REQUEST FOR LETTER OF AUTHORIZATION
FOR THE INCIDENTAL HARASSMENT OF MARINE MAMMALS
RESULTING FROM CONSTRUCTION OF AN AMMUNITION PIER AND TURNING BASIN AT
NAVAL WEAPONS STATION SEAL BEACH

Submitted to:

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ACRONYMS AND ABBREVIATIONS

dB	decibel(s)
dB re 1 μPA^2 @ 1 m	decibels referenced to one micropascal squared at 1 meter
DPS	Distinct Population Segment
EA	Environmental Assessment
ESA	Endangered Species Act
FR	Federal Register
ft.	foot/feet
HF	High Frequency
Hz	Hertz
ICMP	Integrated Comprehensive Monitoring Program
km	kilometer(s)
LF	Low Frequency
LMR	Living Marine Resources
LOA	Letter of Authorization
m	meter(s)
MF	Mid-Frequency
mi.	mile(s)
MMPA	Marine Mammal Protection Act
NAVWPNSTA	Naval Weapons Station
Navy	U.S. Department of the Navy
NEPA	National Environmental Policy Act
NM	nautical mile(s)
NMFS	National Marine Fisheries Service
NWR	National Wildlife Refuge
OA	Otariids in air
ONR	Office of Naval Research
OPNAV N45	Naval Operations Energy and Environmental Research
OW	Otariids in water
PA	Phocids in air
PCAD	Population Consequences of Acoustic Disturbance
PTS	permanent threshold shift
PW	Phocids in water
R&D	Research and Development
re 1 μPA	referenced to one micropascal
rms	root mean square
SEL	sound exposure level
SPL	sound pressure level
TSS	Traffic Separation Scheme
TTS	Temporary threshold shift
U.S.	United States
U.S.C.	United States Code
ZOI	Zone of Influence

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1 Introduction and Description of Proposed Action

Introduction and description of the Action and Action Area. The background, purpose of and need for the Action, and a description of the component(s) that may impact marine mammals in the Action Area.

1.1 Introduction

The United States (U.S.) Department of the Navy (Navy) has prepared this request for a Letter of Authorization (LOA) for the incidental taking of marine mammals during the construction of an ammunition pier and turning basin, and the potential demolition of the wharf primary fendering system at Naval Weapons Station (NAVWPNSTA) Seal Beach, California. The term "take," as defined in Section 3 (16 United States Code [U.S.C.] section 1362 (13)) of the Marine Mammal Protection Act (MMPA), means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The Navy is requesting a five-year LOA from 2020 through 2025 for the Proposed Action. The entire Proposed Action is expected to be completed over five to six years, with pile driving and extraction occurring in two Phases over two-and-a-half to three years. Under the MMPA of 1972 as amended (16 U.S.C. section 1371(a)(5)), the Secretary of Commerce shall allow, upon request, the incidental, but not intentional, taking of marine mammals by U.S. citizens who engage in a specified activity during periods of not more than five years, if certain findings are made and regulations are issued after notice and opportunity for public comment. The Secretary must find that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses. The regulations must set forth the permissible methods of taking, other means of effecting the least practicable adverse impact on the species or stock(s), and requirements pertaining to the monitoring and reporting of such taking.

The Navy has prepared a Final Environmental Assessment (EA) for the Ammunition Pier and Turning Basin at NAVWPNSTA Seal Beach in accordance with the National Environmental Policy Act (NEPA) as implemented by the Council on Environmental Quality regulations and Navy regulations for implementing the National Environmental Policy Act. Potential impacts of construction actions are described in detail in Section 2.3 (Alternatives Carried Forward for Analysis) of the Final EA.

Based on analysis presented in the Final EA, the Navy determined only pile driving and extraction has the potential to affect marine mammals possibly present within the Anaheim Bay portion of the Action Area and rise to Level B harassment under the MMPA. The Navy has determined no aspect of the Proposed Action would have the potential to result in Level A harassment or mortality. Section 1.4 (Proposed Action) of this application describes the proposed activities possibly resulting in Level B harassment under the MMPA.

