved in ship strikes, a multi-sensor acoustic tag was used to measure the responses of whales to passing ships and experimentally tested their responses to controlled sound exposures, which included recordings of ship noise, the social sounds of conspecifics and a signal designed to alert the whales. The alert signal was 18-min of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. The purposes of the alert signal were (a) to provoke an action from the whales via the auditory system with disharmonic signals that cover the whales estimated hearing range; (b) to maximize the signal to noise ratio (obtain the largest difference between background noise) and c) to provide localization cues for the whale. Five out of six whales reacted to the signal designed to elicit such behavior. Maximum received levels ranged from 133 to 148 dB re 1µPa.

Observations of Killer Whales in Haro Strait in the Wild

In May 2003, killer whales (*Orcinus orca*) were observed exhibiting behavioral responses while the USS SHOUP was engaged in MFA sonar activities in the Haro Strait in the vicinity of Puget Sound, Washington. Although these observations were made in an uncontrolled environment, the sound field that may have been associated with the sonar activities had to be estimated, and the behavioral observations were reported for groups of whales, not individual whales, the observations associated with the USS SHOUP provide the only data set available of the behavioral responses of wild, noncaptive animal upon exposure to the SQS-53 MFA sonar. U.S. Department of Commerce (NMFS 2005), DoN (2004), Fromm (2004a, 2004b) documented reconstruction of sound fields produced by the USS SHOUP associated with the behavioral response of killer whales observed in Haro Strait. Observations from this reconstruction included an approximate closest approach time which was correlated to a reconstructed estimate of received level at an approximate whale location (which ranged from 150 to 180 dB), with a mean value of 169.3 dB.

Limitations of the Risk Function Data Sources

There are significant limitations and challenges to any risk function derived to estimate the probability of marine mammal behavioral responses; these are largely attributable to sparse data. Ultimately there should be multiple functions for different marine mammal taxonomic groups, but the current data are insufficient to support them. The goal is unquestionably that risk functions be based on empirical measurement.

The risk function presented here is based on three data sets that NMFS and Navy have determined are the best available science at this time. The Navy and NMFS acknowledge each of these data sets has limitations. However, this risk function, if informed by the limited available data relevant to the MFA sonar application, has the advantages of simplicity and the fact that there is precedent for its application and foundation in marine mammal research.

While NMFS considers all data sets as being weighted equally in the development of the risk function, the Navy believes the SSC San Diego data is the most rigorous and applicable for the following reasons:

- The data represents the only source of information where the researchers had complete control over and ability to quantify the noise exposure conditions.
- The altered behaviors were identifiable due to long term observations of the animals.
- The fatiguing noise consisted of tonal exposures with limited frequencies contained in the MFA sonar bandwidth.

However, the Navy and NMFS do agree that the following are limitations associated with the three data sets used as the basis of the risk function:

- The three data sets represent the responses of only four species: trained bottlenose dolphins and beluga whales, North Atlantic right whales in the wild and killer whales in the wild.
- None of the three data sets represent experiments designed for behavioral observations of animals exposed to MFA sonar.
- The behavioral responses of marine mammals that were observed in the wild (observations of killer whales in Haro Strait) are based on an estimated received level of sound exposure; they do not take into consideration (due to minimal or no supporting data):
    - Potential relationships between acoustic exposures and specific behavioral activities (e.g., feeding, reproduction, changes in diving behavior, etc.), variables such as bathymetry, or acoustic waveguides; or
    - Differences in individuals, populations, or species, or the prior experiences, reproductive state, hearing sensitivity, or age of the marine mammal.

SSC San Diego Trained Bottlenose Dolphins and Beluga Data Set:

- The animals were trained animals in captivity; therefore, they may be more or less sensitive than cetaceans found in the wild (Domjan 1998).
- The tests were designed to measure TTS, not behavior.
- Because the tests were designed to measure TTS, the animals were exposed to much higher levels of sound than the baseline risk function (only two of the total 193 observations were at levels below 160 dB re 1 μPa^2-s).
- The animals were not exposed in the open ocean but in a shallow bay or pool.

North Atlantic Right Whales in the Wild Data Set

- The observations of behavioral response were from exposure to alert stimuli that contained mid-frequency components but was not similar to a MFA sonar ping. The alert signal was 18 min of exposure consisting of three 2-min signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of (1) alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)- high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. This 18-min alert stimuli is in contrast to the average 1-sec ping every 30 sec in a comparatively very narrow frequency band used by military sonar.
- The purpose of the alert signal was, in part, to provoke an action from the whales through an auditory stimulus.

Killer Whales in the Wild Data Set

- The observations of behavioral harassment were complicated by the fact that there were other sources of harassment in the vicinity (other vessels and their interaction with the animals during the observation).
- The observations were anecdotal and inconsistent. There were no controls during the observation period, with no way to assess the relative magnitude of the any observed response as opposed to baseline conditions.

Input Parameters Risk Function

The values of B, K, and A need to be specified in order to utilize the risk function defined in Section 3.8.6.3. The risk continuum function approximates the dose-response function in a manner analogous to pharmacological risk assessment. In this case, the risk function is combined with the distribution of sound exposure levels to estimate aggregate impact on an exposed population.

Basement Value for Risk – The B Parameter

The B parameter defines the basement value for risk, below which the risk is so low that calculations are impractical. This 120 dB level is taken as the estimate received level (RL) below which the risk of significant change in a biologically important behavior approaches zero for the MFA/HFA sonar risk assessment. This level is based on a broad overview of the levels at which multiple species have been reported responding to a variety of sound sources, both mid-frequency and other, was recommended by the NMFS, and has been used in other publications (DoN 2008a,b; NOAA 2009). The Navy recognizes that for actual risk of changes in behavior to be zero, the signal-to-noise ratio of the animal must also be zero. However, the present convention of ending the risk calculation at 120 dB for MFA/HFA sonar has a negligible impact on the subsequent calculations, because the risk function does not attain appreciable values at received levels that low.

The K Parameter

NMFS and the Navy used the mean of the following values to define the midpoint of the function: (1) the mean of the lowest received levels (185.3 dB) at which individuals responded with altered behavior to 3 kHz tones in the SSC data set; (2) the estimated mean received level value of 169.3 dB produced by the reconstruction of the USS SHOUP incident in which killer whales exposed to MFA sonar (range modeled possible received levels: 150 to 180 dB); and (3) the mean of the five maximum received levels at which Nowacek et al. (2004) observed significantly altered responses of right whales to the alert stimuli than to the control (no input signal) is 139.2 dB SPL. The arithmetic mean of these three mean values is 165 dB SPL. The value of K is the difference between the value of B (120 dB SPL) and the 50 percent value of 165 dB SPL; therefore, K=45.

Risk Transition – The A Parameter

The A parameter controls how rapidly risk transitions from low to high values with increasing receive level. As A increases, the slope of the risk function increases. For very large values of A, the risk function can approximate a threshold response or step function. In consultation for the Hawaii Range Complex (HRC) EIS/OEIS, NMFS recommended that the Navy use A=10 as the value for odontocetes (except harbor porpoises), and pinnipeds, and A=8 for mysticetes (Figures 3.8-9 and 3.8-10) (NMFS 2008a, NOAA 2009)

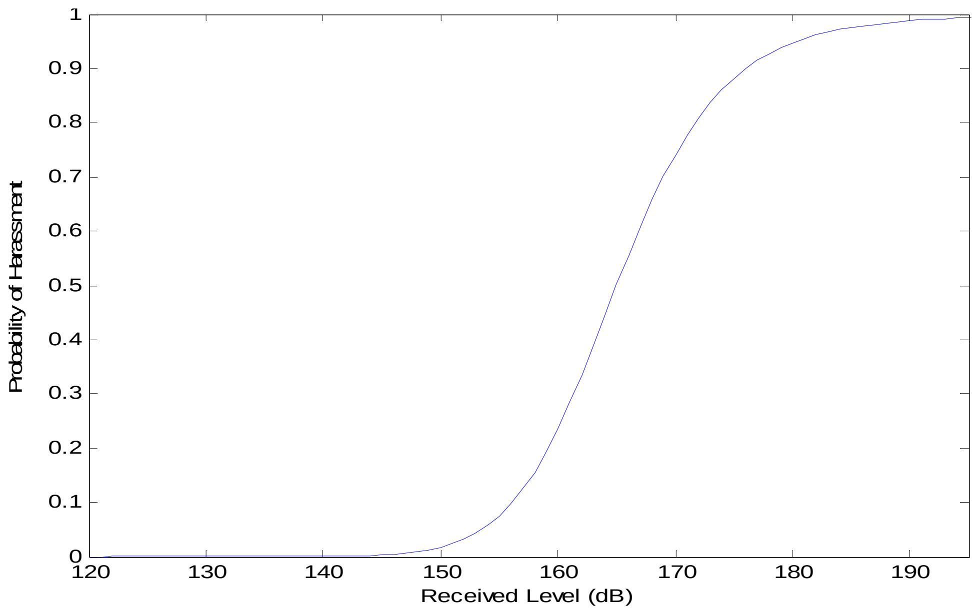


Figure 3.8-9: Risk Function Curve for Odontocetes (toothed whales) and Pinnipeds

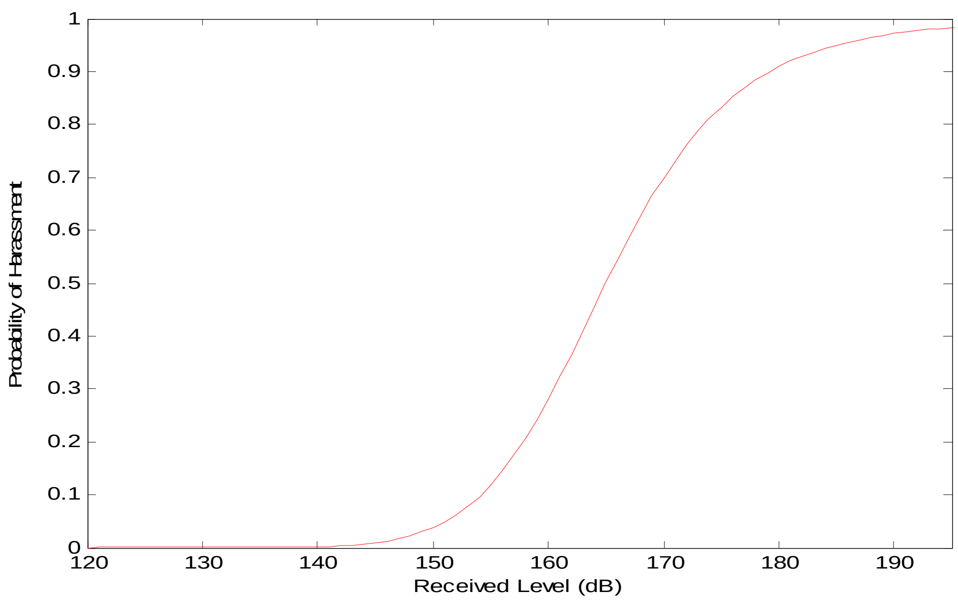


Figure 3.8-10: Risk Function Curve for Mysticetes (baleen whales)

Justification for the Steepness Parameter of A=10 for the Odontocete Curve

The NMFS independent review process described in Section 4.1.2.4.9 of DoN (2008b) provided the impetus for the selection of the parameters for the risk function curves. One scientist recommended staying close to the risk continuum concept as used in the SURTASS LFA sonar EIS. This scientist opined that both the basement and slope values; B=120 dB and A=10 respectively, from the SURTASS LFA sonar risk continuum concept are logical solutions in the absence of compelling data to select alternate values supporting the Feller-adapted risk function for MFA sonar. Another scientist indicated a steepness parameter needed to be selected, but did not recommend a value. Four scientists did not specifically address selection of a slope value. After reviewing the six scientists' recommendations, the two NMFS scientists recommended selection of A=10. Direction was provided by NMFS to use the A=10 curve for odontocetes based on the scientific review of potential risk functions developed for the HRC EIS/OEIS (DoN 2008a,b; NOAA 2009).

As background, a sensitivity analysis of the A=10 parameter was undertaken and presented in Appendix D of the SURTASS/LFA FEIS (DoN 2001). The analysis was performed to support the A=10 parameter for mysticete whales responding to a low-frequency sound source, a frequency range to which the mysticete whales are believed to be most sensitive to. The sensitivity analysis results confirmed the increased risk estimate for animals exposed to sound levels below 165 dB. Results from the Low Frequency Sound Scientific Research Program (LFS SRP) phase II research showed that whales (specifically gray whales in their case) did scale their responses with received level as supported by the A=10 parameter (Buck and Tyack, 2000). In the second phase of the LFS SRP research, migrating gray whales showed responses similar to those observed in earlier research (Malme et al. 1983, 1984) when the low frequency source was moored in the migration corridor (1.1 nm [2 km] from shore). The study extended those results with confirmation that a louder SL elicited a larger scale avoidance response. However, when the source was placed offshore (2.2 nm [4 km] from shore) of the migration corridor, the avoidance response was not evident. This implies that the inshore avoidance model – in which 50 percent of the whales avoid exposure to levels of 141 + 3 dB – may not be valid for whales in proximity to an offshore source (DoN 2001). As concluded in the SURTASS LFA Sonar Final OEIS/EIS (DoN 2001), the value of A=10 produces a curve that has a more gradual transition than the curves developed by the analyses of migratory gray whale studies (Malme et al. 1984; Buck and Tyack 2000; and SURTASS LFA Sonar EIS, Subchapters 1.43, 4.2.4.3 and Appendix D; NMFS 2008a; NOAA 2009).

Justification for the steepness parameter of A=8 for the Mysticete Curve

The Nowacek et al. (2004) study provides the only available data source for a mysticete species behaviorally responding to a sound source (i.e., alert stimuli) with frequencies in the range of tactical mid-frequency sonar (1-10 kHz), including empirical measurements of received levels (RLs). While there are fundamental differences in the stimulus used by Nowacek et al. (2004) and tactical mid-frequency sonar (e.g., source level, waveform, duration, directionality, likely range from source to receiver), they are generally similar in frequency band and the presence of modulation patterns. Thus, while they must be considered with caution in interpreting behavioral responses of mysticetes to mid-frequency sonar, they seemingly cannot be excluded from this consideration given the overwhelming lack of other information. The Nowacek et al. (2004) data indicate that five out the six North Atlantic right whales exposed to an alert stimuli "significantly altered their regular behavior and did so in identical fashion" (i.e., ceasing feeding and swimming to just under the surface). For these five whales, maximum RLs associated with this response ranged from root- mean-square sound (rms) pressure levels of 133-148 dB (re: 1 μPa).

When six scientists (one of them being Nowacek) were asked to independently evaluate available data for constructing a dose response curve based on a solution adapted from Feller (1968), the majority of them (4 out of 6; one being Nowacek) indicated that the Nowacek et al. (2004) data were not only appropriate but also necessary to consider in the analysis. While other parameters associated with the solution adapted from Feller (1968) were provided by many of the scientists (i.e., basement parameter [B], increment above basement where there is 50 percent risk [K]), only one scientist provided a suggestion for the risk transition parameter, A.

A single curve may provide the simplest quantitative solution to estimating behavioral harassment. However, the policy decision, by NMFS-OPR, to adjust the risk transition parameter from A=10 to A=8 for mysticetes and create a separate curve was based on the fact the use of this shallower slope better reflected the increased risk of behavioral response at relatively low RLs suggested by the Nowacek et al. (2004) data. In other words, by reducing the risk transition parameter from 10 to 8, the slope of the curve for mysticetes is reduced. This results in an increase the proportion of the population being classified as behaviorally harassed at lower RLs. It also slightly reduces the estimate of behavioral response probability at quite high RLs, though this is expected to have quite little practical result owing to the very limited probability of exposures well above the mid-point of the function. This adjustment allows for a slightly more conservative approach in estimating behavioral harassment at relatively low RLs for mysticetes compared to the odontocete curve and is supported by the only dataset currently available. It should be noted that the current approach (with A=8) still yields an extremely low probability for behavioral responses at RLs between 133-148 dB, where the Nowacek data indicated significant responses in a majority of whales studied. (Note: Creating an entire curve based strictly on the Nowacek et al. [2004] data alone for mysticetes was advocated by several of the reviewers and considered inappropriate, by NMFS-OPR, since the sound source used in this study was not identical to tactical mid-frequency sonar, and there were only five data points available). The policy adjustment made by NMFS-OPR was also intended to capture some of the additional recommendations and considerations provided by the scientific panel (i.e., the curve should be more data driven and that a greater probability of risk at lower RLs be associated with direct application of the Nowacek et al. 2004 data).

Harbor Porpoises

The information currently available regarding these inshore species that inhabit shallow and coastal waters suggests a very low threshold level of response for both captive and wild animals. Threshold levels at which both captive (e.g. Kastelein et al. 2000, 2005, 2006) and wild harbor porpoises (e.g. Johnston, 2002) responded to sound (e.g. acoustic harassment devices (AHDs), acoustic deterrent devices (ADDs), or other nonpulsed sound sources) is very low (e.g. ~120 dB SPL), although the biological significance of the disturbance is uncertain. Therefore, Navy has not used the risk function curve but has applied a step function threshold of 120 dB SPL to estimate MMPA Level B non-TTS behavioral harassment exposure of harbor porpoises in the TMAA (i.e., assumes that all harbor porpoises exposed to 120 dB or higher MFAS will respond in a way NMFS considers behavioral harassment).

Application of the Risk Function and Current Regulatory Scheme

The risk function is used (in all cases other than the harbor porpoise) to estimate the percentage of an exposed population that is likely to exhibit behaviors that would qualify as MMPA Level B harassment (as that term is defined by the MMPA applicable to military readiness activities, such as the Navy's training and testing with mid- and high-frequency active sonar) at a given received level of sound (NOAA 2009). For example, at 165 dB SPL (dB re: 1µPa rms), the risk (or probability) of harassment is defined according to this function as 50 percent, and Navy/NMFS applies that by estimating that 50 percent of the individuals exposed at that received level are likely to respond by exhibiting behavior that NMFS would classify as behavioral harassment (NOAA 2009). The risk function is not applied to individual animals, only to exposed populations.

The data used to produce the risk function were compiled from four species that had been exposed to sound sources in a variety of different circumstances. As a result, the risk function represents a general relationship between acoustic exposures and behavioral responses that is then applied to specific circumstances. That is, the risk function represents a relationship that is deemed to be generally true, based on the limited, best-available science, but may not be true in specific circumstances. In particular, the risk function, as currently derived, treats the received level as the only variable that is relevant to a marine mammal's behavioral response. However, we know that many other variables—the marine mammal's gender, age, and prior experience; the activity it is engaged in during an exposure event, its distance from a sound source, the number of sound sources, and whether the sound sources are approaching or moving away from the animal—can be critically important in determining whether and how a marine mammal will respond to a sound source (Southall et al. 2007). The data that are currently available do not allow for incorporation of these other variables in the current risk functions; however, the risk function represents the best use of the data that are available (NOAA 2009).

As more specific and applicable data become available, NMFS can use these data to modify the outputs generated by the risk function to make them more realistic (and ultimately, data may exist to justify the use of additional, alternate, or multi-variate functions). As mentioned above, it is known that the distance from the sound source and whether it is perceived as approaching or moving away can affect the way an animal responds to a sound (Wartzok et al. 2003, Southall et al. 2007). In the TMAA, modeling indicates animals exposed to received levels between 120 and 130 dB may be 36 to 57 nm (76 to 105 km) from a sound source; those distances would influence whether those animals might perceive the sound source as a potential threat, and their behavioral responses to that threat (DoN 2008a,b; NOAA 2009). Though there are data showing marine mammal responses to sound sources at that received level, NMFS does not currently have any data that describe the response of marine mammals to sounds at that distance (or to other contextual aspects of the exposure, such as the presence of higher frequency harmonics), much less data that compare responses to similar sound levels at varying distances (NOAA 2009). However, if data were to become available that suggested animals were less likely to respond (in a manner NMFS would classify as harassment) to certain levels beyond certain distances, or that they were more likely to respond at certain closer distances, Navy will re-evaluate the risk function to try to incorporate any additional variables into the "take" estimates. For distances to MMPA Level B harassments from non-TTS and the percent of MMPA Level B harassments for those distances in the TMAA for an SQS-53 sonar, see Table 3.8-5 and Figure 3.8-11.

Table 3.8-5: Non-TTS MMPA Level B Harassments at Each Received Level Band in the TMAA from SQS-53 Sonar

Received Level (dB SPL)	Distance at which Levels Occur in GOA	Percent of Behavioral Harassments Occurring at Given Levels
Below 138	42 km – 105 km	~ 0 %
138<Level<144	28 km – 42 km	< 1 %
144<Level<150	17 km – 28 km	~1 %
150<Level<156	9 km – 17 km	7 %
156<Level<162	5 km – 9 km	18 %
162<Level<168	2.5 km – 5 km	26 %
168<Level<174	1.2 km – 2.5 km	22 %
174<Level<180	0.5 km – 1.2 km	14 %
180<Level<186	335 m – 0.5 km	6 %
186<Level<TTS	178 m – 335 m	5 %

Notes: dB = decibel, GOA = Gulf of Alaska, km = kilometer, TMAA = Temporary Maritime Activities Area, MMPA = Marine Mammal Protection Act, nm = nautical mile, SPL = Sound Pressure Level

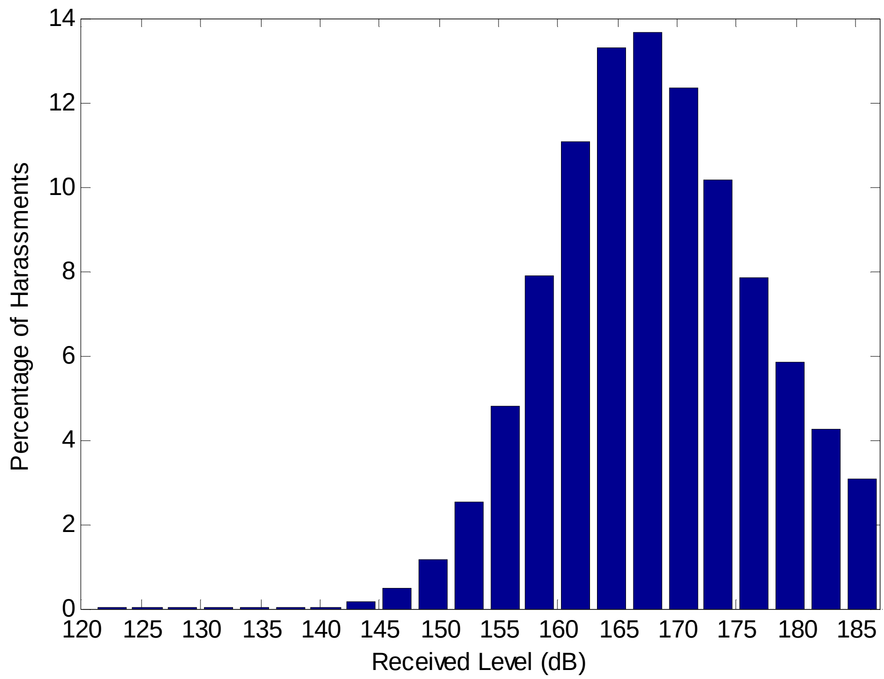


Figure 3.8-11: The Percentage of MMPA Level B Harassments from Non-TTS for Every 3 dB of Received Level in the TMAA

It is worth noting that Navy and NMFS would expect an animal exposed to the levels at the bottom of the risk function to exhibit non-TTS MMPA Level B harassment behavioral responses that are less likely to adversely affect the longevity, survival, or reproductive success of the animals that might be exposed, based on received level, and the fact that the exposures will occur in the absence of some of the other contextual variables that would likely be associated with increased severity of effects, such as the proximity of the sound source(s) or the proximity of other vessels, aircraft, submarines, etc. maneuvering in the vicinity of the exercise. NMFS will consider all available information (other variables, etc.), but all else being equal, takes that result from exposure to lower received levels and at greater distances from the exercises would be less likely to contribute to population level effects (NMFS 2008a, NOAA 2009).