This document has been prepared in accordance with the applicable regulations of the MMPA and its implementing regulations. The request for a LOA is based on (1) the analysis of spatial and temporal occurrence of marine mammals in the Action Area, (2) the review of construction activities that have the potential to incidentally take marine mammals, and (3) a technical risk assessment to determine the likelihood of effects.

1.2 Background

NAVWPNSTA Seal Beach was commissioned in 1944 as a Naval Ammunition and Net Depot. Most base infrastructure was built in the 1940s and 1950s. Anaheim Bay was created by this initial construction. The station's wharf was originally built in 1944 and rebuilt in 1953. The NAVWPNSTA was constructed in response to the need for ammunition depots during World War II. In 1962, the facility was designated as a U.S. NAVWPNSTA (U.S. Department of the Navy, 2013a).

NAVWPNSTA Seal Beach is the U.S. Pacific Fleet's primary weapons station on the West Coast of the United States and is located in the city of Seal Beach, in Southern California, along the Pacific Ocean (Figure 1-1). As such, NAVWPNSTA Seal Beach has three primary missions: storage of Navy and Marine Corps ammunition, missile systems maintenance, and loading and unloading of Navy warships based out of Naval Base San Diego and larger Coast Guard vessels at the wharf in Anaheim Bay. An increase in the number of Navy ships on the West Coast is anticipated due to a rebalancing of naval forces from the Atlantic to the Pacific theatre. By 2020, approximately 60 percent of U.S. naval forces will be based in the Pacific, up from 40 percent a decade earlier. NAVWPNSTA Seal Beach services a majority of the Pacific Fleet, with the next-nearest weapons station port located over 1,000 miles (mi.) from Naval Base San Diego. Using that alternate weapons station would cost the Fleet time, money, and energy, and increase impacts to air and water quality due to the increase in emissions caused by travel from San Diego to the other station.

The existing wharf at NAVWPNSTA Seal Beach is over 65 years old, past its design life, and was constructed prior to the introduction of modern seismic codes. Seismic design deficiencies are of significant concern due to the proximity to active faults and high liquefaction potential of underlying soils. The current condition and configuration of the existing wharf and turning basin limits the size and number of ships that can be loaded and unloaded with ammunition at the same time. The current waterfront configuration of the wharf presents safety and security concerns due to the proximity of naval munitions operations to civilian small boat traffic and Pacific Coast Highway.

Figure 1-1: Regional Map

1.3 Overview of the Purpose and Need

The purpose of the Proposed Action is to sustain and enhance mission capability by eliminating deficiencies associated with the condition, configuration, and capacity of the existing wharf and turning basin at NAVWPNSTA Seal Beach.

The Proposed Action is needed because the existing wharf is past its design life and limits NAVWPNSTA Seal Beach's ability to fully meet its assigned mission. Specifically, the Proposed Action is needed because:

- The existing wharf was built before the introduction of modern seismic (earthquake) codes. In a major earthquake, underlying soils may not support the wharf structure, and the wharf could collapse.
- The existing wharf and turning basin are too small to support large general-purpose amphibious assault ships such as Landing Helicopter, Assault (LHA) and Landing Helicopter, Docks (LHD)-type vessels. Currently, these vessels must be loaded with ammunition at high cost, using helicopters offshore of Marine Corps Base Camp Pendleton.
- The existing wharf is too small to support the loading of more than one medium (destroyer-sized) ship at a time. This limits the station's ability to support the Pacific Fleet as it grows and may impede the Navy's ability to quickly send a large number of ships overseas during a crisis.
- The existing wharf is adjacent to the only civilian public navigation channel between Huntington Harbour and the ocean. This presents serious security challenges for the Navy and leads to regular bay closures, which impact civilian boaters.

1.4 Proposed Action

Overall, the Navy proposes to construct an approximately 1,100 feet (ft.) by 125 ft. pile-supported Ammunition Pier with associated waterfront facilities (Figure 1-2). The entire Proposed Action would include potential upgrades to the existing wharf to remain operational while the new pier is being built, the construction of a breakwater to reduce wave heights at the pier, a causeway, pile-supported mooring dolphins, a navigation channel for public boat access into and out of Huntington Harbour, dredging for the pier and Navy ship turning basin, and operational support buildings on and near the pier. The potential demolition of existing facilities and the wharf primary fendering system would also occur after construction of the new pier and involve cutting the piles at the mudline using either a plasma torch or a diamond wire saw. Suitable dredge material from Anaheim Bay, or other suitable material, if necessary, would be used for fill to create a causeway (a raised road) and a truck turnaround area.