3.8.7.5 Navy Protocols for Acoustic Modeling Analysis of Marine Mammal Exposures

The quantification of the acoustic modeling results for sonar includes additional analysis to increase the accuracy of the number of marine mammals affected. Table 3.8-6 provides a summary of the modeling protocols used in the standard Navy analysis. Modeling for ASW and other sound generating activities in the TMAA differ from these protocols in that the annual required sonar hours data was derived from projected future needs based on input gathered during previous Northern Edge Exercise planning conferences and discussions with U.S. Navy Third Fleet training directorate. Post modeling analysis includes reducing acoustic footprints where they encounter land masses, accounting for acoustic footprints for sources that overlap to accurately sum the total area when multiple ships are operating together, and to better account for the maximum number of individuals of a species that could potentially be exposed to sound sources within the course of one day or a discreet continuous event.

Table 3.8-6: Navy Protocols Providing for Modeling Quantification of Marine Mammal Exposures to Sonar

Historical Data	Sonar Positional Reporting System (SPORTS)	Annual active sonar usage data is obtained from the SPORTS database to determine the number of active sonar hours and the geographic location of those hours for modeling purposes.
Acoustic Parameters	SQS-53 and SQS-56	The SQS-53 and the SQS-56 active sonar sources are modeled separately to account for the differences in source level, frequency, and exposure effects.
	Submarine Sonar	Submarine active sonar use during ASW or ASUW is included in effects analysis calculations using the SPORTS database.
Post Modeling Analysis	Land Shadow	For sound sources within the acoustic footprint of land, the land area is subtracted from the marine mammal exposure calculation.
	Multiple Ships	Correction factors are used to address the maximum potential of exposures to marine mammals resulting from multiple counting based on the acoustic footprint when there are occasions for more than one ship operating within approximately 76 nm (140 km) of one another.
	Multiple Exposures	Accurate accounting for TMAA training events within the course of one day or a discreet continuous sonar event:

Notes: ASW = Anti-submarine Warfare, ASUW = Anti-Surface Warfare, GOA = Gulf of Alaska, km = kilometer, TMAA = Temporary Maritime Activities Areas, nm = nautical mile

3.8.7.6 Analytical Framework for Assessing Marine Mammal Response to At-Sea Explosions

The effects of an at-sea explosion on a marine mammal depends on many factors, including the size, type, and depth of both the animal and the explosive charge; the depth of the water column; the standoff distance between the charge and the animal; and the sound propagation properties of the environment. Potential impacts can range from brief acoustic effects (such as behavioral disturbance), tactile perception, physical discomfort, slight injury of the internal organs and the auditory system, to death of the animal (Yelverton et al. 1973, O'Keeffe and Young 1984, DoN 2001). Non-lethal injury includes slight injury to internal organs and the auditory system; however, delayed lethality can be a result of individual or cumulative sublethal injuries (DoN 2001a). Short-term or immediate lethal injury would result from massive combined trauma to internal organs as a direct result of proximity to the point of detonation (DoN 2001a).

Criteria

The criterion for mortality for marine mammals is "onset of severe lung injury" as presented in the Final Rule for the Hawaii Range Complex MMPA Letter of Authorization (NOAA 2009). This is conservative in that it corresponds to a 1 percent chance of mortal injury, and yet any animal experiencing onset severe lung injury is counted as a lethal exposure.

- The threshold is stated in terms of the Goertner (1982) modified positive impulse with value "indexed to 31 psi-ms."" Since the Goertner approach depends on propagation, source/animal depths, and animal mass in a complex way, the actual impulse value corresponding to the 31-psi-ms index is a complicated calculation. Again, to be conservative, CHURCHILL used the mass of a calf dolphin (at 26.4 pound [lb] [12.2 kilogram {kg}]), so that the threshold index is 30.5 pounds per square inch (psi)-ms (Table 3.8-7).

- Two criteria are used for injury: onset of slight lung hemorrhage and 50 percent eardrum rupture (tympanic membrane [TM] rupture). These criteria are considered indicative of the onset of injury (Table 3.8-7).
- The threshold for onset of slight lung injury is calculated for a small animal (a dolphin calf weighing 27 lb [12 kg]), and is given in terms of the "Goertner modified positive impulse," indexed to 13 psi-ms in the (DoN 2001a, 2008a,b). This threshold is conservative since the positive impulse needed to cause injury is proportional to animal mass, and therefore, larger animals require a higher impulse to cause the onset of injury.
- The threshold for TM rupture corresponds to a 50 percent rate of rupture (i.e., 50 percent of animals exposed to the level are expected to suffer TM rupture); this is stated in terms of an SEL value of 205 dB re 1 μPa^2-s. The criterion reflects the fact that TM rupture is not necessarily a serious or life-threatening injury, but is a useful index of possible injury that is well correlated with measures of permanent hearing impairment (e.g., Ketten 1998 indicates a 30 percent incidence of PTS at the same threshold).

Table 3.8-7: Effects Analysis Criteria for At-Sea Explosions

	Criterion	Metric	Threshold	Comments
Mortality	Mortality Onset of extensive lung hemorrhage	Shock Wave Goertner modified positive impulse	30.5 psi-msec*	All marine mammals (dolphin calf)
Level A Harassment	Slight Injury Onset of slight lung hemorrhage	Shock Wave Goertner modified positive impulse	13.0 psi-msec*	All marine mammals (dolphin calf)
	Slight Injury 50 percent Tympanic Membrane (TM) Rupture	Shock Wave Sound Exposure Level (SEL) for *any single exposure*	205 dB re:1μPa^2-sec	All marine mammals
Level B Harassment	TTS Temporary Auditory Effects	Noise Exposure greatest SEL in any 1/3-octave band *over all exposures*	182 dB re:1μPa^2-sec	For odontocetes greatest SEL for frequencies ≥100 Hz and for mysticetes ≥10 Hz
	TTS Temporary Auditory Effects	Noise Exposure Peak Pressure	23 psi	All marine mammals
	Sub-TTS Behavioral Disturbance (MSE only)	Noise Exposure greatest SEL in any 1/3-octave band *over all exposures*	177 dB re:1μPa^2-sec	For odontocetes greatest SEL for frequencies ≥100 Hz and for mysticetes ≥10 Hz

Notes: Goertner 1982. Prediction of at-sea explosion safe ranges for sea mammals. Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, MD. NSWC/WOL TR-82-188. 25 pp.
DoN, 2001a. USS Churchill Shock Trail FEIS- February, 2001.
NMFS. Briefed to NMFS for VAST-IMPASS.
dB re 1μPa^2-s = decibels referenced to 1 micropascal squared per second, Hz = hertz
MSE = Multiple Successive Explosions, msec = millisecond
psi = pounds per square inch, SEL = Sound Exposure Level
TM = Tympanic membrane, TTS = Temporary Threshold Shift

The following criterion is considered for noninjurious harassment TTS, which is a temporary, recoverable, loss of hearing sensitivity (NMFS 2001, DoN 2001a, NOAA 2009).

- A threshold of 12 psi peak pressure was developed for 10,000-lb charges as part of the CHURCHILL Final EIS (DoN 2001a, [FR70/160, 19 Aug 05; FR 71/226, 24 Nov 06]). It was introduced to provide a more conservative safety zone for TTS when the explosive or the animal approaches the sea surface (for which case the explosive energy is reduced but the peak pressure is not). Navy policy with concurrence from NMFS is to use a 23 psi criterion for explosive charges less than 2,000 lb (907 kg) and the 12 psi criterion for explosive charges larger than 2,000 lb (907 kg). This is below the level of onset of TTS for an odontocete (Finneran et al. 2002). All explosives modeled for the TMAA are less than 1,500 lb (608 kg).
- A threshold of 182 dB re:1µPa^2-sec for any 1/3 octave band over all exposures

The approximate nominal radial distance from various at-sea explosives to these thresholds in the TMAA during the summer time-frame are presented in Table 3.8-7a.

Table 3.8-7a. Approximate Distance to Effects in Meters for At-Sea Explosives in the Temporary Maritime Activities Area

Explosive Source	MMPA Level B Harassment (behavioral disturbance)			MMPA Level A Harassment (slight injury)		Severe Injury or Mortality
	Sub-TTS, 177 dB re 1 µPa^2-s	TTS, 182 dB re 1 µPa2-s	TTS, 23 psi peak pressure	50 percent TM rupture, 205 dB re 1 µPa^2-s	Lung injury, 13 psi-ms	30.5 psi-ms impulse pressure
MK-82	2720	1584	809	302	263	153
MK-83	4056	2374	1102	468	330	195
MK-84	5196	3050	1327	611	378	226
76 mm	168	95	150	19	25	13
5 inch	413	227	269	43	44	23
SSQ-110A sonobuoy (EER/IEER)	NA	325	271	71	135	76

Notes: dB re 1 µPa^2-s = decibels referenced to 1 micropascal squared per second, EER = Extended Echo Ranging, IEER = Improved Extended Echo Ranging, mm = millimeters, MMPA = Marine Mammal Protection Act, psi = pounds per square inch, psi-ms= pounds per square inch per millisecond, TM = Tympanic Membrane, TTS = Temporary Threshold Shift

MMPA Level B Harassment from Sub-TTS for Multiple Successive Explosions (MSE)

There may be rare occasions when multiple successive explosions are part of a static location event such as during SINKEX, BOMBEX, or GUNEX (when using other than inert weapons). For MSEs, accumulated energy over the entire training time is the natural extension for energy thresholds since energy accumulates with each subsequent shot; this is consistent with the treatment of multiple arrivals as first presented in Churchill (DoN 2001). For positive impulse, NMFS has determined it is consistent with Churchill to use the maximum value over all impulses received (NOAA 2009).

For MSE, the acoustic criterion for sub-TTS MMPA Level B harassment is used to account for behavioral effects significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS. The threshold for MMPA Level B harassment from sub-TTS is derived following the approach NMFS has established for the energy-based TTS threshold (NOAA 2009).

The research on pure tone exposures reported in Schlundt et al. (2000) and Finneran and Schlundt (2004) provided the pure-tone threshold of 192 dB as the lowest TTS value. This value is modified for explosives by (a) interpreting it as an energy metric, (b) reducing it by 10 dB to account for the time constant of the mammal ear, and (c) measuring the energy in 1/3 octave bands, the natural filter band of the ear. The resulting TTS threshold for explosives is 182 dB re 1 mPa^2-s in any 1/3 octave band. As reported by Schlundt et al. (2000) and Finneran and Schlundt (2004), instances of altered behavior in the pure tone research generally began five dB lower than those causing TTS. The threshold is therefore derived by subtracting five dB from the 182 dB re 1 mPa^2-s in any 1/3 octave band threshold, resulting in a 177 dB re 1 μPa^2-s sub-TTS MMPA Level B harassment threshold for multiple successive explosives that may result in behavioral disturbance (NOAA 2009).

3.8.7.7 Environmental Consequences

This section discusses the potential environmental effects associated with the use of active sonar and other Navy training activities within the TMAA. In determining the potential environmental consequences, an approach was established to differentiate between significant and non-significant effects. This approach involved using either documented regulatory criteria or the best scientific information available at the time of analysis. Further, the extent of significance was evaluated using the context (e.g., short- versus long-term) of the Proposed Action and the intensity (severity) of the potential effect.

Acoustic Impact Model Process Applicable to All Alternative Discussions

The methodology for analyzing potential impacts from sonar and explosives is presented in Appendix D, which explains the modeling process in detail, describes how the impact threshold derived from Navy-NMFS consultations are derived, and discusses relative potential impact based on species biology.

The Navy acoustic exposure model process uses a number of inter-related software tools to assess potential exposure of marine mammals to Navy generated underwater sound including sonar and explosions. For sonar, these tools estimate potential impact volumes and areas over a range of thresholds for sonar specific operating modes. Results are based upon extensive pre-computations over the range of acoustic environments that might be encountered in the operating area (Appendix D).

The acoustic model includes four steps used to calculate potential exposures:

1. Identify unique acoustic environments that encompass the operating area. Parameters include depth and seafloor geography, bottom characteristics and sediment type, wind and surface roughness, sound velocity profile, surface duct, sound channel, and convergence zones.

2. Compute transmission loss (TL) data appropriate for each sensor type in each of these acoustic environments. Propagation can be complex depending on a number of environmental parameters listed in step one, as well as sonar operating parameters such as directivity, source level, ping rate, and ping length, and for explosives the amount of explosive material detonated. The standard Navy Comprehensive Acoustic Simulation System/Gaussian Ray Bundle (CASS-GRAB) acoustic propagation model is used to resolve complexities for underwater propagation prediction.

3. Use that TL to estimate the total sound energy received at each point in the acoustic environment.

4. Apply this energy to predicted animal density for that area to estimate potential acoustic exposure, with animals distributed in 3-D based on best available science on animal dive profiles.

Model Results Explanation

A large body of research on terrestrial animal and human response to airborne sound exists, but results from those studies are not readily applicable to the development of behavioral criteria and thresholds for marine mammals. Differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (e.g., human data tend to focus on 8-hour-long exposures), and the difference between acoustics in air and in water make extrapolation of human sound exposure standards inappropriate.

For purposes of predicting potential acoustic and explosive effects on marine mammals, the Navy uses an acoustic impact model process with numeric criteria agreed upon with the NMFS (NOAA 2009). While this process is described more completely in Appendix D, there are some caveats necessary to understand in order to put these exposures in context and used in recent Final Rules (NOAA 2008b, 2008c).

For instance, (1) significant scientific uncertainties are implied and carried forward in any analysis using marine mammal density data as a predictor for animal occurrence within a given geographic area; (2) there are limitations to the actual model process based on information available (animal densities, animal depth distributions, animal motion data, impact thresholds, and supporting statistical model); and (3) determination and understanding of what constitutes a significant behavioral effect is still unresolved.

The sources of marine mammal densities used in this analysis are derived from NMFS broad scale surveys. However, although survey design includes statistical placement of survey tracks, the survey itself can only cover so much ocean area and post-survey statistics are used to calculate animal abundances and densities (Barlow and Forney, 2007). There is often significant statistical variation inherit within the calculation of the final density values depending on how many sightings were available during a survey.

Occurrence of marine mammals within any geographic area, such as the TMAA, is highly variable and strongly correlated to parameters such as oceanographic conditions, prey availability, and ecosystem level patterns rather than broad changes in a stock's reproduction success and survival (Forney 2000, Ferguson and Barlow 2001, Benson et al. 2002, Moore et al. 2002, Tynan 2005, Redfern 2006). For some species, distribution may be even more highly influence by relative small scale features over both short and long-term time scales (Ballance et al. 2006, Etnoyer et al. 2006, Ferguson et al. 2006, Skov et al. 2007). Unfortunately, the scientific level of understanding of some large scale and most small scale processes thought to influence marine mammal distribution is incomplete.

Given the uncertainties in marine mammal density estimation and localized distributions, the Navy's acoustic impact models can not currently be used to predict occurrence of marine mammals within specific regions of the GOA. To resolve this issue and allow modeling to proceed, animals are uniformly distributed within acoustic modeling provinces as described in Appendix D. This process does not account for animals that move into or out of the region based on foraging and migratory patterns, and adds a significant amount of variability to the model predictions. Parameters have, therefore, been chosen to err on the side of overestimation.

Results, therefore, from acoustic impact exposure models should be regarded as exceedingly conservative estimates strongly influenced by limited biological data. While numbers generated allow establishment of predicted marine mammal exposures for consultation with NMFS, the short duration and limited geographic extent of most sonar and at-sea explosive events does not necessarily mean that these exposures will in fact occur.

In addition to the predicted exposure numbers or expected values resulting from acoustic modeling, there remains the possibility, although rare, that a marine mammal may be present in the TMAA when Navy activities are occurring (rare in this context refers to a species that is few in number in the GOA).

For some species whose numbers are few but have a known abundance (e.g., sperm whale, gray whale, minke whale), acoustic modeling was completed but the results indicate no predicted exposures for at-sea explosions under any alternative. For other species (blue whale, California sea lion, harbor porpoise, harbor seal, North Pacific Right whale, and sei whale), there are no valid abundance or density estimates for the TMAA. However, even if an accurate abundance or density could be derived for these species, being so few in number in the TMAA, accepted modeling methodology will predict zero exposures (based on modeling results for species with higher abundance such as sperm and gray whale, but having no predicted exposures). To account for the possibility that harassment of rare marine mammals may occur, special consideration has been given these cases. Therefore, for each proposed 21-day exercise period, the number of behavioral harassments per rare species will be based on an assumption of having exposed the species average group size[5] to one instance of behavioral harassment to account for all at-sea explosions and one instance average group size behavioral harassment to account for all acoustic sources (e.g., sonar, pingers, EMATT) for purposes of this analysis in the TMAA. This average group size estimate was only used if there was no density data available for modeling or if modeling resulted in zero exposures for the species. Table 3.8-8 provides the average group size for rare species in the TMAA as derived or reported from the citations listed.

Table 3.8-8: Average Group Size for Rare Species in the TMAA

Species	Average Group Size - Rounded[1]	Total Encounters (number of individuals)	Reference
ESA Listed Cetacea			
Blue whale	1	15(15)	Calambokidis et al., (2009)
Humpback whale	2	11(20)	Rone et al., (2009)
North Pacific right whale	1	1(1)[2]	Angliss and Allen (2008)
Sei whale	4	-	Leatherwood et al., (1988)
Sperm whale	1[3]	-	Rone et al., (2009)
Non-ESA Listed Cetacea			
Baird's beaked whale	11[4]	n/a	Wade et al., (2003)
Gray whale	3	3(8)	Rone et al., (2009)
Harbor porpoise	2	30(89)	Rone et al., (2009)
Minke whale	2	2(3)	Rone et al., (2009)
Non-ESA Listed Pinniped			
California sea lion	1[5]	-	-
Harbor seal	1	2(2)	Rone et al., (2009)

1. Lacking otherwise published numbers for Average Group Size for marine mammals in the TMAA, the method for deriving Average Group Size for use in quantifying the potential for rare animals was to take survey data providing the total number of animals sighted and dividing that by the number of visual encounters for each species during that survey with the resulting number then rounded to a whole number.
2. Based on the sighting in GOA of one lone North Pacific right whale in with a group of humpbacks from Waite (2003).
3. Based on no sightings of family groups although numerous acoustic detections were made.
4. Based on sightings in Alaska waters (DoN 2006).
5. It is assumed given that California sea lions are very rare in GOA, that they would only be encountered individually even if a prey species was running.

[5] With regard to marine mammals, the "average group size" (sometimes also "mean group size") is a commonly reported estimate derived from data collected during a marine mammal survey. Average group size is typically defined as the estimated total number of individual animals of a species divided by the number of sightings of groups of that species. Marine mammal observers generally record best, high, and low group size estimates for each sighting. For species with highly variable group sizes, different methods can be used to derive a measure of "average group size" based on the observers' combined estimates. In addition, when survey data are used to estimate species abundance, various methods are often used to reduce the potential for bias (i.e., larger groups are easier to detect and can be over-represented in a sample) and group size estimates can be derived in a much more complex manner (see Buckland et al. 1993). Resulting average group size numbers are often integers and reported with a corresponding percent coefficient of variation (% CV) to represent the precision of the estimate. For purposes of estimating effects in this analysis, an approximate rounded average group size number is used. This number is not meant to be an accurate representation of average group size for calculating abundance and density but is used to account for the potential presence of rare animals during Navy training in the TMAA.

Behavioral Responses

Behavioral responses to exposure from MFA and HFA sonar, other non-sonar acoustic sources, and at-sea explosions can range from no observable response to panic, flight and possibly stranding (Figure 3.8-12) (NOAA 2009). Recent behavioral response study field experiments with tagged beaked whales found their reactions to MFA sonar consisted of the animals stopping their clicking, producing fewer foraging buzzes than normal, and ending their dives in a long and an unusually slow ascent moving away from the sound source (Tyack 2009). It was further suggested based on these response studies that beaked whales may be "particularly sensitive to anthropogenic sounds, but there is no evidence that they have a special sensitivity to sonar compared with other signals" (Tyack 2009).

It has been long recognized that the intensity of the behavioral responses exhibited by marine mammals depends on a number of conditions including the age, reproductive condition, experience, behavior (foraging or reproductive), species, received sound level, type of sound (impulse or continuous) and duration of sound (Reviews by Richardson et al. 1995, Wartzok et al. 2003, Cox et al. 2006, Nowacek et al. 2007, Southall et al. 2007). Many behavioral responses may be short term (seconds to minutes) and of little immediate consequence for the animal such as simply orienting to the sound source. Alternatively, there may be a longer term response over several hours such as moving away from the sound source. In addition, some responses have the potential life function consequences such as leading to a stranding or a mother-offspring separation (Baraff and Weinrich 1993, Gabriele et al. 2001). Generally the louder the sound source the more intense the response although duration, context, and disposition of the animal are also very important (Southall et al. 2007). Exposure to loud sounds resulting from Navy training would be brief as the ship and other participants are constantly moving and the animal will likely be moving as well.

According to the severity scale response spectrum proposed by Southall et al. (2007) (Figure 3.8-12), responses classified as from 0-3 are brief and minor, those from 4-6 have a higher potential to affect foraging, reproduction, or survival and those from 7-9 are likely to affect foraging, reproduction and survival. Sonar and explosive mitigation measures (sonar power-down or shut-down zones and explosive exclusion zones) would likely prevent animals from being exposed to the loudest sonar sounds or explosive effects that could potentially result in TTS or PTS and more intense behavioral reactions (i.e. 7-9) on the response spectrum.

There are little data on the consequences of sound exposure on vital rates of marine mammals. Several studies have shown the effects of chronic noise (either continuous or multiple pulses) on marine mammal presence in an area exposed to seismic survey airguns or ship noise (e.g., Malme et al. 1984, McCauley et al. 1998, Nowacek et al. 2004). MFA sonar use in Navy ranges is not new and has occurred using the same basic sonar equipment and output for over approximately 30 years. Given this history the Navy believes that risk to marine mammals from sonar training is low.

Even for more cryptic species such as beaked whales, the main determinant of causing a stranding appears to be exposure in a limited egress area (a long narrow channel) with multiple ships. This would be consistent with the recent suggestion that beaked whales are not particularly sensitive to sonar but tend to move away from all anthropogenic noise (Tyack 2009). When animals are unable to avoid the exposure because of constricted areas and multiple ships, in these specific circumstances and conditions MFA sonar is believed to have contributed to the stranding and mortality of a small number of beaked whales in locations other than the GOA. There are no limited egress areas (long narrow channels) or landmasses within the TMAA, therefore, it is unlikely that the proposed sonar use would result in any strandings. Although the Navy has substantially changed operating procedures to avoid the aggregate of circumstances that may have contributed to previous strandings, it is important that future unusual stranding events be reviewed and investigated so that any human cause of the stranding can understood and avoided.

0 -No observable response

1 -Brief orientation response (investigation / visual orientation)

2 -Moderate or multiple orientation behaviors
-Brief or minor cessation/ modification of vocal behavior
-Brief or minor change in respiration rates

3 -Prolonged orientation behavior
-Individual alert behavior
-Minor changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source
-Moderate change in respiration rate
-Minor cessation or modification of vocal behavior (duration < duration of source operation), including the Lombard Effect

4 -Moderate changes in locomotion speed, direction, and/or dive profile, but no avoidance of sound source
-Brief, minor shift in group distribution
-Moderate cessation or modification of vocal behavior (duration approx duration of source operation)

5 -Extensive or prolonged changes in locomotion speed, direction, and/or dive profile but not avoidance of sound source
-Moderate shift in group distribution
-Change in inter-animal distance and/or group size (aggregation or separation)
-Prolonged cessation or modifications of vocal behavior (duration > duration of source operation)

6 -Minor or moderate individual and/or group avoidance of sound source
-Brief or minor separation of females and dependent offspring
-Aggressive behavior related to noise exposure (e.g., tail/flipper slapping, fluke display, jaw clapping/ gnashing teeth, abrupt directed movement, bubble clouds)
-Extended cessation or modification of vocal behavior
-Visible startle response
-Brief cessation of reproductive behavior

7 -Excessive or prolonged aggressive behavior
-Moderate separation of females and dependent offspring
-Clear anti-predator response
-Severe and/ or sustained avoidance of sound source
-Moderate cessation of reproductive behavior

8 -Obvious aversion and/or progressive sensitization
-Prolonged or significant separation of females and dependent offspring with disruption of acoustic reunion mechanisms
-Long-term avoidance of area (> source operation)
-Prolonged cessation of reproductive behavior

9 -Outright panic, flight, stampede, attach of conspecifics, or stranding events
-Avoidance behavior related to predator detection

1-3 DEFINED BY NMFS AS NO MMPA BEHAVIORAL HARASSMENT

7-9 DEFINED BY NMFS AS MMPA BEHAVIORAL HARASSMENT Plus subset behaviors in 4 to 6 depending on context of behavior

Figure 3.8-12: Marine Mammal Response Spectrum to Anthropogenic Sounds (Numbered severity scale for ranking observed behaviors from Southall et al. 2007)

There have been no known beaked whale strandings in the GOA associated with the use of MFA/HFA sonar by fisheries research activities or seismic research. There are critical contextual differences between the TMAA and areas of the world where beaked whale strandings have occurred (see Appendix F). While the absence of evidence does not prove there have been no impacts on beaked whales, decades of use of sonar in Navy concentration areas (e.g., Southern California, the Atlantic Coast, Gulf of Mexico) with no observed beaked whale strandings associated with MFA sonar, or indications of significant effects to species or populations of beaked whales has been given consideration.

TTS

A TTS is a temporary recoverable, loss of hearing sensitivity over a small range of frequencies related to the sound source to which it was exposed. The animal may not even be aware of the TTS and does not become deaf, but requires a louder sound stimulus (relative to the amount of TTS) to detect that sound within the affected frequencies. TTS may last several minutes to several days and the duration is related to the intensity of the sound source and the duration of the sound (including multiple exposures). Sonar exposures from ASW training are generally short in duration and intermittent (several sonar pings per minute from a moving ship), and with mitigation measures in place, TTS in marine mammals exposed to MFA or HFA sonar or other sound sources and at-sea explosions are unlikely to occur. There is currently no information to suggest that if an animal has TTS, that it will decrease the survival rate or reproductive fitness of that animal. TTS range from an SQS-53 sonar's 235 dB source level one second ping is approximately 584 ft (178 m) from the bow of the ship under nominal oceanographic conditions during the summer in the TMAA.

PTS

A PTS is non-recoverable, results from the destruction of tissues within the auditory system and occurs over a small range of frequencies related to the sound exposure. The animal does not become deaf but requires a louder sound stimulus (relative to the amount of PTS) to detect that sound within the affected frequencies. Sonar exposures are general short in duration and intermittent (several sonar pings per minute from a moving ship), and with mitigation measures in place, PTS in marine mammals exposed to MFA or HFA sonar is very unlikely to occur. There is currently no information to suggest that if an animal has PTS that it decrease the survival rate or reproductive fitness of that animal. The distance to PTS from an SQS-53 sonar's 235 dB source level and one second ping is approximately 33 ft (10 m) from the bow of the ship under nominal oceanographic conditions in the TMAA.

Population Level Effects

Some Navy training activities will be conducted in the same general areas across the 42,146 nm^2 (145,482 km^2) of the TMAA over a 21-day (maximum) exercise period, so marine mammal populations could be exposed to activities more than once over the period of the exercise. The acoustic analyses assume that short-term non-injurious sound levels predicted to cause TTS and/or non-TTS behavioral disruptions qualify as MMPA Level B harassment. Based on previous findings from NMFS, however, it is unlikely that most behavioral disruptions or instances of TTS will result in long-term significant effects (NMFS 2008a, NOAA 2009). Mitigation measures reduce the likelihood of exposures to sound levels that would cause significant behavioral disruption (the higher levels of 7-9 in Figure 3.8-12), TTS or PTS. Based on acoustic modeling the Navy has estimated that a total of 420,342 marine mammals per year might be behaviorally disturbed resulting in MMPA Level B harassment from the proposed training activities in the TMAA. The Navy does not anticipate any mortality to result from the proposed training. It is unlikely that the short-term behavioral disruption would adversely affect the species or stock through effects on annual rates of recruitment or survival.

Acoustic Effects Analysis

The impacts on marine mammals from at-sea explosions are based on a modeling approach that considers several factors to ensure an accurate estimation of effects by species.

The impact areas of the at-sea explosions are derived from mathematical calculations and models that predict the distances to which threshold noise levels would travel. The equations for the models consider the amount of net explosive, the properties of detonations under water, and environmental factors such as depth of the explosion, overall water depth, water temperature, and bottom type.

The result of the analysis is an area known as the Zone of Influence (ZOI). A ZOI is based on an outward radial distance from the point of detonation, extending to the limit of a particular threshold level in a 360-degree area. Thus, there are separate ZOIs for mortality, injury (hearing-related injury and slight, nonfatal lung injury), and harassment (temporary threshold shift, or TTS, and sub-TTS). The ZOIs are also influenced by the body size and species of marine mammal exposed. Given the radius, and assuming noise spreads outward in a spherical manner, the entire area ensonified (i.e., exposed to the specific noise level being analyzed) is estimated. The radius is assumed to extend from the point of detonation in all directions, allowing calculation of the affected area.

The number of marine mammal takes is estimated by applying marine mammal density to the ZOI (area) for each detonation type. Species density for the more abundant marine mammals is presented in Tables 3.8-1 and 3.8-2. This derived density data were input into the modeling with factors applied to account for the species specific dive behaviors, as detailed in Appendix D and E. By combining marine mammal density and dive behaviors, a more accurate prediction of acoustic exposure is possible. The model-specific adjustments applied for each type of detonation are described in the following paragraphs.

At-sea explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. Three source parameters influence the effect of an explosive: the weight of the explosive, the type of explosive material, and the detonation depth. The net explosive weight (or NEW) accounts for the first two parameters. The NEW of an explosive is the weight of only the explosive material in a given round, referenced to the explosive power of TNT.

The detonation depth of an explosive is particularly important due to a propagation effect known as surface-image interference increasingly. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface-reflection scattering loss).

For the TMAA, explosive sources having detonations in the water include the following: SSQ-110 EER sonobuoys, MK-82, MK-83, MK-84 bombs, 5” and 76 mm gunnery rounds, MK-48 torpedo, and the Maverick missile. The EER source can be detonated at several depths within the water column. For the modeling analysis, a relatively shallow depth of 65 ft (20 m) was used to optimize the likelihood of the source being positioned in a surface duct. A source depth of two meters was used for bombs and missiles that do not strike their target. The MK-48 torpedo detonates immediately below the target’s hull and a nominal depth of 50 ft (14 m) was used as its source depth in this analysis. For the gunnery rounds, a source depth of one foot was used. The NEW modeled for these sources are as follows:

- SSQ-110 sonobuoy - 4.4 lb (2 kg)
- MK-82 bomb - 238 lb (108 kg),
- MK-83 bomb - 416 lb (189 kg)
- MK-84 bomb – 945 lb (429 kg)
- 5” rounds – 9.5 lb (4.3 kg),
- 76 mm rounds – 1.6 lb (0.7 kg)
- MK-48 torpedo – 851 pounds (386 kg)
- Maverick missile – 78.5 lb (36 kg)

The exposures expected to result from these sources are computed on a per in-water explosive basis. The cumulative effect of a series of explosives can often be derived by simple addition if the detonations are spaced widely in time (exceeding 24 hours per the NMFS threshold for multiple successive explosions) or space, allowing for sufficient animal movements to ensure a different population of animals is considered for each detonation (NOAA 2009).

GUNEX

Modeling was completed for surface gunnery exercises that take place in the open ocean to provide gunnery practice for Navy ship crews. Exercises can involve a variety of surface targets that are either stationary or maneuverable. Gun systems employed against surface targets include the 5-inch, 76mm, 57mm, 25mm, 20mm, .50-caliber, and the 7.62mm (only a small percentage of the 5-inch and 76mm rounds are inert). The ZOI, for explosives when multiplied by the estimated animal densities and total number of events, provides exposure estimates for that animal species for the given gunnery system using live ordnance.

BOMBEX

Modeling was completed for three explosive weights involved in BOMBEX, each assumed detonation at 3.3-ft (1-m) depth. The NEW used in simulations of the MK82, MK83, and MK84 explosives are 192.2 lb (87.2 kg), 415.8 lb (188.6 kg), 944.7 lb (428.5 kg), respectively. The ZOI, when multiplied by the estimated animal densities and total number of events, provides exposure estimates for that animal species for the given bomb source.

SSQ-110 Sonobuoys

Modeling was completed for use of SSQ-110 sonobuoys, which have a charge totaling 4.4 lb (2 kg) for each of two detonations. The ZOI for the detonation is then multiplied by the estimated animal densities and total number of events, provides exposure estimates for that animal species for the use of SSQ-110 sonobuoys for each alternative.

Impact Thresholds

In addition to the impact thresholds described previously, this EIS/OEIS analyzes potential effects to marine mammals in the context of the MMPA, ESA (listed species only), and EO 12114 where applicable. The factors used to assess the significance of effects vary under these Acts and are discussed below.

For purposes of compliance with the MMPA, effects of the action were analyzed to determine if an alternative would result in Level A harassment or Level B harassment of marine mammals based on previous standards established by NMFS (NOAA 2009). For military readiness activities under the MMPA, the relevant definition of harassment is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment).
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered (Level B harassment) [16 U.S.C. 1362 (18)(B)(i)(ii)].
- For purposes of MMPA compliance, exceeding the modeled exposure of 0.5 animals presumes a “take” and requires Navy Action Proponents to seek authorization from the appropriate regulatory agency.

For purposes of ESA compliance, effects of the action were analyzed to make a determination of effect for listed species (for example, no effect or may affect). The definitions used in making the determination of effect under Section 7 of the ESA are based on the USFWS and NMFS *Endangered Species Consultation Handbook* (USFWS and NMFS 1998), and recent NMFS Biological Opinions involving the same activities and many of the same species in the Pacific (e.g., NMFS 2008a, 2009b).

- "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 appropriate. Insignificant effects relate to the magnitude or extent of the impact (for example, they must be small and would not rise to the level of a take of a species).
- For ESA protected marine mammals, if quantitative analysis indicates a modeled exposure exceeds 0.05 protected marine mammals, then there is a presumption that the proposed activity "may affect" the protected marine mammal thus triggering consultation with the appropriate regulatory agency pursuant to reference.
- 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.

For purposes of ESA compliance relative to listed critical habitats and as noted previously, there is no designated critical habitat in the TMAA.

Collisions with Whales

Vessel collisions are an acknowledged source of mortality and injury to all large whales. A discussion of the information available regarding collisions or "ship strikes" as related to individual large whale species in the TMAA has been presented in Sections 3.8.3 and 3.8.4.

Under the preferred alternative and with regard to annual Navy vessel traffic, the Navy has proposed providing the flexibility to conduct (as required) a second summer exercise within the TMAA between 2010 and 2015. Within the maximum two summer exercises, the length of the exercise, the number of vessels, and the allotted at-sea time within the TMAA during an exercise will be variable between years. These variations cannot be predicted given unknowns including the availability of participants for the annual exercise(s), which is a direct result of factors such as Navy responses to real-world events (e.g., tactical deployments, disaster relief, humanitarian assistance, etc.), planned and unplanned deployments, vessel availability due to funding and maintenance cycles, and logistic concerns with conducting an exercise in the GOA. The Navy predicts, however, there will be no increase required in excess of two annual summer exercises as described for Alternative 2 over the course of the 2010 and 2015 timeframe such that it is unlikely increases in steaming days would occur during this time period.

The following paragraphs present a context and assessment for the potential for Navy ship strikes in the TMAA. Accurate data regarding vessel collisions with whales is difficult for several reasons but mainly due to a lack of mandatory reporting by vessels other than the U.S. Navy and Coast Guard (Navy and Coast Guard report all whale collisions to NMFS as a standard procedure). As a result, historic trends, annual rates of collision, and, most importantly, the effect vessel collisions may have on particular stocks of whales or other marine mammals remain unknown.

The Navy requires reporting of all collisions involving marine mammals. While recognizing Navy activity in the TMAA has previously involved no more than an annual brief three-week period in the summer, there have been no known collisions, referred to as "ship strikes" by Navy surface ships or submarines in Alaska waters over many years of operation.

Reviews of the record, involving mostly commercial vessel collisions between ships and whales have been published (e.g., Laist et al. 2001, Jensen and Silber 2004). However, Navy vessel operations differ from commercial vessels in a number of ways important to the prevention of whale collisions. Navy surface ships maintain a constant, 24/7 navigation watch with dedicated lookouts while underway. The Navy has developed a Marine Species Awareness Training, which is required for all lookouts and is designed to recognize marine mammal cues to assist in avoiding potential collisions with whales. In addition to lookouts, there are often other watchstanders such as ship officers and supervisory personnel, as well as lookouts responsible for safe navigation and avoidance of in-water objects (marine mammals, other vessels, flotsam, marine debris, etc.). There are numerous reports from Navy transits and exercises in other locations involving the detection of whales with vessels subsequently proactively maneuvering to avoid a collision with a whale. For the safety of the crew, stewardship of marine mammals, and to avoid damage to vessels, the Navy does what it can to avoid ship strikes.

For Alaska waters, the available whale-vessel collision data has been presented in an unpublished preliminary summary (Gabriele et al. manuscript on file). The summary presents an opportunistically collected record containing reports of 62 whale-vessel collisions between 1978 and 2006 with most occurring in Southeast Alaska. This report is likely biased toward near shore reports and inland waters of Southeast Alaska where the authors were located and where nearshore vessels and a population of humpback whales overlap. Only one collision was recorded within the TMAA (involving a fishing vessel/sperm whale). As is evident from the Alaska record, most known collisions in Alaska waters involve humpback whales, although worldwide historical records indicate fin whales were the most likely species to be struck (Laist et al 2001). Most of the TMAA is above deep water and well offshore, which is not the preferred habitat for humpback whales, but is an area where fin whales or other species may certainly be present.

The following Navy requirements are intended to reduce the likelihood of a collision with whales for ships and surfaced submarines. Naval vessels will maneuver to keep at least 1,500 ft (500 yds) away from any observed whale in the vessel's path and avoid approaching whales head-on. These requirements do not apply if a vessel's safety is threatened, such as when change of course will create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver. Vessels will take all practicable steps to alert other vessels in the vicinity of the whale.

Given there are one to two submarines that may be operating in the TMAA and there is no known record of a marine mammal having ever collided with a submerged submarine, it is very unlikely this event would occur. For submerged submarines, if a marine mammal is vocalizing, then passive acoustic detection may provide information facilitating the avoidance of the marine mammal.

In summary, fin, humpback and other large whales may be present in the TMAA, but the sparse available data on whale-vessel collisions indicates that collisions are unlikely overall. The risk of collision is further reduced by the short duration of the exercise, Navy protocols for maintaining a lookout at all times, and maneuvering to avoid whales when possible. Given these factors, it is unlikely that Navy training activities in the TMAA would result in a collision with a whale.

3.8.7.8 No Action Alternative

Vessel Movements

Overview

Many of the ongoing and proposed activities within the TMAA involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels). Under the No Action Alternative there would be four military combatant surface ships participating in training activities plus up to approximately 19 contracted fishing vessels. Potential variations in these maximum number of vessels participating cannot be predicted given unknowns including the availability of vessels for the annual exercise(s), which is a direct result of factors such as Navy responses to real-world events (e.g., tactical deployments, disaster relief, humanitarian assistance, etc.), planned and unplanned deployments, vessel availability due to funding and maintenance cycles, and logistic concerns with conducting an exercise in the GOA.

Disturbance Associated with Vessel Movements

Vessel movements have the potential to affect marine mammals by directly striking or disturbing individual animals. The probability of vessel and marine mammal interactions occurring in the TMAA is dependent upon several factors including numbers, types, and speeds of vessels; the regularity, duration, and spatial extent of activities; the presence/absence and density of marine mammals; and protective measures implemented by the Navy. During training activities, speeds vary and depend on the specific training activity. In general, Navy vessels will move in a coordinated manner but separated by many miles in distance. These activities are widely dispersed throughout the TMAA, which is a vast area encompassing 42,146 nm^2 (145,458 km^2). Consequently, the density of Navy vessels within the TMAA at any given time is extremely low.

Marine mammals are frequently exposed to vessels traffic as a result of commercial fishing activities, research, ecotourism, commercial and private vessel traffic. The presence of vessels has the potential to alter the behavior patterns of marine mammals. It is difficult to differentiate between responses to vessel sound and visual cues associated with the presence of a vessel; thus, it is assumed that both play a role in prompting reactions from animals (NMFS 2008a). Anthropogenic sound has increased in the marine environment over the past 50 years as a result of increased vessel traffic, marine dredging and construction, oil and gas drilling, geophysical surveys, sonar, and at-sea explosions (Richardson et al. 1995, NRC 2003b). Vessel strikes are rare, but do occur and can result in injury (NMFS 2008a).

Marine mammals react to vessels in a variety of ways and seem to be generally influenced by the activity the marine mammal is engaged in when a vessel approaches (Richardson et al. 1995). Some respond negatively by retreating or engaging in antagonistic responses while other animals ignore the stimulus altogether (Watkins 1986, Terhune and Verboom 1999). The ESA-listed marine mammal species (blue, fin, humpback, North Pacific right, sei, and sperm whales; and Steller sea lion) that occur in the TMAA are not generally documented to approach vessels in their vicinity. The predominant reaction is either neutral or avoidance behavior, rather than attraction behavior. If available, additional information regarding each listed species is provided below.

Blue and Sei Whales

There is little information on blue whale or sei whale response to vessel presence (NMFS 1998a, 1998b). Sei whales have been observed ignoring the presence of vessels and passing close to the vessel (Weinrich et al. 1986). The response of blue and sei whales to vessel traffic is assumed to be similar to that of the other baleen whales, ranging from avoidance maneuvers to disinterest in the presence of vessels. Any behavioral response would be short-term in nature.

Fin and Humpback Whales

Fin whales have been observed altering their swimming patterns by increasing speed, changing their heading, and changing their breathing patterns in response to an approaching vessel (Jahoda et al. 2003). Observations have shown that when vessels remain 328 ft (100 m) or farther from fin and humpback whales, they were largely ignored (Watkins et al. 1981). Only when vessels approached more closely did the fin whales in the study altered their behavior by increasing time at the surface and engaging in evasive maneuvers. The humpback whales did not exhibit any avoidance behavior (Watkins et al. 1981). However, in other instances humpback whales 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 when vessels were between 0 and 6,562 ft (2,000 m) away (Baker et al. 1983): 1) horizontal avoidance (changing direction and/or speed) when vessels were between 6,562 ft (2,000 m) and 13,123 ft (4,000 m) away, or 2) vertical avoidance (increased dive times and change in diving pattern).

Based on existing studies, it is likely that fin and humpback whales would have little reaction to vessels that maintain a reasonable distance from the animals[6]. The distance that will provoke a response varies based on many factors including, but not limited to, vessel size, geographic location, and individual animal tolerance levels (Watkins et al. 1981, Baker et al. 1983, Jahoda et al. 2003). Should the vessels approach close enough to invoke a reaction, animals may engage in avoidance behaviors and/or alter their breathing patterns. Reactions exhibited by the whales would be temporary in nature. They would be expected to return to their pre-disturbance activities once the vessel has left the area.

North Pacific Right Whales

Although very little data exists examining the relationship between vessel presence and significant impact to North Pacific right whales, it is thought that any disturbance impacts would be minor and/or temporary in nature (NMFS 2005). In the North Pacific, ship strikes may pose a potential threat to North Pacific right whales. However, because of their rare occurrence and scattered distribution, it is impossible to assess the threat of ship strikes to this species at this time. For these reasons, NMFS has not identified ship collisions as major threat because the estimated annual rate of human-caused mortality and serious injury appears minimal (NMFS: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/ rightwhale_northpacific.htm, accessed May 30, 2008). Through 2002, there were no reports of ship strikes of North Pacific right whales by large ships along the U.S. West Coast and Canada (Jensen and Silber 2003). In addition, North Pacific right whales are protected through measures such as the 500-yard (1,500-m) no-approach limit, which affords them additional protection and further alleviates any effect vessel traffic might have on behavior or distribution (NMFS 1997).

Sperm Whale

Sperm whales generally show little to no reaction to ships, except on close approaches (within several hundred meters); however, some did show avoidance behavior such as quick diving (Würsig et al. 1998). In addition, in the presence of whale watching and research boats, changes in respiration and echolocation patterns were observed in male sperm whales (Richter et al. 2006). Disturbance from boats did not generally result in a change in behavior patterns and is short-term in nature (Magalhães et al. 2002).

Killer Whale

In Washington and British Columbia beginning in the late 1970s, whale watching involving mainly killer whales has become an important regional tourist industry. Both commercial and private vessels engage in whale watching. The number of vessels engaged in this activity increased from a few boats and fewer

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[6] Regulations governing approach distances to humpback whales in Alaska waters were promulgated by NMFS in 2001 (NOAA 2001b).

than 1,000 passengers annually in the early 1980s to about 41 companies with 76 boats and more than 500,000 passengers annually in 2006 (Koski 2007). The growth of whale watching during the past 20 years has meant that killer whales in the region are experiencing increased exposure to vessel traffic. Not only do greater numbers of boats accompany the whales for longer periods of the day, but there has also been a gradual lengthening of the viewing season. Several studies have linked vessels with short-term behavioral changes in northern and southern resident killer whales (Kruse 1991, Kriete 2002, Williams et al. 2002, Bain et al. 2006), although whether it is the presence and activity of the vessel, the sounds of the vessel or a combination these factors is not well understood. Individual whales have been observed to react in a variety of ways to whale-watching vessels. Responses include swimming faster, adopting less predictable travel paths, making shorter or longer dives, moving into open water, and altering normal patterns of behavior at the surface (Kruse 1991, Williams et al. 2002, Bain et al. 2006), while in some cases, no disturbance seems to occur. Avoidance tactics often vary between encounters and the sexes, with the number of vessels present and their proximity, activity, size, and "loudness" affecting the reaction of the whales (Williams et al. 2002). Avoidance patterns often become more pronounced as boats approach closer.