The Proposed Action would be completed in two different phases. A critically important feature of Phase 1, with regard to the extent of underwater acoustic effects, is the construction of a breakwater perpendicular to the entrance channel as one of the first steps in the Proposed Action. An acoustic modeling study of Anaheim Bay and the proposed pile driving activities in Dahl (2018) concluded that subsequent construction and pile-driving-related underwater noise would be blocked from propagating through the entrance channel or otherwise extending beyond Anaheim Bay by that breakwater. The remainder of Phase 1 would consist of potential upgrades to the existing wharf to allow for continued operation while the new pier is under construction, dredging of the turning basin and navigation channel for public access, removal of existing navigation aids, fill of mitigation areas, partial fill of the causeway, creation of a breakwater and jetties for the navigation channel for public access, relocation of barge mooring buoys, installation of a new floating security barrier, placement of new Navy navigation buoys, implementation of an indicator pile program to determine feasibility of concrete piles, and, potentially, partial construction of a new ammunition pier with concrete pile supports at NAVWPNSTA Seal Beach.

Phase 2 would consist of fill to expand the east mole for the truck turnaround, completion of causeway fill, installation of remaining pier structural and support piles, construction of the new pier and fender system, construction of waterfront facilities, installation of utilities, and demolition of the wharf primary fendering system. The total duration of the Proposed Action is estimated to be approximately five to six years (2020 through 2026). However, the LOA application is being submitted for pile driving and extraction activities during Phase 1 and 2 (2020–2025).

Although the Proposed Action includes several activities, the Navy has determined that the only activities that have the potential to affect marine mammals that may be present within the Action Area and rise to the level of Level B harassment under the MMPA are pile driving and extraction. Those activities are described in more detail in the sections below and include pile installation as potential upgrades to the existing wharf, removal of existing navigation piles, installation of mooring anchors, and installation of piles required for the new ammunition pier. As noted above, these actions would occur after the new breakwater has been built. The new breakwater, which would be centered on and perpendicular to the Anaheim Bay entrance channel, would block construction-related underwater noise from exiting Anaheim Bay (Dahl, 2018). Section 2.3 (Alternatives Carried Forward for Analysis) of the Final EA has a description of the entire Proposed Action. See Table 1-1 for a descrption of all pile types and sizes for the entire Proposed Action.

1.4.1 Upgrades to Existing Wharf

To maintain use of the current wharf during construction of the new pier, the Navy may need to modify the existing wharf to allow access for larger ships. In the event that wharf upgrades are necessary, twelve steel pipe piles (48-inch diameter) would be installed on land. Because these steel pipe piles would be driven on land, they would not impact marine mammals and are not considered further in this LOA.

1.4.1.1 Demolition

Existing waterfront supporting facilities (Waterfront Field Office, Waterfront Operations Locker/Break Room, Operational Storage, and Waterfront Operations Trailer) no longer required to support ordnance operations would be demolished. However, the Navy may retain the existing wharf for possible future ordnance contingency operations. If the wharf primary fendering system is to be demolished, it would be left in service until the new ammunition pier is constructed. If demolition does occur, the method for removing the wharf primary fendering system would include cutting the piles at the mudline using either a plasma torch or a diamond wire saw at the mudline. The primary fendering system consists of approximately 84 concrete piles that are 24 inches in diameter.

1.4.2 Removal of Existing Navigation Piles

The navigation piles that currently guide public vessel traffic would require removal under the Proposed Action. The existing navigation piles are 24 inches in diameter and consist of two timber pile clusters (dolphins) of approximately 8 to 10 piles per cluster as well as three single steel pipe piles (Table 1-1). Removal of these navigation piles would likely entail a combination of divers to cut the piles at mudline and a barge/derrick to recover the pieces and haul them away. Pile cutting may involve a plasma torch or diamond wire saw. Additionally, it may be necessary, to use vibratory extraction to remove the navigation piles as well.