The potential impacts of whale watching on killer whales remain controversial and inadequately understood. Although numerous short-term behavioral responses to whale watching vessels have been documented, no studies have yet demonstrated a long-term adverse effect from whale watching on the health of any killer whale population in the northeastern Pacific (NMFS 2008a). There are no reported instances of killer whale strikes, mortality, or injury reported because of these vessel activities (NMFS 2008a).

Delphinids

Species of delphinids can vary widely in their reaction to vessels. Many exhibit mostly neutral behavior, but there are frequent instances of observed avoidance behaviors (Hewitt 1985, Würsig et al. 1998). In addition, approaches by vessels can elicit changes in behavior, including a decrease in resting behavior or change in travel direction (Bejder et al. 2006). Alternately, many of the delphinid species exhibit behavior indicating attraction to vessels. This can include solely approaching a vessel (observed in harbor porpoises and minke whales) (David 2002), but many species such as common, rough-toothed and bottlenose dolphins are frequently observed bow riding or jumping in the wake of a vessel (Norris and Prescott 1961, Shane et al. 1986, Würsig et al. 1998, Ritter 2002). While this is also a regular occurrence wit Navy vessels, in the past, this also occurred when Navy vessels when using mid-frequency active sonar (current mitigation measures now preclude this from occurring). These behavioral alterations are short-term and would not result in any lasting effects.

Summary

If vessel traffic related to the proposed activity passed near marine mammals, this would only occur on an incidental basis. Most of the studies mentioned previously examine the reaction of animals to vessels that approach and intend to follow or observe an animal (i.e., whale watching vessels, research vessels, etc.). Reactions to vessels not pursuing the animals, such as those transiting through an area or engaged in training exercises, may be similar but would likely result in less stress to the animal because they would not intentionally approach animals. In fact, Navy mitigation measures include several provisions to avoid approaching marine mammals (see Section 5.1.7 for a detailed description of mitigation measures). As previously noted, all quick avoidance maneuvers are short-term alterations and not expected to permanently impact an animal. Most studies have ascertained the short-term response to vessel sound and vessel traffic (Watkins et al. 1981, Baker, et al. 1983, Magalhães et al. 2002); however, the long-term implications of ship sound on marine mammals is largely unknown (NMFS 2007a).

Marine mammals exposed to a passing Navy vessel may not respond at all, or they could exhibit a short-term behavioral response, but not to the extent where natural behavioral patterns would be abandoned or significantly altered. Human disturbance to wild animals may elicit similar reactions to those caused by natural predators (Gill et al. 2001, Beale and Monaghan 2004). Behavioral responses may also be accompanied by a physiological response (Romero 2004), although this is very difficult to study in the wild. Short-term exposures to stressors result in changes in immediate behavior (Frid 2003). Repeated exposure to stressors, including human disturbance such as vessel disturbance and anthropogenic sound, can result in negative consequences to the health and viability of an individual or population. Chronic stress can result in decreased reproductive success (Lordi et al. 2000, Beale and Monaghan 2004), decreased energy budget (Frid 2003), displacement from habitat (Sutherland and Crockford 1993), and lower survival rates of offspring (Lordi et al. 2000). At this time, it is unknown what the long-term implications of chronic stress may be on marine mammal species.

Vessel movements under the No Action Alternative are not expected to result in chronic stress because, as discussed above, Navy vessel density in the TMAA would remain low and the Navy implements mitigation measures to avoid marine mammals. General disturbance associated with vessel movements may affect ESA-listed marine mammals. It is not likely that disturbance associated with vessel movements during training activities would result in effects to the life functions of marine mammals in the TMAA. This same disturbance is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, harm to marine mammals from vessel disturbance in nonterritorial seas (seaward of 12 nm [22 km]) would be minimal. The Navy is working with NMFS through the ESA consultation and MMPA permitting processes accordingly.

Vessel Collisions with Marine Mammals

Based on the implementation of Navy mitigation measures and the relatively low density of Navy ships in the TMAA, it is very unlikely that a vessel collision would occur under the No Action Alternative. It is therefore unlikely that vessel movements associated with training activities would result in effects to the life functions of marine mammals in the TMAA. Because the possibility cannot be categorically dismissed, a vessel collision may affect large whales (mysticetes and sperm whales) in the TMAA. Vessel movement may affect Steller sea lions but collisions are not likely. There are no training activities taking place in territorial seas (shoreline to 12 nm [22 km]). Vessel collisions in nonterritorial seas (seaward of 12 nm [22 km]) are not anticipated and would not cause significant harm to marine mammal stocks or populations in accordance with EO 12114. The Navy is working with NMFS through the ESA consultation and MMPA permitting processes accordingly.

Aircraft Overflights

Overview

Various types of fixed-wing aircraft and helicopters are used in training exercises throughout the TMAA. These aircraft overflights would produce airborne noise and some of this energy would be transmitted into the water. Marine mammals could be exposed to noise associated with subsonic and supersonic fixed-wing aircraft overflights and helicopter activities while at the surface or while submerged. In addition to sound, marine mammals could react to the shadow of a low-flying aircraft and/or, in the case of helicopters, surface disturbance from the downdraft.

Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors and has been addressed by Urick (1972), Young (1973), Richardson et al. (1995), Eller and Cavanagh (2000), Laney and Cavanagh (2000), and others. Sound is transmitted from an airborne source to a receptor underwater by four principal means:

- Direct path, refracted upon passing through the air-water interface;

- Direct-refracted paths reflected from the bottom in shallow water;
- Lateral (evanescent) transmission through the interface from the airborne sound field directly above; and
- Scattering from interface roughness due to wave motion.

Aircraft sound is refracted upon transmission into water because sound waves move faster through water than through air (a ratio of about 0.23:1). Based on this difference, the direct sound path is totally reflected if the sound reaches the surface at an angle more than 13 degrees from vertical. As a result, most of the acoustic energy transmitted into the water from an aircraft arrives through a relatively narrow cone with a 26 degree apex angle extending vertically downward from the aircraft (Figure 3.8-13). The intersection of this cone with the surface traces a "footprint" directly beneath the flight path, with the width of the footprint being a function of aircraft altitude.

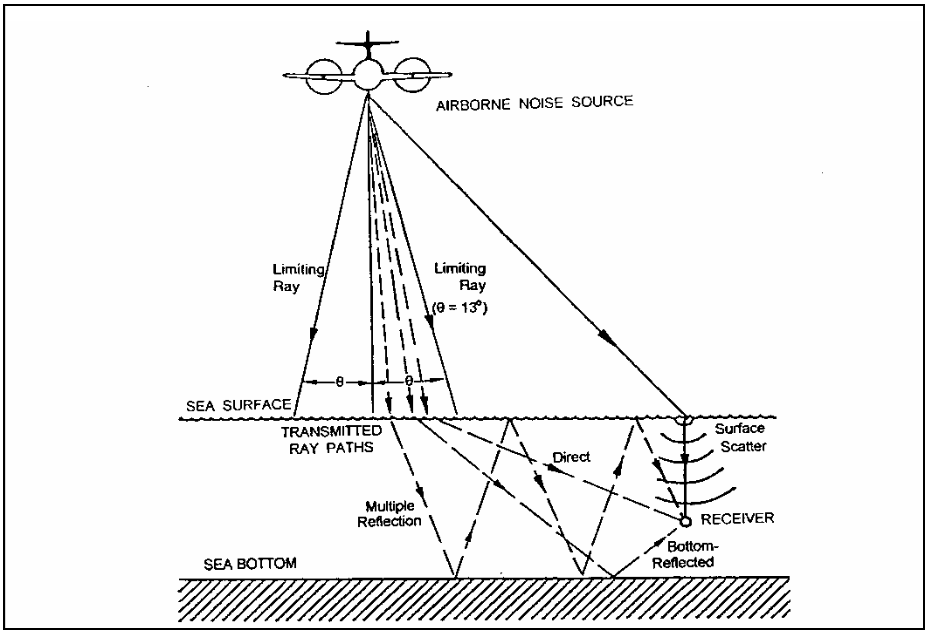

Figure 3.8-13: Characteristics of Sound Transmission through Air-Water Interface

The sound pressure field is actually doubled at the air-to-water interface because the large difference in the acoustic properties of water and air. For example, a sonic boom with a peak pressure of 10 pounds per square foot (48.8 kg/square meter [m^2]) at the sea surface becomes an impulsive wave in water with a maximum peak pressure of 20 pounds per square foot (97.6 kg/m^2). The pressure and sound levels then decrease with increasing depth.

Eller and Cavanagh (2000) modeled estimates of SPL as a function of time at selected underwater locations (receiver animal depths of 7 ft [2 m], 33 ft [10 m], and 164 ft [50 m]) for F-18 aircraft subsonic overflights (250 knots [463 km/hr]) at various altitudes (984 ft [300 m], 3,281 ft [1,000 m], and 9,842 ft [3,000 m]). As modeled for all deep water scenarios, the sound pressure levels ranged from approximately 120 to 150 dB re 1 µPa] in water. They concluded that it is difficult to construct cases (for any aircraft at any altitude in any propagation environment) for which the underwater sound is sufficiently intense and long lasting to cause harm to any form of marine life.

The maximum overpressures calculated for FA-18 aircraft supersonic overflights range from 5.2 pounds per square foot (psf) (25.4 kg/m^2) at 10,000 ft (3,048 m) to 28.8 psf (140.6 kg/m^2) at 1,000 ft (305 m) (Ogden 1997). Considering an extreme case of a sonic boom that generates maximum overpressure of 50 psf (244.1 kg/m^2) in air, it would become an impulsive wave in water with a maximum peak pressure of 100 psf (488.2 kg/m^2) or about 0.7 psi (0.05 kg/cm^2). Therefore, even a worst-case situation for sonic booms would produce a peak pressure in water well below the level that would cause harassment or injury to marine mammals (Laney and Cavanagh, 2000).

Fixed-Wing Aircraft Overflights

Approximately 300 fixed-wing sorties would occur in the TMAA annually under the No Action and Alternative 1. Many of these sorties will generally take place above 30,000 ft (9,144 m). All aircraft overflights between the shore and 12 nm (22 km) from land would occur at altitudes at or above 15,000 ft (915 m) and have no effect on marine mammals. While fixed-wing aircraft activities can occur in Special Use Airspace throughout the Alaska Training Area, a majority of the sorties are associated with Navy Air Combat Maneuver (ACM) training, will take place in the TMAA. Under the No Action Alternative, approximately 300 ACM sorties would occur annually (average of 21 sorties per day). Altitudes range from approximately 6,000 ft (1,920 m) to 30,000 ft (9,144 m) and typical airspeeds range from very low (less than 100 knots [185.2 km/hr]) to high subsonic (less than 600 knots [1,111.2 km/hr]). ACM training in the TMAA will also involve supersonic flight which produces sonic booms, but this would not occur below 15,000 ft (4,572 m) AMSL.

Exposure to fixed-wing aircraft noise would be brief (seconds) as an aircraft quickly passes overhead. Exposures would be infrequent based on the transitory and dispersed nature of the overflights; repeated exposure to individual animals over a short period of time (hours or days) is extremely unlikely. Furthermore, the sound exposure levels would be relatively low to marine mammals that spend the majority of their time underwater.

Most observations of cetacean responses to aircraft overflights are from aerial scientific surveys that involve aircraft flying at relatively low altitudes and low airspeeds. It should be noted that most of the aircraft overflight exposures analyzed in the studies mentioned above are different than Navy aircraft overflights. Survey and whale watching aircraft are expected to fly at lower altitudes than typical Navy fixed-wing overflights. Exposure durations would be longer for aircraft intending to observe or follow an animal. These factors might increase the likelihood of a response to survey or whale watching aircraft.

Mullin et al. (1991) reported that sperm whale reactions to aerial survey aircraft (standard survey altitude of 750 ft [229 m]) were not consistent. 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 the sighting.

Smultea et al. (2001) reported that a group of sperm whales responded to a circling aircraft (altitude of 800 ft [244 m] to 1,100 ft [335 m]) by moving closer together and forming a fan-shaped semi-circle with their flukes to the center and their heads facing the perimeter. Several sperm whales in the group were observed to turn on their sides, to apparently look up toward the aircraft. Richter et al. (2003) reported that the number of sperm whale blows per surfacing increased when recreational whale watching aircraft were present, but the changes in ventilation were small and probably of little biological consequence. The presence of whale watching aircraft also 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). A review of behavioral observations of baleen whales indicates that whales will either demonstrate no behavioral reaction to an aircraft or, occasionally, display avoidance behavior such as diving (Koski et al. 1998). Smaller delphinids also generally display a neutral or startle response (Würsig et al. 1998). Species, such as *Kogia* spp. and beaked whales, that show strong avoidance behaviors with ship traffic, also exhibit disturbance reactions to aircraft (Würsig et al. 1998). Although there is little information regarding reactions to aircraft overflights for other cetacean species, it is expected that reactions would be similar to those described above; either no reaction or quick avoidance behavior.

Marine mammals exposed to a low-altitude fixed-wing aircraft overflights could exhibit a short-term behavioral response, but not to the extent where natural behavioral patterns would be abandoned or significantly altered. Fixed-wing aircraft overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be repeatedly exposed to low altitude overflights. Fixed-wing aircraft overflights may affect ESA-listed marine mammals. It is not likely that aircraft overflights associated with training activities would result in effects to the life functions of marine mammals in the TMAA. This same disturbance is not expected to result in Level A or Level B harassment as defined by the MMPA. High-altitude fixed-wing aircraft overflights over nonterritorial seas (seaward of 12 nm [22 km]) would not cause significant harm to marine mammals in accordance with EO 12114. The Navy is working with NMFS through the ESA consultation and MMPA permitting processes accordingly.

Helicopter Overflights

Approximately 32 training events could involve helicopters in the TMAA annually under the No Action Alternative. Helicopter overflights can occur throughout the TMAA. Unlike fixed-wing aircraft, helicopter training activities can occur at low altitudes (75 ft [23 m] to 100 ft [30 m]), which increases the likelihood that marine mammals would respond to helicopter overflights. However, the only places that helicopters are below 500 ft [152 m] above ground level (AGL) over water is during training when personnel jump from the helicopter into water from 75 ft [23 m] to 100 ft [30 m] above the surface, when doing Deck Landing Qualifications, or when using dipping sonar. Otherwise, helicopters are 500 ft [152 m] AGL or higher while in transit. There are no haul outs or rookeries in the TMAA and none of these overflight activities in the TMAA would take place near a haul out or rookery location.

Very little data are available regarding reactions of cetaceans to helicopters. One study observed that sperm whales showed no reaction to a helicopter until the whales encountered the downdrafts from the helicopter rotors (Clarke 1956). Other species such as bowhead whale and beluga whales show a range of reactions to helicopter overflights, including diving, breaching, change in direction or behavior, and alteration of breathing patterns, with belugas exhibiting behavioral reactions more frequently than bowheads (Patenaude et al. 2002). These reactions were less frequent as the altitude of the helicopter increased to 492 ft (150 m) or higher.

Helicopters are used in studies of several species of seals hauled out and is considered an effective means of observation (Gjertz and Børset 1992, Bester et al. 2002, Bowen et al. 2006), although they have been known to elicit behavioral reactions such as fleeing (Hoover 1988). Jehl and Cooper (1980) indicated that low-flying helicopters, humans on foot, sonic booms, and loud boat noises were the most disturbing influences to pinnipeds. In other studies, harbor and other species of seals and sea lions showed no reaction to helicopter overflights (Gjertz and Børset 1992). Among the pinnipeds, harbor seals are the most likely to startle; no serious disturbance was recorded among northern elephant seals. Numerous observations of marine mammal reactions (or lack of reaction) to aircraft have been reported. In most cases, airborne or waterborne noise from aircraft was the apparent stimulus (Richardson et al. 1995). Other studies have shown less drastic reactions. Hoover (1988) reported strong reactions to aircraft below 200 ft (61 m), but minimal reaction to aircraft above 250 ft (76 m). Other studies have suggested that harbor seals can become sensitized to overflights and show little or no reaction after frequent exposure (Frost and Lowry 1993). Harbor seals have been noted to react to aircraft flyovers when on the beach, however, Navy fixed wing aircraft would be at high altitude over harbor seal haul out locations and within established air transit routes. In the case of helicopter flyovers of less than 393 ft (120 m), mothers have abandoned newborn pups and retreated into the water. This behavior can result in permanent separation of newborn pups and subsequent death (Johnson 1967). Helicopters overflights of rookeries would not occur in the TMAA as there are no haul out locations within the TMAA.

If animals do flush into the water, they may return to the haul-out site immediately, stay in the water for a length of time and then return to the haul-out, or temporarily haul-out at another site. Many factors contribute to the degree of behavioral modification, if any, including seasonality, group composition of the pinnipeds, type of activity they are engaged in, and noises they may be accustomed to experiencing. Short-term reactions such as startle or alert reactions are not likely to disrupt behavior patterns such as migrating, breeding, feeding and sheltering, nor would they be likely to result in serious injury to marine mammals. However, if startle reactions were accompanied by large-scale movements of marine mammals, such as stampedes into the water, the disruption could result in injury of individuals, especially if pups were present.

Marine mammals exposed to a low-altitude helicopter overflights under the No Action Alternative could exhibit a short-term behavioral response, but not to the extent where natural behavioral patterns would be abandoned or considerably altered. Helicopter overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be repeatedly exposed. Helicopter overflights can occur throughout the TMAA, but will not be in close proximity land and therefore far from known haul out areas and established rookeries. In addition, the Navy complies with restrictions prohibiting fixed wing aircraft or helicopter overflight or surface training activities within 3,000 ft (914 m) of Steller sea lion critical habitat (NMFS 1993), rookeries or pinniped haulout areas (DoN 2002). These mitigation measures minimize adverse reactions of seals and Steller sea lions to training activities.

As such, helicopter overflights in the TMAA may affect ESA-listed marine mammals. These overflights are not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that helicopter flights associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, harm to marine mammals from helicopter overflights over nonterritorial seas (seaward of 12 nm [22 km]) would be minimal. The Navy is working with NMFS through the ESA consultation and MMPA permitting processes accordingly.

Non-explosive Practice Ordnance

Current Navy training activities include firing a variety of weapons that employ a variety of non-explosive training rounds, including naval gun shells, cannon shells, and small caliber ammunition. As part of this training, Navy regulations require visual clearance before the training exercise of any range where ordnance (including non-explosive inert practice ordnance) is to be dropped. This analysis focuses on non-explosive training rounds, while potential effects of explosive munitions in the water are analyzed below in the explosions section. Missiles used in air to air training events at sea, although part of a live fire event, are designed to detonate in the air and do not constitute an at-sea explosion occurring in water as analyzed in this document.

The number of non-explosive practice ordnance events by type of projectile occurring for the No Action Alternative is presented in Table 2-8. Non-explosive practice ordnance includes naval gunshells (20mm, 25mm, 57mm, 76mm, and 5-inch projectiles) and small arms rounds (7.62mm and .50-caliber projectiles). Annually, there would be about 10,524 inert naval gunshells and about 5,000 small arms projectiles expended into the ocean with the No Action Alternative.

Direct ordnance strikes and disturbance associated with sound from firing are potential stressors to other listed marine mammals. Ingestion of expended ordnance is not a potential concern for marine mammals given it should sink to the ocean floor very quickly.

The potential for marine mammals to be struck by fired ordnance is extremely low given the density of marine mammals in the TMAA and the rapid loss of velocity once entering the water. The probability of a direct ordnance strike is further reduced by Navy mitigation measures, which require the area be clear of marine mammals before ordnance is used (see Section 5.1.7). Non-explosive ordnance may affect marine mammals although it is not likely that use of non-explosive ordnance associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance EO12114, non-explosive ordnance use in nonterritorial seas (seaward of 12 nm [22 km]) would not cause significant harm to marine mammals.

Weapons Firing Disturbance

Transmitted Gunnery Sound

A gun fired from a ship on the surface of the water propagates a blast wave away from the gun muzzle. This spherical blast wave reflects off and diffracts around objects in its path. As the blast wave hits the water, it reflects back into the air, transmitting a sound pulse back into the water in proportions related to the angle at which it hits the water.

Propagating energy is transmitted into the water in a finite region below the gun. A critical angle (about 13°, as measured from the vertical) can be calculated to determine the region of transmission in relation to a ship and gun (DoN 2006).

The largest proposed shell size for these activities is a 5-inch shell. This will produce the highest pressure and all analysis will be done using this as a conservative measurement of produced and transmitted pressure, assuming that all other smaller ammunition sizes would fall under these levels.

Aboard the USS Cole in June 2000, a series of pressure measurements were taken during the firing of a five-inch gun. Average pressure measured approximately 200 decibels (dB) with reference pressure of one micro Pascal (dB re 1 µPa) at the point of the air and water interface. Based on the USS Cole data, down-range peak pressure levels were calculated to be less than 186 dB re 1 µPa at 328 ft (100 m) (DoN 2000) and as the distance increases, the pressure would decrease.

In reference to the energy flux density (EFD) harassment criteria, the EFD levels (greatest in any 1/3 octave band above 0.01 kHz) of a 5-inch gun muzzle blast were calculated to be 190 dB with reference pressure of one micropascal squared in one second (dB re 1 μPa^2-sec) directly below the gun muzzle decreasing to 170 dB re 1 μPa^2-sec at 328 ft (100 m) into the water (DoN 2006). The rapid dissipation of the sound pressure wave coupled with the mitigation measures implemented by the Navy (see Section 5.1.7 for details) to detect marine mammals in the area prior to conducting activities, would likely result in a blast from a gun muzzle having no effect, however, the sound from gunfire may affect marine mammal species listed under the ESA. In with EO 12114, there would be no significant harm to marine mammals resulting from transmitted gunnery sound during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

Sound Transmitted Through Ship Hull

A gun blast will also transmit sound waves through the structure of the ship which can propagate into the water. The 2000 study aboard the USS Cole also examined the rate of sound pressure propagation through the hull of a ship (DoN 2000). The structurally borne component of the sound consisted of low-level oscillations on the pressure time histories that preceded the main pulse, due to the air blast impinging on the water (DoN 2006).

The structural component for a standard round was calculated to be 6.19 percent of the air blast (DoN 2006). Given that this component of a gun blast was a small portion of the sound propagated into the water from a gun blast, and far less than the sound from the gun muzzle itself, the transmission of sound from a gun blast through the ship's hull may affect species listed under the ESA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from sound transmitted through a ship hull during training exercises in nonterritorial seas (seaward of 12 nm [22 km]). Furthermore, performing visual clearance of the range prior to conducting training exercises further reduce the likelihood of practice ordnance hitting marine mammals.

Explosive Ordnance and At-Sea Explosions

The number of high explosive events by type of ordnance occurring for the No Action Alternative is presented in Table 2-8. In addition to 30 5-inch and 10 76mm live rounds, a total of 48 high-explosive bombs (MK-82, MK-83 and MK-84 types) will be detonated in the water annually.

The modeled explosive exposure harassment numbers by species (as derived using the methods described in Section 3.8.6.5) and harassment exposures for rare species (few in number in the TMAA) are presented in Table 3.8-9. The table quantifies MMPA Level B harassment from behavioral disturbance and MMPA Level A harassment from potential injury to marine mammals.

For at-sea explosions under the No-Action Alternative, quantification from modeling, accounting for rare species for which modeling was not possible, and for which modeling provided an estimate of zero exposures, indicates 80 MMPA Level B harassments from sub-TTS for MSE. The modeling indicates 22 MMPA Level B harassments from TTS. Under the No Action Alternative from at-sea explosions, quantification from modeling and accounting for rare species indicates a total of 102 MMPA Level B harassments annually.

These exposure modeling results are estimates of marine mammal at-sea explosion sound exposures without consideration of standard operating procedures and mitigation procedures. The implementation of the mitigation presented in Section 5.2.1 will reduce the potential occurrence for some of these modeled marine mammal exposures and harassments as a result of area clearance procedures (NMFS 2008a). For example, modeling for at-sea explosions under the No Action Alternative also indicates potential for one MMPA Level A harassment from slight injury and no annual exposures that could cause severe injury or mortality. This slight injury exposure should not occur given it is predicted for Dall's porpoise, which should be readily detectable given the species general large group size and characteristic porpoising behavior.

Without consideration of mitigation measures, modeling and accounting for rare species indicates at-sea explosion exposures with the No Action Alternative may affect ESA listed blue, fin, humpback, North Pacific right, sei, and sperm whales, and Steller sea lions. Although modeling was not possible for rare species as defined in this analysis, it is unlikely these few animals would co-occur in the TMAA during the short duration of the training and in areas cleared of marine mammals.

The implementation of the mitigation and monitoring procedures as addressed in Section 5.1.7 will further minimize the potential for marine mammal exposures to at-sea explosions. When reviewing the acoustic exposure modeling results, it is also important to understand that the estimates of marine mammal exposures are presented without consideration of standard protective measure operating procedures. Section 5.1.7 presents details of the mitigation measures currently used for ASW activities including detection of marine mammals and power down procedures if marine mammals are detected within one of the safety zones. The Navy will work through the MMPA incidental harassment regulatory process to discuss the mitigation measures and their potential to reduce the likelihood for incidental harassment of marine mammals. It is not likely that any exposures from training activities associated with at-sea explosions would result in effects to the life functions of marine mammals in the TMAA.

Table 3.8-9: No Action Alternative Annual At-Sea Explosions Exposures Summary

Species	Level B Harassment		Level A Harassment	Mortality
	Sub-TTS 177 dB re 1μPa^2-s	TTS 182 dB / 23 psi	50 percent TM Rupture 205 dB Slight Lung Injury or 23 psi-ms	Onset massive Lung Injury or Mortality 31 psi-ms
ESA Species				
Blue whale	1*	0	0	0
Fin whale	5	3	0	0
Humpback whale	2*	0	0	0
North Pacific Right whale	1*	0	0	0
Sei whale	4*	0	0	0
Sperm whale	1*	0	0	0
Steller sea lion	1	0	0	0
Non-ESA Listed Species				
Baird's beaked whale	11*	0	0	0
Cuvier's beaked whale	1	0	0	0
Dall's porpoise	29	13	1	0
Gray whale	3*	0	0	0
Harbor Porpoise	2*	0	0	0
Killer whale	1	0	0	0
Minke whale	2*	0	0	0
Pacific white-sided dolphin	3	2	0	0
Stejneger's beaked whale	1	0	0	0
California sea lion	1*	0	0	0
Harbor seal	1*	0	0	0
Northern elephant seal	1	0	0	0
Northern fur seal	9	4	0	0
Total	**80**	**22**	**1**	**0**

Notes: dB = decibel, dB re 1μPa^2-s = decibels referenced to 1 micropascal squared per second, ESA = Endangered Species Act, psi = pound per square inch, psi-ms = pounds per square inch per millisecond, PTS = Permanent Threshold Shift, TM = Tympanic membrane, TTS = Temporary Threshold Shift; * = Accounting for rare animals.

Active Sonar

There would be no effects to marine mammals from active sonar for the No Action Alternative. For the No Action Alternative, there is no use of active sonar for ASW Training, no ASW Tracking Exercise – Maritime Patrol Aircraft, Extended Echo Ranging (EER) ASW, Surface Ships ASW, or Submarine ASW TRACKEX.

Expended Materials

The Navy expends a variety of materials during training exercises. Under the No Action Alternative, 15,982 expendable items may be used. The types and quantities of materials expended and information regarding fate and transport of these materials within the marine environment are discussed in Section 3.2 (Expended Materials), and Section 3.3 (Water Resources). The analyses in these sections determined that most expended materials rapidly sink to the seafloor where they become encrusted by natural processes or are incorporated into the seafloor, with no substantial accumulations in any particular area and no significant negative effects to water quality or marine benthic communities. Given that materials expended during training do not remain at the surface and are generally used in areas where the water depth is beyond that of foraging marine mammals, it is unlikely expended materials would be later encountered by any marine mammal.

Ordnance Related Materials

Ordnance related materials include various sizes of non-explosive training rounds and shrapnel from explosive rounds. Under the No Action Alternative, 15,706 items of ordnance or related materials would be expended. These solid metal materials would quickly move through the water column and settle to the sea floor. These materials would become encrusted by natural processes and incorporated into the seafloor, with no significant accumulations in any particular area and no negative effects to water quality. Ingestion of expended ordnance is not expected to occur in the water column because it is assumed the ordnance (which is composed of dense metal) would quickly sink. However, benthic foraging marine mammals could be exposed to expended ordnance through ingestion. Some materials such as an intact non-explosive training bomb would be too large to be ingested by a marine mammal, but many materials such as cannon shells, small caliber ammunition, and shrapnel could be ingested. Records indicate that generally metal debris ingested by marine mammals is small (e.g., fishhooks, bottle caps, metal spring; Walker and Coe 1990). The effects of ingesting solid metal objects on marine mammals are unknown. Extensive literature searches reveal no studies related to potential toxic effects of ordnance ingestion by marine mammals. Ingestion of marine debris in general can cause digestive tract blockages or damage the digestive system (Stamper et. al. 2006, Gorzelany 1998). Relatively small objects with smooth edges such a cannon shell or small caliber ammunition might pass through the digestive tract without causing harm, while a piece of metal shrapnel with sharp edges would be more likely to cause damage.

The potential for ordnance ingestion depends on species-specific feeding habitats and where ordnance use will occur. The blue, fin, and sei whales and Steller sea lion feed at the surface or in the water column and would not ingest ordnance from the bottom. Activities involving ordnance use will most likely occur in the open ocean beyond the shelfbreak areas above in deep water (> 3,280 ft [1,000 m] depth).

While humpback whales feed predominantly by lunging through the water after krill and fish, there have been instances of humpback whales disturbing the bottom in an attempt to flush prey, the northern sand lance (*Ammodytes dubius*) (Hain et al. 1995). Right whales can also be bottom feeders, however, North Pacific right whales and Humpback whales are not expected to ingest ordnance because abundant prey is available in the water column in the TMAA. Ordnance ingestion under the No Action Alternative would have no effect on the ESA listed blue whales, fin whales, humpback whales, North Pacific right whales, sei whales, and Steller sea lions.

Although sperm whales feed predominantly on cephalopods, they also frequently feed on or near the bottom (Whitehead et al. 1992). In doing so, animals may ingest nonfood items such as rocks and sand (NMFS 2006a). Sperm whales are known to incidentally ingest foreign objects while foraging (Walker and Coe 1990), suggesting that the potential exists to ingest military expended material that has settled on the ocean floor as a result of the proposed activities. Sperm whales display a strong offshore preference (Rice 1989) and are mostly associated with waters over the continental shelf edge, continental slope, and offshore waters (CETAP 1982, Hain et al. 1985, Smith et al. 1996, Waring et al. 2001, Davis et al. 2002). Although the possibility exists for ingestion of expended ordnance, the potential that exposed ordnance would be at a depth where it could be encountered, that it would not be buried, and that in those very rare events the animal would ingest that ordnance creates so unlikely a series of events that the potential is discountable. Ordnance ingestion under the No Action Alternative under the ESA may affect sperm whales. However, it is not likely that ordnance ingestion would result in effects to the life functions of marine mammals in the TMAA.

Most other nonlisted baleen and toothed whales, and other pinnipeds, which feed at the surface or in the water column, would not be expected to ingest ordnance from the bottom. Gray and beaked whales are, however, known to be bottom feeders. The habitat preference of gray whales with an occurrence being inshore of the shelfbreak, is not an area where ordnance use is likely to occur. Beaked whales have exhibited bottom feeding behavior using suction feeding techniques (MacLeod et al. 2003) and are known to incidentally ingest foreign objects while foraging (Walker and Coe 1990). Although the possibility exists for ingestion of expended ordnance, the potential that exposed ordnance would be encountered and that in that very rare event the animal would ingest that ordnance is discountable. Ordnance related materials are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, ordnance related materials would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Target Related Materials

A variety of at-sea targets are used ranging from high-technology, remotely operated airborne and surface targets (such as airborne drones and Seaborne Powered Targets) to low-technology floating at-sea targets (such as inflatable targets) and towed banners. Many of the targets are designed to be recovered for reuse and are not destroyed during training. There are 64 target related items used under the No Action Alternative. The expendable targets used in the TMAA are the Tactical Air Launched Decoy (TALD), Killer Tomatoes, SPAR, BQM-74E unmanned aircraft, LUU-2B/B illuminating flares, and the MK-58 Marine Marker. Flares and Marine Markers are generally small in size, and sink to the bottom. Killer Tomatoes, SPAR, and BQM-74 are recovered after use. Killer Tomato target balloons are made of lightweight vinyl and measure 10x10x10 in size and weigh approximately 55 lb (25 kg). TALDs are approximately 7 ft (2 m) long and weigh approximately 400 lb (180 kg). Because of these characteristics, neither present an unlikely ingestion hazard to marine mammals.

As discussed above for ordnance-related materials, species that feed on or near the bottom (which are the sperm whales and beaked whales) may encounter an expended target while feeding; however, the size of the target would suggest ingestion by any listed species it is unlikely. The use of targets under the No Action Alternative may affect listed marine mammals. It is not likely that use targets associated with training activities would result in effects to the life functions of marine mammals in the TMAA. Targets are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, targets would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Chaff

As detailed in Section 3.2.1.1, chaff consists of aluminum-coated fibers used as an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Upon deployment, the chaff fibers are widely dispersed in the air and eventually land in the water and sink to the ocean floor.

Chaff will only be used during Electronic Combat (EC) exercises and mainly by fixed wing aircraft and as projectiles from ships. Under the No Action Alternative, 540 lb (245 kg) of chaff would be used annually. The only hazardous material associated with chaff is the pyrotechnic deployment charge (approximately 0.02 oz [0.48 g] of pyrotechnic material for each charge). Chaff consists of aluminum-coated polymer fibers inside of a launching mechanism. Upon deployment, the chaff and small pieces of plastic are expended. Chaff may be deployed mechanically or pyrotechnically. Mechanical deployment results in expended paper materials, along with the chaff. Pyrotechnic deployment uses a small explosive cartridge to eject the chaff from a small tube that does not affect water or sediment quality because most of the material is consumed during combustion and the remaining amounts are be dispersed over a large area. Chaff fibers are widely dispersed on deployment. Chaff settling on the ocean surface may temporarily raise turbidity, but will quickly disperse with particles eventually settling to the ocean floor.

As first presented in DoN (2009), the dispersion characteristics of chaff make it likely that marine mammals would occasionally come in direct contact with chaff fibers while at the water's surface and while submerged, but such contact would be inconsequential. Chaff is similar in form to fine human hair with the fibers being flexible and soft. Evaluation of the potential for chaff to be inhaled by humans, livestock, and animals found that the fibers are too large to be inhaled into the lung (Arfsten et al. 2002, Hullar et al. 1999, USAF 1997). Although these reviews did not specifically consider the respiratory system of large whales, any effects of chaff inhalation on marine mammals are considered insignificant given the dispersal of chaff fibers resulting in very low concentration in the air.

While no studies have been conducted to evaluate the effects of chaff ingestion on marine mammals, the effects are expected to be insignificant and discountable based the low concentrations when dispersed, the small size of chaff fibers, available data on the toxicity of chaff components (silicon dioxide and aluminum), and evidence indicating the lack of significant accumulation of aluminum in sediments after prolonged training (DoN 2009). Silicon and aluminum are two of the most abundant elements in the earth's crust. Marine mammals, such as gray whales that forage on the bottom, routinely ingest sediment containing these elements. The aluminum concentrations in brain tissue of gray whales are within the range for terrestrial mammals that may receive high concentrations of aluminum in their diets, suggesting a broad range in tolerance to aluminum in mammals (Varanasi et al. 1993, Tilbury 2002, DoN 2009). Chaff cartridge plastic end-caps and pistons would also be expended into the marine environment, where they would sink and could potentially be ingested by marine mammals. Based on the low concentration of these components in the TMAA, it is very unlikely a marine mammal would encounter a plastic end-cap or piston from the chaff cartridge. Even in the very unlikely event one of these components was encountered and then consumed by a marine mammal, the small size of chaff end-caps and pistons (1.3 inch [33 mm] diameter and 0.13 inch [3.3 mm] thick) would suggest it would likely pass through the digestive tract and be voided without causing harm.

Under ESA, chaff use under the No Action Alternative may affect blue, fin, humpback, North Pacific right, sei, and sperm whales. Use of chaff is not expected to result in Level A or Level B harassment as defined by the MMPA and would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

Marine Markers

The MK-58 marine marker produces chemical flames and regions of surface smoke and is used in various training exercises to mark a surface position to simulate divers, ships, and points of contact on the surface of the ocean. When the accompanying cartridge is broken, an area of smoke is released. The smoke dissipates in the air having little effect on the marine environment. The marker burns similar to a flare, producing a flame until all burn components have been used. While the light generated from the marker is bright enough to be seen up to 3 mi (5 km) away in ideal conditions, the resulting light would either be reflected off the water’s surface or would enter the water and attenuate in brightness over depth. The point source of the light would be focused and be less intense than if an animal were to look to the surface and encounter the direct path of the sun. The MK-58 is composed of tin and contains two red phosphorus pyrotechnic candles and a seawater-activated battery. The MK-58 marine marker is 22 inch (0.5 m) long and 5 inch (0.1 m) in diameter, weighs 13 lb (6 kg), and produces a yellow flame and white smoke for a minimum of 40 min and a maximum of 60 min (The Ordnance Shop 2007). The marker itself is not designed to be recovered and would eventually sink to the bottom and become encrusted and/or incorporated into the sediments. Approximately 20 marine markers would be used in the TMAA per year under the No Action Alternative.

It is unlikely that marine mammals would be exposed to any chemicals that produce either flames or smoke because these components are consumed in their entirety during the burning process. Animals are unlikely to approach and/or get close enough to the flame to be exposed to any chemical components.

Expended marine markers are a potential ingestion hazard for marine mammals while they are floating or after they sink to the bottom. However, the probability of ingestion is extremely low based on the low number of marine markers expended per year (20) versus the large operational area of the TMAA. Marine marker ingestion under the No Action Alternative will not affect ESA-listed marine mammals. The use of marine markers is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of marine markers associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of marine markers during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

Tactical Air Launched Decoys (TALDs)

Under the No Action Alternative, eight TALDs would be used annually. A TALD is an aircraft shaped target approximately 7 ft 8 in (2.3 m) long and weighs approximately 400 lb (180 kg). TALDs operate as an expendable vehicle with no recovery capabilities, and use lithium sulfur dioxide batteries. An important component of the thermal battery is a hermetically-sealed casing of welded stainless steel 0.03 to 0.1-in thick that is resistant to the battery electrolytes. As discussed in Section 3.2, in the evaluation of the potential effects associated with seawater batteries, it is expected that in the marine environment, lithium potentially released from these batteries would be essentially nontoxic in seawater. Because of these factors, lithium batteries would not adversely affect marine mammals.

Pieces of expended TALDS (if any) are a potential ingestion hazard for marine mammals after they sink to the bottom. However, the probability of ingestion is extremely low based on size of the likely pieces (if any) the low number of TALDS expended per year (8), and the large operational area of the TMAA. TALD ingestion under the No Action Alternative may affect ESA-listed marine mammals. The use of TALDS is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of TALDS associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of TALDS during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

BQM-74E

The BQM-74E is a remote-controlled, subsonic, jet-powered aerial target that can be launched from the air or surface and recovered on land or at sea. It is powered by a jet engine, and thus contains oils, hydraulic fluid, batteries, and explosive cartridges. The hazardous materials of concern include propellant, petroleum products, metals, and batteries; however, the hazardous materials in aerial targets would be mostly consumed during training use.

Although BQM-74Es are recovered, pieces of expended BQM-74Es (if any) are a potential ingestion hazard for marine mammals after they sink to the bottom. However, the probability of ingestion is extremely low based on the low number of BQM-74Es expended per year (2) versus the large operational area of the TMAA. BQM-74E ingestion under the No Action Alternative may affect ESA-listed marine mammals. The use of BQM-74Es is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of BQM-74Es associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of BQM-74Es during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

Sonobuoys

One sonobuoy type, a SSQ-036 BT (a temperature sensor with no active emissions), would be used under this alternative. Sonobuoys are deployed by either surface vessels or aircraft to monitor the environment, to passively detect sounds created by submarines and/or surface vessels, or to actively detect submerged or surface vessels by generating their own sonar signals. Sonobuoys are temporary devices that are activated once they contact ocean water. When their operating service life is attained, the sonobuoy shuts down and sinks to the ocean bottom to decompose. Under the No Action Alternative, up to 24 SSQ-036 BT sonobuoys would be deployed in the TMAA.

Aircraft-launched sonobuoys, flares, and markers deploy nylon parachutes of various sizes. At water impact, the parachute assembly is expended and sinks, as all of the material is negatively buoyant. Metallic components are heavy and will sink rapidly. Parachute and cord are lighter and sink more slowly but are weighted to insure they will do so. While these materials are sinking through in the water column, they represent a potential entanglement risk to passing marine mammals in the area. An estimated 24 sonobuoys, 12 flares, and 20 markers will be expended under the No Action Alternative (see Table 2-8). Given this number of sonobuoys, flares, and markers deployed, the large size of the TMAA, and the relatively low density of marine mammals in the area, the risk of a marine mammal encounter with a parachute assembly, and other military expended material is unlikely. Entanglement and the eventual drowning of a marine mammal in a parachute assembly would be unlikely, since such an event would require the parachute to land directly on an animal, or the animal would have to swim into it before it sinks. The expended material will accumulate on the ocean floor and will be covered by sediments over time, remaining on the ocean floor and reducing the potential for entanglement. If bottom currents are present, the canopy may billow and pose an entanglement threat to marine animals with bottom-feeding habits; however, the probability of a marine mammal encountering a submerged parachute assembly and the potential for accidental entanglement in the canopy or suspension lines is considered to be unlikely.

Expended sonobuoys are a potential ingestion hazard for marine mammals while they are floating, while they are descending to the seafloor, or after they sink to the bottom although this seems extremely unlikely. The probability of ingestion is also low based on the number of sonobuoys expended per year (24) compared to the size of the TMAA. It is not likely that sonobuoy ingestion would result in effects to the life functions of marine mammals in the TMAA. Sonobuoy ingestion under the No Action Alternative may affect ESA-listed marine mammals because it cannot be discounted. The use of sonobuoys is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, harm to marine mammals resulting from use of passive sonobuoys during training exercises in nonterritorial seas (seaward of 12 nm [22 km]) would also be minimal.

Critical Habitats

There are no critical habitats in the TMAA. Provisions of the ESA require a determination of whether proposed federal actions may destroy or adversely modify critical habitat. Critical habitat designation is based on the presence and condition of certain physical and biological habitat factors called primary constituent elements (PCEs) that are considered essential for the conservation of the listed species (USFWS and NMFS 1998, ESA §3[5][A][i], 50 C.F.R. §424.12[b]). There are no designated Critical Habitat PCEs in the TMAA.

Therefore, in accordance with ESA consultation provisions to assess potential effects of Proposed Action to critical habitat, it is concluded that Navy activities will have no effect on any critical habitats.

3.8.7.9 Alternative 1

Under Alternative 1, the general level of some activities in the TMAA would increase relative to those under the No Action Alternative. In addition, training activities associated with force structure changes would be implemented for the EA-18G Growler, SSGN, P-8 MMA, DDG 1000, and UASs. Force structure changes associated with new weapons systems would include new sonobuoys. Force structure changes associated with new training instrumentation include the Portable Underwater Training Range (PUTR).

Marine mammals would have the potential to be affected by vessel movements, aircraft overflights, sonar, weapons firing/nonexplosive ordnance use, explosive ordnance, and expended materials under Alternative 1.

Vessel Movements

Under Alternative 1, the number of Navy vessels would increase by four (three surface vessels and one submarine) for a total of eight Navy vessels, a 50 percent increase over the No Action Alternative. This increase would include both training and transit activities for Alternative 1. Contracted support vessels would remain at 19. The total increase in vessel activity equates to a 17 percent increase over the No Action Alternative. These changes would result in increased potential for short-term behavioral reactions to naval vessels. Potential for collision would increase slightly compared to the No Action Alternative; however, Navy mitigation measures would reduce the probability and collisions would remain unlikely. Vessel movements are not expected to result in effects to the life functions of marine mammals. Vessel movements under Alternative 1 may affect ESA-listed marine mammals. Vessel movements are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, vessel movements would cause minimal harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Aircraft Overflights

Alternative 1 would have no increase in the 300 fixed-wing aircraft sorties under the No Action, but would add six training events as described in Table 2-7. Alternative 1 would also add 26 helicopter events associated with ASW, Deck Launch Qualifications, and Air-to-Surface training. Peak noise levels generated by the MH-60R/S helicopters would be similar to the noise levels generated with the No Action Alternative.

The additional overflights may result in increased instances of behavioral disturbance due to sound, shadow-effects, and/or, in the case of helicopters, water column disturbance. As with the No Action Alternative, the responses would be limited to short-term behavioral or physiological reactions. It is not likely that exposures to aircraft overflights associated with training activities would result in effects to the life functions of marine mammals in the TMAA. Aircraft overflights under Alternative 1 may affect ESA-listed marine mammals. Aircraft overflights of the TMAA are not expected to result in Level A or Level B harassment as defined by the MMPA. Furthermore, aircraft overflights would not cause notable harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]) in accordance with EO 12114. All aircraft overflights between the shore and 12 nm (22 km) from land would occur at altitudes at or above 15,000 ft (915 m) and would have no effect on marine mammals.

Non-explosive Practice Ordnance

The number of non-explosive practice ordnance events by type of projectile occurring for Alternative 1 is presented in Table 2-8. Non-explosive practice ordnance includes naval gunshells (20mm, 25mm, 57mm, 76mm, and 5-in projectiles) and small arms rounds (7.62mm and .50-caliber projectiles). Under Alternative 1, there would be about 13,132 naval gunshells and about 5,700 small arms projectiles expended into the ocean. Compared to the No Action Alternative, this equates to an increase of about 24 percent and 14 percent respectively, in naval gunshells and small arms projectiles.