In the event that vibratory extraction is required, a vibratory hammer attached to the pile head could be used to extract piles by applying a rapidly alternating force to the pile by rotating eccentric weights about shafts, resulting in an upward vibratory force on the pile. The vertical vibration in the pile disturbs or "liquefies" the sediment next to the pile, causing the sediment particles to lose their frictional grip on the pile. This also allows sediment to fill back into the hole that is left after the pile is removed. A more detailed description of construction activities is presented in the Final EA.

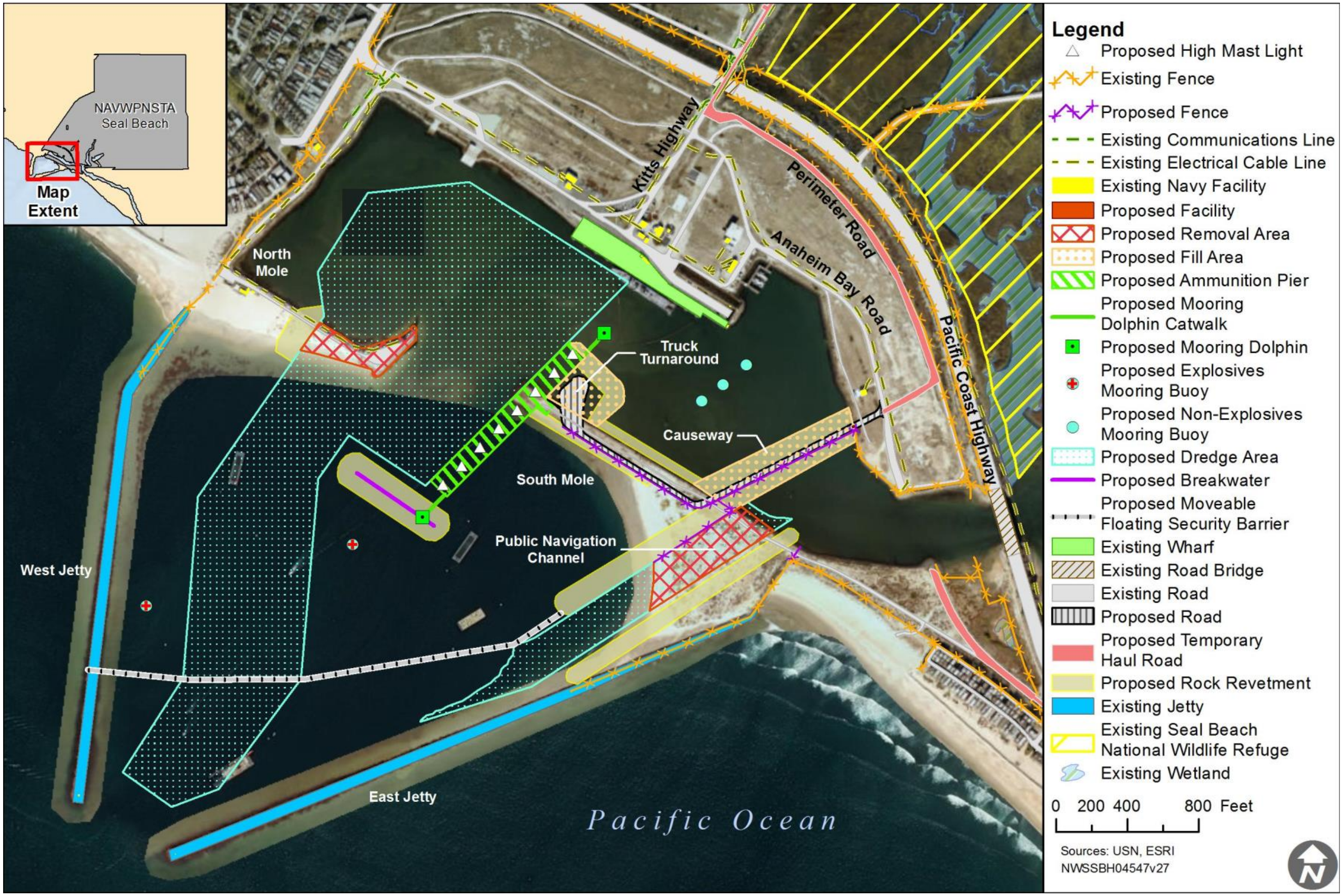

Figure 1-2: Action Area

Given that the planned removal of the existing navigation piles would occur after the new breakwater has been installed, all underwater noise associated with the removal activities would be confined to Anaheim Bay.