These changes would result in increased potential exposure of marine mammals to ordnance strikes; however, Navy standard operating procedures and mitigation measures would reduce the probability of strikes by modifying activities when marine mammals are known to be in the area. It is not likely that use of non-explosive ordnance associated with training activities would result in effects to the life functions of marine mammals in the TMAA. There should be no effect from use of non-explosive practice ordnance, but it may affect ESA-listed marine mammals under Alternative 1. Non-explosive ordnance use is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, non-explosive practice ordnance would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Explosive Ordnance (At-Sea Explosions)

The number of explosive events by type of ordnance occurring for Alternative 1 is presented in Table 2-8. In addition to 42 5-inch and 14 76mm live rounds, a total of 72 high-explosive bombs (MK-82, MK-83 and MK-84 types) will be detonated in the water annually. Detonation of bombs represents an increase of 40 percent for live gunfire and 150 percent for bomb detonations compared to the No Action Alternative. These changes would represent an increased potential for marine mammals exposure to detonation concussion effects and behavioral disturbance.

SSQ-110 Sonobuoys (IEER; At-Sea Explosions)

Also introduced under Alternative 1 would be the use of the Extended Echo Ranging (EER) system using approximately 40 SSQ-110 active and 40 passive SSQ-101 Air Deployable Active Receiver (ADAR) (in pairs). These are used by Maritime Patrol Aircraft (MPA) (P-3 or P-8 aircraft) when conducting "large area" searches for submarines. The SSQ-110's active component contains a small explosive charge that generates acoustic energy when detonated (Note: for this reason effects from use of SSQ-110 are covered under this section dealing with at-sea explosions). If an underwater target is within range, the echo is received by the passive ADAR sonobuoy and transmitted to the aircraft. The sonobuoy pairs are dropped from a MPA in a predetermined pattern with a few buoys covering a very large area. Upon command from the aircraft, the ribbon charge is released and subsequently detonated, generating a "ping." There is only one detonation in the pattern of buoys at a time. Under Alternative 1, approximately 40 of the SSQ-110 would be used for training in the TMAA.

Proposed for replacement of the SSQ-110 (EER/IEER) is the SSQ-125 Acoustic Extended Echo Ranging (AEER) system, which is similar to the existing EER/IEER system in that it will be used for the same purpose and will use the same ADAR sonobuoy as the acoustic receiver. However, instead of using an explosive SSQ-110 as an impulsive source for the active acoustic wave, the AEER system will use a battery powered (electronic) source for the SSQ 125 sonobuoy. The output and operational parameters for the SSQ-125 sonobuoy (source levels, frequency, wave forms, etc.) are classified. The SSQ-125 sonobuoy is intended to replace function of the SSQ-110 buoy. Acoustic impact analysis for the SSQ-125 in this document was not undertaken given the uncertainty of the deployment year.

To get a sense of the potential differences between these buoy systems it is necessary to understand that not every SSQ-110 buoy deployed is command activated (via radio) to explosively generate an acoustic wave; however, those that are not command activated do explode when commanded to scuttled or via an automatic timing device. Given that the SSQ-125 has an electronically generated acoustic wave and may be scuttled without ever being activated (unlike the SSQ-110), the potential to affect marine mammals is less for the same number of SSQ-110 buoys. The analysis presented for SSQ-110 in this EIS/OEIS models every buoy as having detonated and therefore provides an overestimate of potential effects to marine mammals from the use of replacement SSQ-125 if that should occur in the future.

The modeled explosive exposure harassment numbers by species and harassment exposures for rare species or those few in number are presented in Table 3.8-10. The table quantifies MMPA Level B harassments from behavioral disturbance and MMPA Level A harassments from potential injury to marine mammals from Alternative 1.

Table 3.8-10: Alternative 1 Annual At-Sea Explosion Exposures Summary

Species	MMPA Level B Harassment		MMPA Level A Harassment	Mortality
	Sub-TTS 177 dB re 1μPa^2-s	TTS 182 dB / 23 psi	50 percent TM Rupture 205 dB Slight Lung Injury or 23 psi-ms	Onset massive Lung Injury or Mortality 31 psi-ms
ESA Species				
Blue whale	1*	0	0	0
Fin whale	7	2	0	0
Humpback whale	2*	0	0	0
North Pacific Right whale	1*	0	0	0
Sei whale	4*	0	0	0
Sperm whale	1*	0	0	0
Steller sea lion	1	1	0	0
Non-ESA Listed Species				
Baird's beaked whale	11*	0	0	0
Cuvier's beaked whale	1	0	0	0
Dall's porpoise	42	19	1	0
Gray whale	3*	0	0	0
Harbor Porpoise	2*	0	0	0
Killer whale	2	1	0	0
Minke whale	2*	0	0	0
Pacific white-sided dolphin	6	3	0	0
Stejnger's beaked whale	1	0	0	0
California sea lion	1*	0	0	0
Harbor Seal	1*	0	0	0
Northern elephant seal	2	1	0	0
Northern fur seal	12	7	0	0
Total	**103**	**34**	**1**	**0**

Notes: dB = decibel, dB re 1μPa^2-s = decibels referenced to 1 micropascal squared per second, ESA = Endangered Species Act, psi = pound per square inch, psi-ms =pounds per square inch per millisecond, PTS = Permanent Threshold Shift, TM = Tympanic membrane, TTS = Temporary Threshold Shift; * = Accounting for rare animals.

At-Sea Explosions Summary

For at-sea explosions under Alternative 1, quantification from modeling and accounting for rare species indicates 103 MMPA Level B harassments from sub-TTS for MSE. The modeling indicates 34 MMPA

Level B harassments from TTS. Under Alternative 1 for at-sea explosions, quantification from modeling and accounting for rare species, indicates a total of 137 MMPA Level B harassments annually. These exposure modeling results are estimates of marine mammal at-sea explosion sound exposures without consideration of standard operating procedures and mitigation procedures. The implementation of the mitigation presented in Section 5.2.1 will reduce the potential occurrence for some of these modeled marine mammal exposures and harassments as a result of area clearance procedures for harassments (NMFS 2008a). Modeling for at-sea explosions under Alternative 1 also indicates potential for one MMPA Level A harassment from slight injury and no annual exposures that could cause severe injury or mortality. This slight injury exposure should not occur given it is predicted for Dall's porpoise, which should be readily detectable given the species general large group size and characteristic porpoising behavior.

Behavioral effects modeling, accounting for rare species for which modeling was not possible, and for which modeling provided an estimate of zero exposures, indicates at-sea explosion exposures under Alternative 1 may affect ESA listed blue, fin, humpback, North Pacific right, sei, and sperm whales, and Steller sea lions. It is not likely that use of ordnance or SSQ-110 sonobuoys associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, at-sea explosions would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Active Sonar for ASW Training

Sonar use for ASW did not occur under the No Action alternative. Under Alternative 1, mid- and high frequency active sonar use would be undertaken including SQS-53 (289 hours) and SQS-56 (26 hours) surface ship sonars, the BQQ-10 (24 hours) and BQS-15 (12 Hours) submarine sonars, plus SSQ-62 sonobuoys (133 ea; Note: use of SSQ-110 [EER] sonobuoys are covered under the section dealing with at-sea explosions), and 96 dips of helicopter dipping sonar that would be deployed (Table 3.8-11).

Table 3.8-11: Annual Sonar Hours and Sources for Alternative 1

	SQS 53 Sonar [a]	SQS-56 Sonar [a]	BQQ-10 Sonar [a]	BQS-15 Sonar [a]	SSQ-62 DICASS Sonobuoy[b]	AQS 22 Dipping Sonar[c]
Alternative 1	289	26	24	12	133	96

Notes: a = Number reflects hours of operations not total transmission time, representative for all variants of system. b = Number is counted by buoy, c = Number is counted as individual use "dips" of the system

Non-Sonar Acoustic Sources Used During Training

In addition to the use of mid- and high frequency sonar, additional non-sonar acoustic sources used during training under the proposed alternatives. For Alternative 1, this would include components of the Portable Undersea Tracking Range, including MK-84 Range Tracking Pingers (40 ea) and Transponders (40 ea), and other sources consisting of MK-39 EMATT targets (6 ea) and SUS MK-84 signaling devices (12 ea). Use of these sources did not occur under the No Action Alternative. Each of these acoustic sources is described in the following paragraphs with the total proposed use under Alternative 1 provided in Table 3.8-12.

Table 3.8-12: Annual Non-Sonar Acoustic Sources for Alternatives 1

	MK-84 PUTR Tracking Pingers [a]	PUTR Transponders [a]	MK-39 EMATT targets[b]	SUS MK-84 signaling devices[b]
Alternative 1	40	40	6	12

Notes: a = This number reflects hours of operation for the PUTR system under average conditions and is not total transmission time of the components. b = Number is counted by device.

Portable Undersea Tracking Range (PUTR) – MK-84 Pingers and Transponders

The use of Portable Undersea Tracking Range (PUTR) is proposed to support ASW training under the proposed alternatives. The PUTR is a self-contained, portable, undersea tracking system that employs modern technologies to support coordinated undersea warfare training for Forward Deployed Naval Forces. PUTR will be available in two variants to support both shallow and deep water remote activities in keeping with Navy requirements to exercise and evaluate weapons systems and crews in the environments that replicate potential combat areas. The system will be capable of tracking submarines, surface ships, weapons, targets, and Unmanned Underwater Vehicles (UUVs) and distribute the data to a data processing and display system, either aboard ship, or at a shore site. No specific area for use of a PUTR system has been identified in the TMAA.

The PUTR functions by the use of MK-84 tracking pingers affixed to vessels and targets with anchored transponders detecting the pinger signals and relaying those signals to a hydrophone on a buoy or stationary vessel serving as a hub for relay to range controllers via radio. The pingers in the TMAA were modeled as using having a 12.9 kHz, 15 millisecond signal at 194 dB re 1µPa every two seconds. The transponders were modeled as in 1,800 m depth and operating at 8.8 kHz with each pinger report assumed to be 15 milliseconds duration. The transponder spacing is designed so that four transponders will hear each pinger signal. Therefore, for every pinger signal there will be four transducer reports – one ping every two seconds is representative. However, not every ping will be heard. The design of the PUTR assumes 63% (5 in 8) will be received by the transducer. It is therefore assumed that of the 30 pinger signals per minute (per pinger), an average of 19 (63%) pinger signals will be received by four transponders and therefore generate 76 pinger signal reports from transponders to the range relay hub.

MK-39 Expendable Mobile Anti-Submarine Warfare Training Target (EMATT)

An Expendable Mobile Anti-Submarine Warfare Training Target (EMATT) is a device approximately two feet in length and three inches in diameter looking like a small torpedo. EMATT can be launched by hand from a surface vessel or deployed from a submarine or aircraft. EMATTs are programmed to move through the water and provide acoustic broadband noise and magnetic signals that mimic a submarine. For modeling, a speed of five knots and a depth of 100 meters was modeled as representative with the acoustic output a continuous tone 900 Hz at 130 db for four hours.

SUS MK-84 Signaling Devices

The SUS MK-84 signaling device is a small bomb shaped device that can be deployed from aircraft and ships and is used to communicate with submarines. Two seconds after the SUS MK-84 enters the water, it begins emitting a coded signal for approximately 70 seconds. Depending on the mode selected, the tone alternates between two frequencies (3.3 kHz and 3.5 kHz) in a one to three second interval, or operates at the single 3.5 kHz frequency. For modeling, a total of 35 pings at 3.4 kHz and a source level of 160 dB/uPa for two seconds each at one second intervals at 50 meters depth was modeled to be representative of the device.

Quantification from acoustic impact modeling for active sonar and other non-sonar acoustic sources use under Alternative 1 and possible exposures for rare animals indicates 215,053 MMPA Level B harassments from non-TTS (Table 3.8-13). The modeling also indicates 466 MMPA Level B harassments from TTS. Without consideration of the reduction expected from implementation of mitigation measures, the total MMPA Level B harassments for active sonar use is 215,519 under Alternative 1.

Without consideration of the reduction expected from implementation of mitigation measures, modeling indicates potential for one MMPA Level A harassment under Alternative 1 for acoustic sources. This one exposure should not occur given it is predicted for Dall's porpoise, which should be readily detectable given their general large group size and characteristic porpoising behavior. The implementation of the mitigation procedures presented in Section 5.1.7 will also reduce the potential occurrence for some of the modeled MMPA Level B marine mammal exposures and harassments (NMFS 2008a).

Table 3.8-13: Alternative 1 Annual Sonar and Non Sonar Acoustic Exposures Summary

Species	MMPA Level B Harassment		MMPA Level A Harassment
	Non-TTS	TTS	PTS
ESA Species			
Blue whale	1*	0	0
Fin whale	5,501	11	0
Humpback whale	694	3	0
North Pacific Right whale	1*	0	0
Sei whale	4*	0	0
Sperm whale	164	0	0
Steller sea lion	5,553	1	0
Non-ESA Listed Species			
Baird's beaked whale	243	1	0
Cuvier's beaked whale	1,151	3	0
Dall's porpoise	102,750	384	1
Gray whale	192	1	0
Harbor Porpoise	5,438	0	0
Killer whale	5,301	20	0
Minke whale	341	1	0
Pacific white-sided dolphin	8,456	30	0
Stejneger's beaked whale	1,151	3	0
California sea lion	1*	0	0
Harbor seal	1*	0	0
Northern elephant seal	1,031	0	0
Northern fur seal	77,079	8	0
Total	**215,053**	**466**	**1**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s; * = Accounting for rare animals.

Notes: ESA = Endangered Species Act; MMPA = Marine Mammal Protection Act, PTS = Permanent Threshold Shift, TTS = Temporary Threshold Shift

Behavioral effects modeling indicates sonar use under Alternative 1 may affect ESA listed blue, fin, humpback, North Pacific right, sei, and sperm whales, and Steller sea lions. It is not likely that use of acoustic sources associated with training activities would result in effects to the life functions of marine mammals in the TMAA based on previous NMFS Biological Opinions for the same actions in other locations (NMFS 2008a, 2009b; NOAA 2009). In accordance with EO 12114, non-explosive practice ordnance would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Expended Materials

Under the Alternative 1, 20,223 expendable items may be used resulting in a 26 percent increase over the No Action. The types and quantities of materials expended and information regarding fate and transport of these materials within the marine environment are discussed in Section 3.2 (Expended Materials), and Section 3.3 (Water Resources). The analyses in these sections determined that most expended materials rapidly sink to the seafloor where they become encrusted by natural processes or are incorporated into the seafloor, with no substantial accumulations in any particular area and no significant negative effects to water quality or marine benthic communities. Given that materials expended during training do not remain at the surface and are generally used in areas where the water depth is beyond that of foraging marine mammals, it is unlikely expended materials would later be encountered by any marine mammal.

Portable Undersea Tracking Range (PUTR) Materials

Upon deployment of the PUTR, clump weights are used to anchor up to 7 transponders in place. As a result of these anchor weights, there would be direct localized impact to bottom habitat; however, this should have no impact on marine mammals. Sediments stirred up by the clump weight anchors should only result in a temporary and localized turbidity. Upon completion of the exercise, the transponders are recovered, which eliminates any potential impacts associated with hazardous materials such as batteries and electronic components associated with the PUTR system. The clump weights are not recovered, and since they are composed of inert material (such as iron, chain, or concrete), they are not a potential source of contaminants. The expending of PUTR anchor weights under Alternative 1 should have no effect on ESA-listed blue whales, fin whales, humpback whales, North Pacific right whales, sei whales, Steller sea lions or other marine mammals in the TMAA. Expending PUTR anchor weights would not be expected to result in MMPA Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, expending of PUTR anchor weights would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Ordnance-Related Materials

The number of ordnance related materials used in the TMAA would increase under Alternative 1 (Table 2-8) to 19,101, increasing by approximately 21 percent from current conditions.

Ingestion of ordnance under Alternative 1 may affect sperm whales. Ordnance-related materials under Alternative 1 should have no effect on ESA listed blue whales, fin whales, humpback whales, North Pacific right whales, sei whales, Steller sea lions or other marine mammals in the TMAA based on the feeding habits of these species. Ordnance-related materials would not be expected to result in MMPA Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, ordnance-related materials would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Target Related Materials

The number of targets and target-related material used in the TMAA would increase to 125 or by about 95 percent over the No Action. There would be the introduction of Expendable Mobile Anti-Submarine Warfare Training Target (EMATT) under Alternative 1. As discussed above for the No Action Alternative, species that feed on or near the bottom (which are the sperm whales and beaked whales) may encounter an expended target while feeding; however, the size of the target would generally prohibit any listed species from ingesting it. Therefore, the use of targets under Alternative 1 likely would have no effect, but may affect ESA listed marine mammals. Targets would not be expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with E.O. 12114, targets would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Chaff

Under Alternative 1, there would be no change in the quantity of chaff used (540 lbs/245 kg) for the No Action. As detailed in Section 3.2.1.1, chaff consists of aluminum-coated fibers used as an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Upon deployment, the chaff fibers are widely dispersed in the air and eventually land in the water and sink to the ocean floor.

As first presented in DoN (2009), the dispersion characteristics of chaff make it likely that marine mammals would occasionally come in direct contact with chaff fibers while at the water's surface and while submerged, but such contact would be inconsequential. Chaff is similar in form to fine human hair with the fibers being flexible and soft. Evaluation of the potential for chaff to be inhaled by humans, livestock, and animals found that the fibers are too large to be inhaled into the lung (Arfsten et al. 2002, Hullar et al. 1999, USAF 1997). Although these reviews did not specifically consider the respiratory system of large whales, any effects of chaff inhalation on marine mammals are considered insignificant given the dispersal of chaff fibers resulting in very low concentration in the air.

While no studies have been conducted to evaluate the effects of chaff ingestion on marine mammals, the effects are expected to be insignificant and discountable based the low concentrations when dispersed, the small size of chaff fibers, available data on the toxicity of chaff components (silicon dioxide and aluminum), and evidence indicating the lack of significant accumulation of aluminum in sediments after prolonged training (DoN 2009). Silicon and aluminum are two of the most abundant elements in the earth's crust. Marine mammals, such as gray whales that forage on the bottom, routinely ingest sediment containing these elements. The aluminum concentrations in brain tissue of gray whales are within the range for terrestrial mammals that may receive high concentrations of aluminum in their diets, suggesting a broad range in tolerance to aluminum in mammals (Varanasi et al. 1993, Tilbury 2002, DoN 2009). Chaff cartridge plastic end-caps and pistons would also be expended into the marine environment, where they would sink and could potentially be ingested by marine mammals. Based on the low concentration of these components in the TMAA, it is very unlikely a marine mammal would encounter a plastic end-cap or piston from the chaff cartridge. Even in the very unlikely event one of these components was encountered and then consumed by a marine mammal, the small size of chaff end-caps and pistons (1.3 inch [33 mm] diameter and 0.13 inch [3.3 mm] thick) would suggest it would likely pass through the digestive tract and be voided without causing harm.

Under ESA, chaff use under the Alternative 1 may affect blue, fin, humpback, North Pacific right, sei, and sperm whales. Use of chaff is not expected to result in Level A or Level B harassment as defined by the MMPA and would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

Marine Markers

The number of marine markers used in the TMAA would increase under Alternative 1 to 60 per year. The probability of a marine mammal ingesting an expended marine marker would be essentially the same as under the No Action Alternative (using 20 markers). Marine marker ingestion under Alternative 1 may affect ESA-listed marine mammals. The use of marine markers is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of marine markers during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

TALDS

The number of TALDS used in the TMAA would increase under Alternative 1 to 12 per year. The probability of a marine mammal ingesting pieces of an expended TALD would be essentially the same as under the No Action Alternative (using 8 TALDS). TALD ingestion under Alternative 1 may affect ESA-listed marine mammals. The use of TALDS is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of TALDS during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

BQM-74Es

The number of BQM-74Es used in the TMAA under Alternative 1 would remain at 2 per year. The probability of a marine mammal ingesting pieces of an expended BQM-74E would be the same as under the No Action Alternative. BQM-74E ingestion under Alternative 1 may affect ESA-listed marine mammals. The use of BQM-74Es is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of BQM-74Es during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

EMATT

There was no use of EMATTs under the No Action Alternative. The use of up to 6 EMATTs could occur under Alternative 1 in support of ASW Training. An EMATT is a small device (approximately 2 ft in length and 3 inches in diameter) shaped like a torpedo that can be launched by hand from a surface vessel or deployed from a submarine or aircraft. EMATTs are programmed to move through the water and provide acoustic and other sensor that mimic a submarine. At the end of its use, an EMATT will sink to the floor of the ocean. Expended EMATTs are unlikely to result in any physical impacts to the sea floor. Expended EMATTs would sink into a soft bottom or would lie on a hard bottom, where they may provide a substrate for benthic colonization and may be covered eventually by shifting sediments.

Use of EMATT under Alternative 1 may affect ESA-listed marine mammals. The use of EMATT is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of EMATT associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from the use of EMATT during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

DICASS, SUS MK-84, and Passive Sonobuoys

There was no use of active sonobuoys under the No Action Alternative, however, the number of SSQ-36 expendable Bathythermograph (BT) sonobuoys would increase from 24 under current conditions to 60 under Alternative 1. The use of passive and active sonobuoys for ASW is proposed under Alternative 1. Introduced for the first time under Alternative 1, approximately 133 active (SSQ-62 DICASS) acoustic sonobuoys would be deployed in the TMAA annually and approximately 500 passive SSQ-53 Directional Frequency and Ranging (DIFAR) sonobuoys would be used in conjunction with the DICASS sonobuoys. Approximately 60 SSQ-77 Very Long Range Acoustic Detection (VLAD) passive sonobuoys would also be used under Alternative 1. Approximately 12 SUS MK-84 signaling devices would be used under Alternative 1.

Entanglement impacts to marine mammals from sonobuoys and other military expended material are unlikely. The assemblies would sink and the density of such military expended materials in the TMAA would be a very low concentration. Expended sonobuoys are a potential ingestion hazard for marine mammals while they are floating, while they are descending to the seafloor, or after they sink to the bottom. However, the probability of ingestion is extremely low based on the low number of sonobuoys expended per year (745) across the TMAA. Sonobuoy ingestion under Alternative 1 may affect ESA-listed marine mammals. The use of passive sonobuoys is not expected to result in Level A or Level B harassment as defined by the MMPA. Effects of active sonobuoys are addressed as part of the sonar analysis. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of passive sonobuoys during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

Critical Habitats

There is no critical habitat located or PCEs in the TMAA. Therefore, in accordance with ESA consultation provisions to assess potential effects of proposed actions to critical habitat, it is concluded that Navy activities of Alternative 1 will have no effect on any critical habitat.

3.8.7.10 Alternative 2

Implementation of Alternative 2 would include all elements of Alternative 1 (accommodating training activities currently conducted, increasing specific training activities to include the use of active sonar, and accommodating force structure changes). In addition, under Alternative 2 the following activities would occur:

- Conduct one additional separate summertime CSG exercise lasting up to 21 days within the ATA.
- Conduct a SINKEX in each summertime exercise (a maximum of two) in the TMAA.

Marine mammals would have the potential to be affected by vessel movements, aircraft overflights, sonar, weapons firing/nonexplosive ordnance use, explosive ordnance, and expended materials under Alternative 2.

Vessel Movements

Under Alternative 2, the number of vessels would remain the same as under Alternative 1. However, The Navy has proposed providing the flexibility to conduct (as required) a second summer exercise within the TMAA between 2010 and 2015. Within the maximum two summer exercises, the length of the exercise, the number of vessels, and the allotted at-sea time within the TMAA during an exercise will be variable between years. These variations cannot be predicted given unknowns including the availability of participants for the annual exercise(s), which is a direct result of factors such as Navy responses to real-world events (e.g., tactical deployments, disaster relief, humanitarian assistance, etc.), planned and unplanned deployments, vessel availability due to funding and maintenance cycles, and logistic concerns with conducting an exercise in the GOA. The Navy predicts, however, there will be no increase required in excess of two annual summer exercises as described for Alternative 2 over the course of the 2010 and 2015 timeframe such that it is unlikely increases in steaming days would occur during this time period.

The additional vessel movements under Alternative 2 would result in a small increased potential for short-term behavioral reactions to naval vessels. Potential for collision would increase slightly compared to the No Action Alternative during each of two possible summertime exercises; however, Navy mitigation measures would reduce the probability and vessel collisions with whales remains unlikely. Vessel movements under Alternative 2 may affect ESA-listed marine mammals. Vessel movements are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, vessel movements would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]) in accordance with EO 12114.

Aircraft Overflights

Alternative 2 would include 600 fixed-wing aircraft sorties (a 100 percent increase over the No Action). There would be 118 events involving helicopters in the TMAA compared to 32 under the No Action Alternative (existing conditions). The number of aircraft sorties and events using helicopter are double for

Alternative 2 as compared to Alternative 1 and would occur in the same locations. As a result, the potential for marine mammals to be exposed to overflights would increase compared to baseline conditions. Some training would involve supersonic flight, resulting in sonic booms, but such airspeeds are infrequent and occur above 30,000 ft (9,144 m) and at least 30 nm (56 km) offshore, further reducing their potential for noise impacts. Peak noise levels generated by individual SH-60 helicopters would be similar to the noise levels generated with the No Action Alternative.

The additional overflights may result in increased instances of behavioral disturbance due to sound, shadow-effects, and/or, in the case of helicopters, water column disturbance. Similar to the No Action Alternative, the responses would be limited to short-term behavioral or physiological reactions. It is not likely that exposures to aircraft overflights associated with training activities would result in effects to the life functions of marine mammals in the TMAA. Aircraft overflights under Alternative 2 may affect ESA-listed marine mammals. Aircraft overflights are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO12114, aircraft overflights would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]). All aircraft overflights between the shore and 12 nm (22 km) from land would occur at altitudes at or above 15,000 ft (915 m) and would have no effect on marine mammals.

Non-explosive Practice Ordnance

The total number of non-explosive practice projectiles would increase with Alternative 2. The number of non-explosive practice ordnance events by type of projectile occurring for Alternative 2 is presented in Table 2-7. Non-explosive practice ordnance includes naval gunshells (20mm, 25mm, 57mm, 76mm, and 5-in projectiles) and small arms rounds (7.62mm and .50-caliber projectiles). Under Alternative 2, there would be about 27,176 naval gunshells and about 11,400 small arms projectiles expended into the ocean. Compared to the No Action Alternative, there would be increases of about 157 percent and 128 percent respectively, in naval gunshells and small arms projectiles.

These changes would result in increased potential exposure of marine mammals to non explosive practice ordnance strikes; however, Navy standard operating procedures and mitigation measures would reduce the probability of strikes by modifying training activities when marine mammals are known to be in the area. It is not likely that use of non-explosive ordnance associated with training activities would result in effects to the life functions of marine mammals in the TMAA. There should be no effect from use of non-explosive practice ordnance, but it may affect ESA-listed marine mammals under Alternative 2. Non-explosive ordnance use is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, non-explosive practice ordnance would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Explosive Ordnance (At-Sea Explosions)

The number of high explosive events by type of ordnance occurring for Alternative 2 is presented in Table 2-8. In addition to 84 5-inch and 28 76mm live rounds, a total of 144 high-explosive bombs (MK-82, MK-83 and MK-84 types), and two MK-48 torpedoes will be detonated in the water annually. Much of this increase in at-sea explosions is due to the introduction of two proposed SINKEX events per year. While recognizing a SINKEX event concentrates explosives at a single location that has been observed to be free of marine mammals and sea turtles, this represents a 580 percent increase in live gunfire and a 206 percent increase for bomb detonations in the water as compared to the No Action Alternative. These changes would represent an increased potential for marine mammals exposure to detonation concussion effects from ordnance use and behavioral disturbance. In addition, under Alternative 2 approximately 80 of the SSQ-110 sonobuoys, which have an explosive as a sound source, would be used for training in the TMAA.

SINKEX

In addition to the events noted above, under Alternative 2 the potential to conduct a SINKEX training event during each of the two possible summer exercise periods is also proposed. During a SINKEX, a decommissioned vessel is towed to a deep-water location and sunk using a variety of ordnance containing high explosives that may include missiles, bombs, and gunfire. For each SINKEX, there may be up to 17 missiles, 10 non-inert bombs, and 400 explosive rounds of 5-inch gunfire used during the event. For modeling purposes it was assumed that all missiles except a portion of the Maverick missiles fired would hit the target vessel. Approximately one third of the non-guided munitions used (one Maverick missile, three bombs, and 120 of the 5-inch rounds) were modeled as missing the target vessel and exploding in the water (for details, see Appendix D). SINKEX may also include the use of one MK-48 torpedo, which can be used at the end of SINKEX if the target is still afloat.

Aspects of the SINKEX event that have potential effects on marine mammals (e.g., vessel movement, aircraft overflights, gunfire firing noise, munitions constituents) have been analyzed separately in previous sections. If a marine mammal remained in the immediate vicinity of the SINKEX, ordnance missed the target vessel, and then impacts the water at or near a marine mammal, behavioral disturbance, injury, or mortality could occur. SINKEX under Alternative 2 is, however, not likely to result in injury or mortality given the assumption that marine mammals will not remain in the vicinity of the activities surrounding a SINKEX event and that mitigation involving area clearance requirements during the lengthy set-up to safely conduct a SINKEX (see Section 5.2.1.2) will reduce the likelihood that animals would be in the vicinity during the event. The modeled explosive exposure harassment numbers by species are presented in Table 3.8-14. The table quantifies MMPA Level B harassment from behavioral disturbance and MMPA Level A harassment from potential injury to marine mammals.

Without consideration of target area clearance procedures as standard mitigation, quantification from behavioral effects modeling, accounting for rare species indicates at-sea explosion exposures under Alternative 2 may affect ESA listed blue, fin, humpback, North Pacific right, sei, and sperm whales, and Steller sea lions. For large whales, exposures in vicinity to a source are unlikely to occur given the sightability of species such as blue, fin, humpback, North Pacific right, sei, and sperm whales.

For at-sea explosions under Alternative 2, quantification from modeling and accounting for rare species indicates 170 MMPA Level B harassments from sub-TTS for MSE. The modeling indicates 70 MMPA Level B harassments from TTS. Under Alternative 2 for at-sea explosions, quantification from modeling and accounting for rare species, indicates a total of 240 MMPA Level B harassments annually.

Quantification from modeling also indicates potential for four MMPA Level A harassments from slight injury and one estimated exposure that could result in severe injury or mortality. The exposure modeling results are an estimate of marine mammal at-sea explosion sound exposures without consideration of standard mitigation procedures summed across all at-sea explosion events during the two proposed exercises per year. The implementation of the mitigation procedures presented in Section 5.1.7 will reduce the potential for marine mammal exposure and harassment through area clearance procedures (NMFS 2008a). The set up procedures and checks required for safety of event participants make it unlikely Dall's porpoise, Pacific white-sided dolphin, or Northern fur seal would remain in an area undetected during the set-up of the event or before explosive detonation occurred during the period the target area or SINKEX is under observation. In addition, the distances from an at-sea explosion at which these injuries would occur are relatively short and well within the buffer zones established as standard mitigation (see Section 5.1.7.2). Therefore, the four MMPA Level A harassments and the one severe injury/mortality are predicted by the modeling without consideration of standard mitigation should not occur. In accordance with EO 12114, a SINKEX training event during each of the two possible summer exercise periods would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Table 3.8-14: Alternative 2 Annual At-Sea Explosion Exposures Summary

Species	MMPA Level B Harassment		MMPA Level A Harassment	Mortality
	Sub-TTS 177dB dB re 1μPa^2-s (MSE)	TTS 182 dB / 23 psi	50 percent TM Rupture 205 dB Slight Lung Injury or 23 psi-ms	Onset massive Lung Injury or Mortality 31 psi-ms
ESA Species				
Blue whale	1*	0	0	0
Fin whale	13	5	0	0
Humpback whale	1	0	0	0
North Pacific Right whale	1*	0	0	0
Sei whale	4*	0	0	0
Sperm whale	1*	0	0	0
Steller sea lion	2	1	0	0
Non-ESA Listed Species				
Baird's beaked whale	1	0	0	0
Cuvier's beaked whale	3	1	0	0
Dall's porpoise	84	37	2	1
Gray whale	3*	0	0	0
Harbor Porpoise	2*	0	0	0
Killer whale	4	2	0	0
Minke whale	2*	0	0	0
Pacific white-sided dolphin	12	6	1	0
Stejnger's beaked whale	4	1	0	0
California sea lion	1*	0	0	0
Harbor Seal	1*	0	0	0
Northern elephant seal	4	1	0	0
Northern fur seal	26	16	1	0
Total	**170**	**70**	**4**	**1**

Notes: dB = decibel, dB re 1μPa2-s = decibels referenced to 1 micropascal squared per second, ESA = Endangered Species Act, MMPA = Marine Mammal Protection Act, MSE = Multiple Successive Explosions, psi = pound per square inch, psi-ms = pounds per square inch per millisecond, TM = Tympanic membrane, TTS = Temporary Threshold Shift; * = Accounting for rare animals.

Active Sonar and Other Non-Sonar Acoustic Sources for ASW Training

There was no sonar use in conjunction with ASW training under the No Action Alternative. Under Alternative 2, use of sonar and other non-sonar acoustic sources would double above that proposed in Alternative 1. This sonar and other non-sonar acoustic source use for ASW training is associated with the potential addition of another carrier strike group participating in the training during a second summer time-frame exercise. However, it is unlikely that effects to marine mammals from sonar and other non-sonar acoustic source use would be significant because of the mitigation measures employed by the Navy to exclude marine mammal presence in the vicinity of the sources.

Alternative 2 would include mid and high frequency sonar use, including 578 hours of SQS-53 and 52 hours of SQS-56 surface ship sonar (315 additional hours of usage over Alternative 1), the BQQ-10 (48 hours) and BQS-15 (24 Hours) submarine sonars (twice that of Alternative 1), 266 active SSQ-62 sonobuoys (increase of 133 sonobuoys compared to Alternative 1), and 192 dips (an increase of 96 compared to Alternative 1) of helicopter dipping sonar (see Table 3.8-15 and 3.8-16).

Table 3.8-15: Annual Sonar Hours and Sources for Alternative 2

	SQS 53 Sonar [a]	SQS-56 Sonar [a]	BQQ-10 Sonar [a]	BQS-15 Sonar [a]	SSQ-62 DICASS Sonobuoy[b]	AQS 22 Dipping Sonar[c]
Alternative 2	578	52	48	24	266	192

Notes: a = Number reflects hours of operations not total transmission time, representative for all variants of system. b = Number is counted by buoy, c = Number is counted as individual use "dips" of the system

Non-Sonar Acoustic Sources Used During Training

In addition to the use of mid- and high frequency sonar, additional non-sonar acoustic sources used during training under the Alternative 2 would include components of the Portable Undersea Tracking Range including MK-84 Range Tracking Pingers (80 ea) and Transponders (80 ea), plus MK-39 EMATT targets (12 ea) and SUS MK-84 signaling devices (24 ea) as shown in Table 3.8-16. Use of these sources did not occur under the No Action Alternative and are double the numbers proposed for Alternative 1.

Table 3.8-16: Annual Non-Sonar Acoustic Sources for Alternative 2

	MK-84 Range Tracking Pinger[a]	PUTR Transponder[a]	MK-39 EMATT targets[b]	SUS MK-84 signaling devices[b]
Alternative 2	80	80	12	24

Notes: a = This number reflects hours of operation for the PUTR system under average conditions and is not total transmission time of the components. b = Number is counted by device.

Quantification from behavioral effects modeling, accounting for rare species for which modeling was not possible, and for which modeling provided an estimate of zero exposures, indicates sonar use under Alternative 2 may affect ESA listed blue, fin, humpback, North Pacific right, sei, and sperm whales, and Steller sea lions.

Quantification from behavioral effects modeling and accounting for rare species indicates 424,620 MMPA Level B harassments from non-TTS for Alternative 2 (Table 3.8-17). The modeling also indicates 931 MMPA Level B harassments from TTS. There is one predicted MMPA Level A harassment from PTS for Alternative 2. This one MMPA Level A harassment should not, however, occur given it is predicted for Dall's porpoise, which should be readily detectable given their general large group size and characteristic porpoising behavior. Without consideration of the reduction expected from implementation of mitigation measures, modeling and accounting for rare species estimates a total of 425,551 MMPA Level B harassments for active sonar and non-sonar acoustic sources for Alternative 2. The implementation of the mitigation and monitoring procedures presented in Section 5.1.7 will reduce the potential occurrence for some of these modeled marine mammal exposures and harassments (NMFS 2008a).

Under Alternative 2, sonar use may result in Level B harassment as defined by the MMPA. Sonar and non-sonar acoustic source use under Alternative 2 would not result in Level A harassment as defined by the MMPA. MMPA Level B harassments associated with Alternative 2 may affect the ESA listed blue whales, fin whales, humpback whales, North Pacific right whales, sei whales, sperm whales, and Steller sea lions.

It is not likely that use of sonar and other acoustic sources associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, use of sonar and other acoustic sources would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Table 3.8-17: Alternative 2 Annual Sonar and Non-Sonar Acoustic Exposures Summary

Species	MMPA Level B Harassment		MMPA Level A Harassment
	Non-TTS	TTS	PTS
ESA Species			
Blue whale	1*	0	0
Fin whale	10,998	21	0
Humpback whale	1,388	6	0
North Pacific Right whale	1*	0	0
Sei whale	4*	0	0
Sperm whale	327	1	0
Steller sea lion	11,104	1	0
Non-ESA Listed Species			
Baird's beaked whale	485	1	0
Cuvier's beaked whale	2,302	6	0
Dall's porpoise	205,485	768	1
Gray whale	384	1	0
Harbor Porpoise	5,438	0	0
Killer whale	10,602	41	0
Minke whale	677	2	0
Pacific white-sided dolphin	16,912	61	0
Stejneger's beaked whale	2,302	6	0
California sea lion	1*	0	0
Harbor seal	1*	0	0
Northern elephant seal	2,064	0	0
Northern fur seal	154,144	16	0
Total	**424,620**	**931**	**1**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s; * = Accounting for rare animals.

Notes: ESA = Endangered Species Act, MMPA = Marine Mammal Protection Act, PTS = Permanent Threshold Shift, TTS = Temporary Threshold Shift

<u>Special Considerations for Beaked Whales</u>

Neither NMFS nor the Navy anticipates that marine mammal strandings or mortality will result from the operation of mid-frequency sonar during Navy exercises within the TMAA. The history of Navy activities in the Gulf of Alaska and analysis in this document indicate that military readiness activities are not expected to realistically result in any sonar-induced Level A injury or mortalities to marine mammals.

However, evidence from five beaked whale strandings occurring at various locations around the world over approximately a decade, suggests that the exposure of beaked whales to mid-frequency sonar in the presence of certain conditions (e.g., multiple units using tactical sonar, steep bathymetry, constricted channels, strong surface ducts, etc.) may result in strandings, potentially leading to mortality. Although these physical factors believed to contribute to the likelihood of beaked whale strandings are not present, in their aggregate, in the TMAA, scientific uncertainty exists regarding what other factors, or combination of factors, may contribute to beaked whale strandings. Recent data from the Southern California Range Complex (Falcone et al. 2009), where Navy ASW activities have been occurring year-round for decades, indicates Cuvier's beaked whales are resident at that ASW training location with no apparent effect from exposure to mid-frequency sonar.

To allow for scientific uncertainty regarding the strandings of beaked whales and the exact mechanisms of the physical effects, the Navy will request authorization for take, by mortality, of the beaked whale species present in the TMAA despite the decades long history of these same training operations with the same basic equipment having had no known effect on beaked whales at any Navy training ranges where mid-frequency sonar training routinely has occurred.

Accordingly and to account for this potential under the preferred alternative, the MMPA Letter of Authorization request will include an annual mortality take request for a total of three (3) beaked whales of the Ziphidae family, to include any combination of Baird's beaked whale, Cuvier's beaked whale, Stejneger's beaked whale, and Mesoplodon sp.

Expended Materials

The amount of expended materials would increase to 41,298 items or approximately 160 percent in the TMAA under Alternative 2 as compared to the No Action Alternative.

Portable Undersea Tracking Range (PUTR) Materials

Upon deployment of the PUTR, clump weights are used to anchor transponders in place. As a result of these anchor weights, there would be direct localized impact to bottom habitat; however, this should have no impact on marine mammals. Sediments stirred up by the clump weight anchors should only result in a temporary and localized turbidity. Upon completion of the exercise, the transponders are recovered, which eliminates any potential impacts associated with hazardous materials such as batteries and electronic components associated with the PUTR system. The clump weights are not recovered, and since they are composed of inert material, they are not a potential source of contaminants. The expending of PUTR anchor weights under Alternative 2 should have no effect on ESA listed blue whales, fin whales, humpback whales, North Pacific right whales, sei whales, Steller sea lions or other marine mammals in the TMAA. Expending PUTR anchor weights would not be expected to result in MMPA Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, expending of PUTR anchor weights would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Ordnance-Related Materials

The amount of ordnance-related materials would increase to 39,060 items or approximately 149 percent in the TMAA under Alternative 2 as compared to the No Action Alternative. Ingestion of ordnance under Alternative 2 may affect sperm whales. Ordnance-related materials under Alternative 2 should have no effect on the remaining ESA-listed species (blue, fin, humpback, North Pacific right, sei and sperm whales, and Steller sea lions) or other marine mammals in the TMAA based on the feeding habits of these species and the likely deep water areas where training using ordnance will occur. It is not likely that use of ordnance related material associated with training activities would result in effects to the life functions of marine mammals in the TMAA. Ordnance-related materials would not be expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, ordnance related materials would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Target-Related Materials

Under Alternative 2, the number of targets used in the TMAA would increase to 250, or approximately 290 percent over the No Action Alternative. As discussed above for the No Action Alternative, species that feed on or near the bottom (which are the sperm whales and beaked whales) could possibly encounter an expended target while feeding; however, the size of the target or pieces would generally prohibit any listed species from ingesting it. However, if target materials are fragmented into smaller pieces, there is a possibility to ingest fragments while feeding on the sea floor although the required co-occurrence of these unlikely events is considered discountable. Therefore, Alternative 2 may affect sperm whales under the ESA. Ingestion of target-related materials under Alternative 2 should not affect the other ESA listed marine mammals (blue, fin, humpback, North Pacific right, sei, and sperm whales, and Steller sea lions) given their feeding habits. Target materials would not be expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of targets associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO12114, targets would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Chaff

Under Alternative 2, the quantity of chaff used (1080 lbs/490 kg) would increase by 100 percent from the No Action. This increase is not considered significant given the size of the area involved. As detailed in Section 3.2.1.1, chaff consists of aluminum-coated fibers used as an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Upon deployment, the chaff fibers are widely dispersed in the air and eventually land in the water and sink to the ocean floor.

As first presented in DoN (2009), the dispersion characteristics of chaff make it likely that marine mammals would occasionally come in direct contact with chaff fibers while at the water's surface and while submerged, but such contact would be inconsequential. Chaff is similar in form to fine human hair with the fibers being flexible and soft. Evaluation of the potential for chaff to be inhaled by humans, livestock, and animals found that the fibers are too large to be inhaled into the lung (Arfsten et al.2002, Hullar et al. 1999, USAF 1997). Although these reviews did not specifically consider the respiratory system of large whales, any effects of chaff inhalation on marine mammals are considered insignificant given the dispersal of chaff fibers resulting in very low concentration in the air.

While no studies have been conducted to evaluate the effects of chaff ingestion on marine mammals, the effects are expected to be insignificant and discountable based the low concentrations when dispersed, the small size of chaff fibers, available data on the toxicity of chaff components (silicon dioxide and aluminum), and evidence indicating the lack of significant accumulation of aluminum in sediments after prolonged training (DoN 2009). Silicon and aluminum are two of the most abundant elements in the earth's crust. Marine mammals, such as gray whales that forage on the bottom, routinely ingest sediment containing these elements. The aluminum concentrations in brain tissue of gray whales are within the range for terrestrial mammals that may receive high concentrations of aluminum in their diets, suggesting a broad range in tolerance to aluminum in mammals (Varanasi et al. 1993, Tilbury 2002, DoN 2009). Chaff cartridge plastic end-caps and pistons would also be expended into the marine environment, where they would sink and could potentially be ingested by marine mammals. Based on the low concentration of these components in the TMAA, it is very unlikely a marine mammal would encounter a plastic end-cap or piston from the chaff cartridge. Even in the very unlikely event one of these components was encountered and then consumed by a marine mammal, the small size of chaff end-caps and pistons (1.3

inch [33 mm] diameter and 0.13 inch [3.3 mm] thick) would suggest it would likely pass through the digestive tract and be voided without causing harm.

Under ESA, chaff use under the Alternative 2 may affect blue, fin, humpback, North Pacific right, sei, and sperm whales but these effects are insignificant and discountable. Use of chaff is not expected to result in Level A or Level B harassment as defined by the MMPA and would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

SINKEX

As described previously in Section 2.6.1.1, a SINKEX event involves use of a decommissioned and environmentally remediated vessel as a target for training involving the use of bombs, missiles, gunfire, and torpedoes. Analysis of effects on marine mammals from at-sea explosions during a SINKEX was presented in the preceding sub-section. Analysis of the SINKEX vessel as expended material was presented in Section 3.2.2.6. In summary, however, each target vessel is made environmentally safe for sinking according to standards set by the U.S. Environmental Protection Agency (EPA). Requirements are that the SINKEX must occur greater than 50 nm (93 km) out to sea and in water depths greater than 6,000 ft (1,830 m) (40 C.F.R. § 229.2), which is beyond the known dive depth of marine mammals. The presence of a vessel hull on the bottom in excess of 6,000 ft (1,830 m) depth should have no effect on marine mammals.

Marine Markers

The number of marine markers used in the TMAA would increase 500 percent from the No Action under Alternative 2 to 120 per year. The probability of a marine mammal ingesting an expended marine marker would be extremely low based on the low concentration in the TMAA (0.014/nm^2). Marine marker ingestion under Alternative 2 may affect ESA-listed marine mammals. The use of marine markers is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of marine markers associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of marine markers during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

TALDS

The number of TALDS used in the TMAA would increase 200 percent from the No Action under Alternative 2 to 24 per year. The probability of a marine mammal ingesting a piece of an expended TALD would be extremely low based on the size of the TMAA. TALD ingestion under Alternative 2 may affect ESA-listed marine mammals. The use of TALDS is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of TALDS associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from the use of TALDS during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

BQM-74Es

The number of BQM-74Es used in the TMAA would increase 100 percent from the No Action under Alternative 2 to 4 per year. The probability of a marine mammal ingesting a piece of an expended BQM-74E would be extremely low based on the size of the TMAA. BQM-74E ingestion under Alternative 2 may affect ESA-listed marine mammals. The use of BQM-74Es is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of BQM-74Es associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from the use of BQM-74Es during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

EMATT

Use of EMATTs was not part of the No Action Alternative. The use of up to 12 EMATTs could occur under Alternative 2 in support of ASW Training. This is an increase of 100 percent over Alternative 1. Use of EMATT under Alternative 2 may affect ESA-listed marine mammals. The use of EMATT is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of EMATT associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from the use of EMATT during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

DICASS, SUS MK-84, and Passive Sonobuoys

The number of SSQ-36 BT sonobuoys could increase up to 120 under Alternative 2 (from 24 under the No Action; a 400 percent increase). There were no active sonobuoys used in conjunction with ASW training under the No Action Alternative. The number of passive and active sonobuoys would increase annually under Alternative 2 by approximately 200 percent more than Alternative 1. Approximately 1,507 sonobuoys would be deployed in the TMAA. Approximately 66 percent of the sonobuoys would be passive SSQ-53 DIFAR and an additional 8 percent would be passive SSQ-101 VLAD. About 17 percent of all sonobuoys would be active sonar emitters (SSQ-62 DICASS Active). Approximately 267 active (SSQ-62 DICASS) acoustic sonobuoys would be deployed in the TMAA annually and approximately 1,000 passive SSQ-53 Directional Frequency and Ranging (DIFAR) sonobuoys would be used in conjunction with the DICASS sonobuoys. Approximately 120 SSQ-77 Very Long Range Acoustic Detection (VLAD) passive sonobuoys would also be used under Alternative 2. Approximately 24 SUS MK-84 signaling devices would also be used under Alternative 2. Also under Alternative 2 would be the use of the EER system using approximately 80 SSQ-110 active and 80 passive SSQ-101 ADAR.

With regard to potential entanglement encounters between marine mammals and unrecovered sonobuoy and flare parachute assemblies expended during military activities, the entanglement effects would be potentially greater than those described for the No Action Alternative and Alternative 1 because of the greater number of sonobuoy and flare deployments (1,507 more sonobuoys than the No Action Alternative and 732 more sonobuoys than Alternative 1). With Alternative 2 unrecovered materials would sink; the amount remaining on or near the sea surface would be low, and the density of such military expended material would be double that resulting from Alternative 1 activities. Entanglement impacts to marine mammals from this and other military expended material are unlikely.

Expended sonobuoys are a potential ingestion hazard for marine mammals while they are floating, while they are descending to the seafloor, or after they sink to the bottom. However, the probability of ingestion is extremely low based on the number of sonobuoys expended (1,507) and the size of the TMAA. Sonobuoy ingestion under Alternative 2 may affect ESA-listed marine mammals. The use of passive sonobuoys is not expected to result in Level A or Level B harassment as defined by the MMPA. Acoustic effects of active sonobuoys and SUS MK-84 are addressed as part of the acoustic effects analysis. It is not likely that use of passive sonobuoys associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of passive sonobuoys during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

Critical Habitats

There is no designated critical habitat or PCEs within the TMAA. Therefore, in accordance with ESA consultation provisions to assess potential effects of proposed actions to critical habitat, it is concluded that Navy activities of Alternative 2 will have no effect on any critical habitat.

3.8.8 Mitigation

The Navy has implemented a comprehensive suite of mitigation measures that will serve to reduce impacts to marine mammals that might result from Navy training in the TMAA. The mitigation measures applicable to this Proposed Action are described in Section 5.1.7. In order to make the findings necessary to issue a LOA under the MMPA, it may be necessary for NMFS to require additional mitigation or monitoring measures beyond those addressed in this EIS/OEIS. These measures could include measures considered, but eliminated in this EIS/OEIS, or as yet undeveloped measures. The public will have an opportunity, through the MMPA process, both to provide information to NMFS in the comment period following NMFS' Notice of Receipt of the application for an LOA, and to review any additional mitigation or monitoring measures that NMFS might propose in the comment period at the proposed rule stage. The final suite of measures developed as a result of the MMPA process would be identified and analyzed in the Final EIS/OEIS.

Effective training in the TMAA dictates that ship, submarine, and aircraft participants utilize their sensors and exercise weapons to their optimum capabilities as required by the mission. Section 5.1.7 presents a comprehensive list of mitigation measures that would be utilized for training activities analyzed in this EIS/OEIS in order to minimize potential for impacts on marine mammals and sea turtles in the TMAA.

Section 5.1.7 includes mitigation measures that are followed for all types of exercises; those that are associated with a particular type of training event; and those that apply generally to all Navy training at sea. For major exercises, the applicable mitigation measures are incorporated into a naval message which is disseminated to all of the units participating in the exercise or training event and applicable responsible commands. Appropriate measures are also provided to non-Navy participants (other DoD and allied forces) as information in order to ensure their use by these participants.

The extensive set of protective measures avoids, minimizes, and reduces potential adverse effects of surface, air, and subsurface training and testing activities on marine mammals. In general the protective measures include:

- Training personnel (watchstanders) to detect and report the presence of marine mammals so that activities can be stopped or altered to prevent conflicts or injuries.
- Maneuvering to keep at least 1,500 ft (500 yds) away from any observed whale in the vessel's path and avoid approaching whales head-on. These requirements do not apply if a vessel's safety is threatened, such as when change of course will create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver.
- Taking all practicable steps to alert other vessels in the vicinity of an observed whale.
- Conducting pre-training site surveys for events involving ordnance in the water to detect and clear training areas of marine mammals that might be affected by activities before training activities are initiated.
- Reducing sound from sonar when marine mammals are detected in the vicinity of naval activities.
- Adjusting, delaying or moving activities when marine mammals are detected in the area.

- Maintaining protective buffer zones around ships and other vessels when marine mammals are detected within established safety zone distances of ships and sonar exercises.
- Maintaining marine mammal exclusion zones around areas that involve at-sea explosions.
- Coordinating with NMFS before, during, and after major training exercises and reporting incidents that may have involved marine mammals.

The effectiveness of these protective measures was considered in determining the impacts of the proposed alternatives to marine mammals.

Navy shipboard lookouts (also referred to as "watchstanders") are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the Officer of the Deck (e.g., trash, a periscope, marine mammals, sea turtles) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water. Navy lookouts undergo extensive training in order to qualify as a lookout. This training includes on-the-job instruction under the supervision of an experienced lookout, followed by completion of the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects).

The Navy also includes marine species awareness as part of its training for its bridge lookout personnel on ships and submarines. Lookouts are trained how to look for marine species, and report sightings to the Officer of the Deck so that action may be taken to avoid the marine species or adjust the exercise to minimize effects to the species. Marine Species Awareness Training (MSAT) was updated in 2006, and the additional training materials are now included as required training for Navy ship and submarine lookouts. This training addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information to aid in avoiding interactions with marine species. Additionally, all Commanding Officers and Executive Officers (CO/XOs) of units involved in training exercises are also required to review the marine species awareness training material.

3.8.1.2 Alternative Mitigation Measures Considered but Eliminated

As described in Section 3.8.6, the vast majority of estimated sound exposures of marine mammals during proposed active sonar activities would not cause injury. Potential acoustic effects on marine mammals would be further reduced by the mitigation measures described in Section 5.1.7. Therefore, the Navy concludes the Proposed Action and mitigation measures would achieve the least practical adverse impact on species or stocks of marine mammals.

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

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

- Use of ramp-up to attempt to clear the range prior to the conduct of exercises. Ramp-up procedures, (slowly increasing the sound in the water to necessary levels), are not a viable alternative for training exercises because the ramp-up would alert opponents to the participants' presence. This affects the realism of training in that the target submarine would be able to detect the searching unit prior to themselves being detected, enabling them to take evasive measures. This would insert a significant anomaly to the training, affecting its realism and effectiveness. Though ramp-up procedures have been used in testing, the procedure is not effective in training sailors to react to tactical situations, as it provides an unrealistic advantage by alerting the target. Using these procedures would not allow the Navy to conduct realistic training, thus adversely impacting the effectiveness of the military readiness activity.
- Visual monitoring using third-party observers from air or surface platforms, in addition to the existing Navy-trained lookouts.
    - The use of third-party observers would compromise security due to the requirement to provide advance notification of specific times/locations of Navy platforms.
    - Reliance on the availability of third-party personnel would also impact training flexibility, thus adversely affecting training effectiveness.
    - The presence of other aircraft in the vicinity of naval exercises would raise safety concerns for both the commercial observers and naval aircraft.
    - Use of Navy observers is the most effective means to ensure quick and effective implementation of mitigation measures if marine species are spotted. A critical skill set of effective Navy training is communication. Navy lookouts are trained to act swiftly and decisively to ensure that appropriate actions are taken.
    - Use of third-party observers is not necessary because Navy personnel are extensively trained in spotting items on or near the water surface. Navy spotters receive more hours of training, and use their spotting skills more frequently, than many third-party trained personnel.
    - Crew members participating in training activities involving aerial assets have been specifically trained to detect objects in the water. The crew's ability to sight from both surface and aerial platforms provides excellent survey capabilities using the Navy's existing exercise assets.
    - Security clearance issues would have to be overcome to allow non-Navy observers onboard exercise participants.
    - Some training events will span one or more 24-hour periods, with operations underway continuously in that timeframe. It is not feasible to maintain non-Navy surveillance of these activities, given the number of non-Navy observers that would be required onboard.
    - Surface ships having active mid-frequency sonar have limited berthing capacity. As exercise planning includes careful consideration of this limited capacity in the placement of exercise controllers, data collection personnel, and Afloat Training Group personnel on ships involved in the exercise. Inclusion of non-Navy observers onboard these ships would require that in some cases there would be no additional berthing space for essential Navy personnel required to fully evaluate and efficiently use the training opportunity to accomplish the exercise objectives.
    - Contiguous ASW events may cover many hundreds of square miles. The number of civilian ships and/or aircraft required to monitor the area of these events would be considerable. It is, thus, not feasible to survey or monitor the large exercise areas in the time required ensuring these areas are devoid of marine mammals. In addition, marine mammals may move into or

out of an area, if surveyed before an event, or an animal could move into an area after an exercise took place. Given that there are no adequate controls to account for these or other possibilities and there are no identified research objectives, there is no utility to performing either a before or an after the event survey of an exercise area.

- Survey during an event raises safety issues with multiple, slow civilian aircraft operating in the same airspace as military aircraft engaged in combat training activities. In addition, most of the training events take place far from land, limiting both the time available for civilian aircraft to be in the exercise area and presenting a concern should aircraft mechanical problems arise.
- Scheduling civilian vessels or aircraft to coincide with training events would impact training effectiveness, since exercise event timetables cannot be precisely fixed and are instead based on the free-flow development of tactical situations. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would slow the unceasing progress of the exercise and impact the effectiveness of the military readiness activity.
- Multiple simultaneous training events continue for extended periods. There are not enough qualified third-party personnel to accomplish the monitoring task.

- Reducing or securing power during the following conditions.
  - Low-visibility / night training: ASW can require a significant amount of time to develop the “tactical picture,” or an understanding of the battle space such as area searched or unsearched, identifying false contacts, understanding the water conditions, etc. Reducing or securing power in low-visibility conditions would affect a commander’s ability to develop this tactical picture and would not provide realistic training.
  - Strong surface duct: The complexity of ASW requires the most realistic training possible for the effectiveness and safety of the sailors. Reducing power in strong surface duct conditions would not provide this training realism because the unit would be operating differently than it would in a combat scenario, reducing training effectiveness and the crew’s ability. Additionally, water conditions may change rapidly, resulting in continually changing mitigation requirements, resulting in a focus on mitigation versus training.
- Vessel speed: Establish and implement a set vessel speed.
  - Navy personnel are required to use caution and operate at a slow, safe speed consistent with mission and safety. Ships and submarines need to be able to react to changing tactical situations in training as they would in actual combat. Placing arbitrary speed restrictions would not allow them to properly react to these situations, resulting in decreased training effectiveness and reduction the crew proficiency.
- Increasing power down and shut down zones:
  - The current power down zones of 457 and 914 m (500 and 1,000 yd), as well as the 183 m (200 yd) shut down zone were developed to minimize exposing marine mammals to sound levels that could cause TTS or PTS, levels that are supported by the scientific community. Implementation of the safety zones discussed above will prevent exposure to sound levels greater than 195 dB re 1µPa for animals sighted. The safety range the Navy has developed is also within a range sailors can realistically maintain situational awareness and achieve visually during most conditions at sea.
  - Although the three action alternatives were developed using marine mammal density data and areas believed to provide habitat features conducive to marine mammals, not all such areas could be avoided. ASW requires large areas of ocean space to provide realistic and

meaningful training to the sailors. These areas were considered to the maximum extent practicable while ensuring Navy's ability to properly train its forces in accordance with federal law. Avoiding any area that has the potential for marine mammal populations is impractical and would impact the effectiveness of the military readiness activity.

- Using active sonar with output levels as low as possible consistent with mission requirements and use of active sonar only when necessary.
  - Operators of sonar equipment are always cognizant of the environmental variables affecting sound propagation. In this regard, the sonar equipment power levels are always set consistent with mission requirements.
  - Active sonar is only used when required by the mission since it has the potential to alert opposing forces to the sonar platform's presence. Passive sonar and all other sensors are used in concert with active sonar to the maximum extent practicable when available and when required by the mission.

3.8.9 Summary of Effects

3.8.9.1 Endangered Species Act

The Navy is consulting with NMFS under Section 7 of the ESA regarding its determination of effect for federally-listed marine mammals and critical habitat. Table 3.8-18 provides a summary of the Navy's determination of acoustic effects for federally listed marine mammals that potentially occur in the TMAA. The analysis presented above indicates that all seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from Alternative 2 (Preferred Alternative) training activities. All species may be affected by exposures to sound from sonar and at-sea explosions.

This assessment focused on five aspects of the proposed Navy training events—ship traffic, use of active sonar, other non-sonar acoustic sources, aircraft overflights, expended materials, and at-sea explosions. Potential risks associated with sonars and other non-sonar acoustic sources that are likely to be employed during anti-submarine warfare exercises were assessed by treating the acoustic energy produced by those sources as a pollutant introduced into the ocean environment. The acoustic analyses evaluated the likelihood of listed species being exposed to sound pressure levels associated with active sonar and other non-sonar acoustic sources, which includes estimating the intensity, duration, and frequency of exposure. The analysis assumed that active sonar and other non-sonar acoustic sources posed no risk to listed species if they were not exposed to sound pressure levels exceeding established regulatory thresholds. The analyses also assumed that the potential consequences of exposure to sonar and other non-sonar acoustic sources on individual animals would be a function of the intensity (measured in both SPL in decibels and frequency), duration, and frequency of the animal's exposure to the mid- and high frequency sonar transmissions and to other acoustic sources.

Potential risks associated with at-sea explosions that are likely to be employed during BOMBEX, GUNEX, SINKEX, and use of SSQ-110 sonobuoys were assessed by treating the impulse energy produced by at-sea explosions as an energy force introduced into the ocean environment. The at-sea explosion analysis evaluated the likelihood of ESA listed species being exposed to sound pressure levels associated with at-sea explosions, which includes estimating the intensity, duration, and frequency of exposure. The analysis assumed that the energy from at-sea explosions posed no risk to marine mammal species if they were not exposed to sound or pressure levels from the detonations.

There are no critical habitats in the TMAA and Navy training activities will not destroy or adversely modify critical habitat. There are no primary constituent elements of critical habitat present in the TMAA. Therefore, in accordance with ESA consultation provisions to assess potential effects of Proposed Action to critical habitat, it is concluded that Navy activities will have no effect on any critical habitats.

3.8.9.2 Marine Mammal Protection Act

The analysis presented above indicates that several species of marine mammals could be exposed to impacts associated with at-sea explosions and explosive ordnance use under Alternative 2 that could result in Level A or Level B harassment as defined by MMPA provisions that are applicable to the Navy. Exposure estimates are provided in Tables 3.8-8, 3.8-9, 3.8-12. 3.8-13, and 3.8-16. Other stressors associated with Alternative 2 are not expected to result in MMPA Level A or Level B harassment. It is not likely that any of the proposed training activities would result in effects to the life functions of marine mammals in the TMAA. Accordingly, the Navy is working with NMFS through the MMPA permitting process to ensure compliance with the MMPA.

3.8.9.3 National Environmental Policy Act and Executive Order 12114

Table 3.8-19 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on marine mammals under both NEPA and EO 12114.

Table 3.8-18: Summary of the Navy's Determination of Effect for Federally Listed Marine Mammals That May Occur in the TMAA – Alternative 2 (Preferred Alternative)

Stressor	Blue Whale	Fin Whale	Humpback Whale	North Pacific Right Whale	Sei Whale	Sperm Whale	Steller Sea Lion
Vessel Movements							
Vessel Disturbance	MA	MA	MA	MA	MA	MA	MA
Vessel Collisions	MA	MA	MA	MA	MA	MA	MA
Aircraft Overflights							
Aircraft Disturbance	MA	MA	MA	MA	MA	MA	MA
Non-explosive Practice Ordnance							
Weapons Firing Disturbance	MA	MA	MA	MA	MA	MA	MA
Non-explosive Ordnance Strikes	MA	MA	MA	MA	MA	MA	MA
High Explosive Ordnance							
At-Sea Explosion	MA	MA	MA	MA	MA	MA	MA
Explosive Ordnance	MA	MA	MA	MA	MA	MA	MA
Active Sources							
Mid- and High-Frequency Sonar	MA	MA	MA	MA	MA	MA	MA
Non-Sonar Acoustic Sources	MA	MA	MA	MA	MA	MA	MA
Expended Materials							
Ordnance Related Materials	MA	MA	MA	MA	MA	MA	MA
Chaff	MA	MA	MA	MA	MA	MA	MA
MK-58 Marine Markers	MA	MA	MA	MA	MA	MA	MA
Target Related Materials	MA	MA	MA	MA	MA	MA	MA
Sonobuoys	MA	MA	MA	MA	MA	MA	MA

MA = May Affect; TMAA = Temporary Maritime Activities Area

Table 3.8-19: Summary of Effects of the Alternatives

Alternative and Stressor	NEPA (U.S. Territorial Seas, 0 to 12 nm)	Executive Order 12114 (Non-Territorial Seas, >12 nm)
No Action	• Aircraft overflights of U.S. Territorial Seas would occur at altitudes at or above 15,000 ft (915 m) and have no effect on marine mammals.	**Vessel Movements** • Short-term behavioral responses from general vessel disturbance possible. Potential for injury or mortality from vessel collisions but occurrence is very unlikely. **Aircraft Overflights** • Potential for short-term behavioral responses to low level overflights. No long-term population-level effects. **Non-explosive Practice Ordnance** • Extremely low probability of direct strikes. **At-Sea Explosions** • Behavioral effects modeling and accounting for rare species indicates 102 MMPA Level B harassments (80 from sub-TTS and 22 from TTS), one MMPA Level A harassment resulting from slight injury, and no exposures resulting in potential severe injury or mortality. Mitigation would reduce the number of these harassments. With implementation of mitigation measures, the MMPA Level A harassment should not occur. **Active Sonar** • Not applicable **Expended Materials** • Low potential for ingestion of expended materials. **ESA-Listed Species** • All seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from No Action Alternative training activities. All species may be affected by at-sea explosions.

Table 3.8-18: Summary of Effects of the Alternatives (continued)

Alternative and Stressor	NEPA (U.S. Territorial Seas, 0 to 12 nm)	Executive Order 12114 (Non-Territorial Seas, >12 nm)
Alternative 1	• Aircraft overflights of U.S. Territorial Seas would occur at altitudes at or above 15,000 ft (915 m) and have no effect on marine mammals.	**Vessel Movements** • Short-term behavioral responses from general vessel disturbance possible. Potential for injury or mortality from vessel collisions but occurrence is very unlikely. **Aircraft Overflights** • Potential for short-term behavioral responses to low level overflights. No long-term population-level effects. **Non-explosive Practice Ordnance** • Extremely **low probability of** direct strikes. **At-Sea Explosions** • Behavioral effects modeling and accounting for rare species indicates 137 MMPA Level B harassments (103 from sub-TTS and 34 from TTS), one MMPA Level A harassments from slight injury, and no exposures resulting in potential severe injury. Mitigation would reduce the number of these harassments. With implementation of mitigation measures, the one MMPA Level A harassments should not occur. **Active Sonar and Other Non-Sonar Acoustic Sources** • Behavioral effects modeling and accounting for rare species provided an estimate of zero exposures indicates 215,519 MMPA Level B harassments (215,053 from sub-TTS and 466 TTS) There is one predicted MMPA Level A harassment from PTS, but with implementation of mitigation measures, this MMPA Level A harassment should not occur. **Expended Materials** • Low potential for ingestion of expended materials. **ESA-Listed Species** • All seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from Alternative 1 training activities. All species may be affected by exposures to sound from sonar and at-sea explosions.

Table 3.8-18: Summary of Effects of the Alternatives (continued)

Alternative and Stressor	NEPA (U.S. Territorial Seas, 0 to 12 nm)	Executive Order 12114 (Non-U.S. Territorial Seas, >12 nm)
Alternative 2 (Preferred Alternative)	• Aircraft overflights of U.S. Territorial Seas would occur at altitudes at or above 15,000 ft (915 m) and have no effect on marine mammals.	**Vessel Movements** • Short-term behavioral responses from general vessel disturbance possible. Potential for injury or mortality from vessel collisions but occurrence is very unlikely. **Aircraft Overflights** • Potential for short-term behavioral responses to low level overflights. No long-term population-level effects. **Non-explosive Practice Ordnance** • Extremely low probability of direct strikes. **At-Sea Explosions** • Behavioral effects modeling and accounting for rare species indicates 240 MMPA Level B harassments (170 from sub-TTS and 70 from TTS), four MMPA Level A harassments, and one exposure resulting in potential severe injury or mortality. Mitigation would reduce the number of these harassments. With implementation of mitigation measures, the four MMPA Level A harassments and one severe injury should not occur. • Increase in at-sea explosions from SINKEX are offset by area clearance procedures. **Active Sonar and Other Non-Sonar Acoustic Sources** • Behavioral effects modeling and accounting for rare species indicates 425,551 MMPA Level B harassments (424,620 from sub-TTS and 931 from TTS). There is one predicted MMPA Level A harassment from PTS, but with implementation of mitigation measures, this MMPA Level A harassment should not occur. **Expended Materials** • Low potential for ingestion of expended materials. **ESA-Listed Species** • All seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from Alternative 2 training activities. All species may be affected by exposures to sound from sonar and at-sea explosions.

Notes: MAA = Temporary Maritime Activities Area, MMPA = Marine Mammal Protection Act, NEPA = National Environmental Protection Act, nm = nautical mile, PTS = Permanent Threshold Shift, SPL = Sound Pressure Level, TTS = Temporary Threshold Shift