1.4.3 Indicator Pile Program and Construction of New Pier

The Indicator Pile Program would facilitate two major elements of the overall project. It would validate the length of pile required and the method of installation (vibratory and impact).

The indicator pile program involves the following activities:

- Near the beginning of the project, there would be 15–24-inch octagonal pier piles driven in non-production locations. Each pile typically takes 1 day to drive. After 72 hours the pile is re-struck.
- Two 24-inch square fender indicator piles would be driven in their production pile locations.
- Therefore, there is a total of 17 indicator piles (see Table 1-1), the majority of which would be accomplished near the beginning of the project (to allow the casting of the proper lengths and hammer settings).

The purpose of the indicator piles is to verify the driving conditions and establish the final driving lengths prior to fabrication of the final production piles that would be used to construct the new pier. Upon completion of the program, the 15 piles in non-production locations would be cut off near the mudline, and the two fender piles would remain in place to be used as part of the fender system for the new pier.

The new ammunition pier would be located at the end of the south mole (Figure 1-2). Use of concrete piles rather than creosote wood pilings would be consistent with Navy policy and is preferred by the Regional Water Quality Control Board, because, unlike creosote pilings, these materials would not introduce polycyclic aromatic hydrocarbons into Anaheim Bay. The fender system for the new pier would include foam-filled fenders at the berths and plastic log camels.

The pier would consist of a pile supported system with a total of 898 piles (concrete and concrete filled fiberglass) of various sizes connected to a cast-in-place concrete deck and beams. The new pier would consist of approximately 728 octagonal concrete piles (24 inches), 119 square concrete piles (24 inches), and 53 concrete-filled fiberglass piles (16 inches). The piles would be spaced 20 ft. by 20 ft., except within the mole region, which would have a spacing of 8 ft. by 8 ft., 8 ft. by 10 ft., or 10 ft. by 10 ft. on center. Two mooring dolphins with aluminum catwalks for access would also be constructed. Pier grounding would be achieved by driving copper clad ground rods 30 ft. into the mud below the pier along the front and back edges of the pier, approximately 100 ft. apart from each other.

Under this LOA, the Navy is assuming all of the approximately 898 piles required for the new pier would be driven in some capacity. The majority would likely be jetted to within 5–10 ft. of tip elevation and then driven via impact hammering for the remainder. The impact hammer is a large metal ram attached to a crane. A vertical support holds the pile in place and the ram is dropped or forced downward. The energy is then transferred to the pile which is driven into the seabed. The ram is typically lifted by a diesel power source. Some piles, including all of the fender piles, may also be pre-drilled for a portion of the pile length.

Sound from pile driving and extraction activities associated with the new pier and mole would be blocked by the new breakwater and therefore not be present underwater outside of Anaheim Bay (Dahl, 2018).

1.4.4 New Mooring Buoys and Anchors

There will be a total of five new moorings installed with two of those moorings outside of the new breakwater (Figure 1-3). The plate anchors for the mooring buoys consist of a steel plate that is driven to project depth (30–40 feet) beneath the harbor's seafloor (Figure 1-4). The anchor is driven by use of a 12-inch steel beam called a "follower." The follower is slotted on the bottom, fits into the plate anchor, and together the assembly consisting of the plate anchor and follower are driven into the harbor floor. Once the assembly has been driven to the required depth using a combination of hammer and vibratory driving, the follower is removed using vibratory extraction, leaving the plate anchor at the required depth. Upon successful pull testing of the anchor, the installation of the plate anchor is complete. As planned and once the equipment is on site, this sequence of events and maximum estimated installation time involved would be as follows:

1. The plate anchor is driven with a vibratory hammer to within several feet of final depth (up to a maximum of approximately 45 minutes).
2. An impact hammer is used to drive the plate anchor to final elevation (up to a maximum of approximately 45 minutes).
3. The follower is extracted with vibratory hammer (up to a maximum of 30 minutes).
4. A pull test is performed to set the anchor and check capacity, thus completing the installation.

Figure 1-3: Proposed Locations of New Mooring Buoys in Anaheim Bay

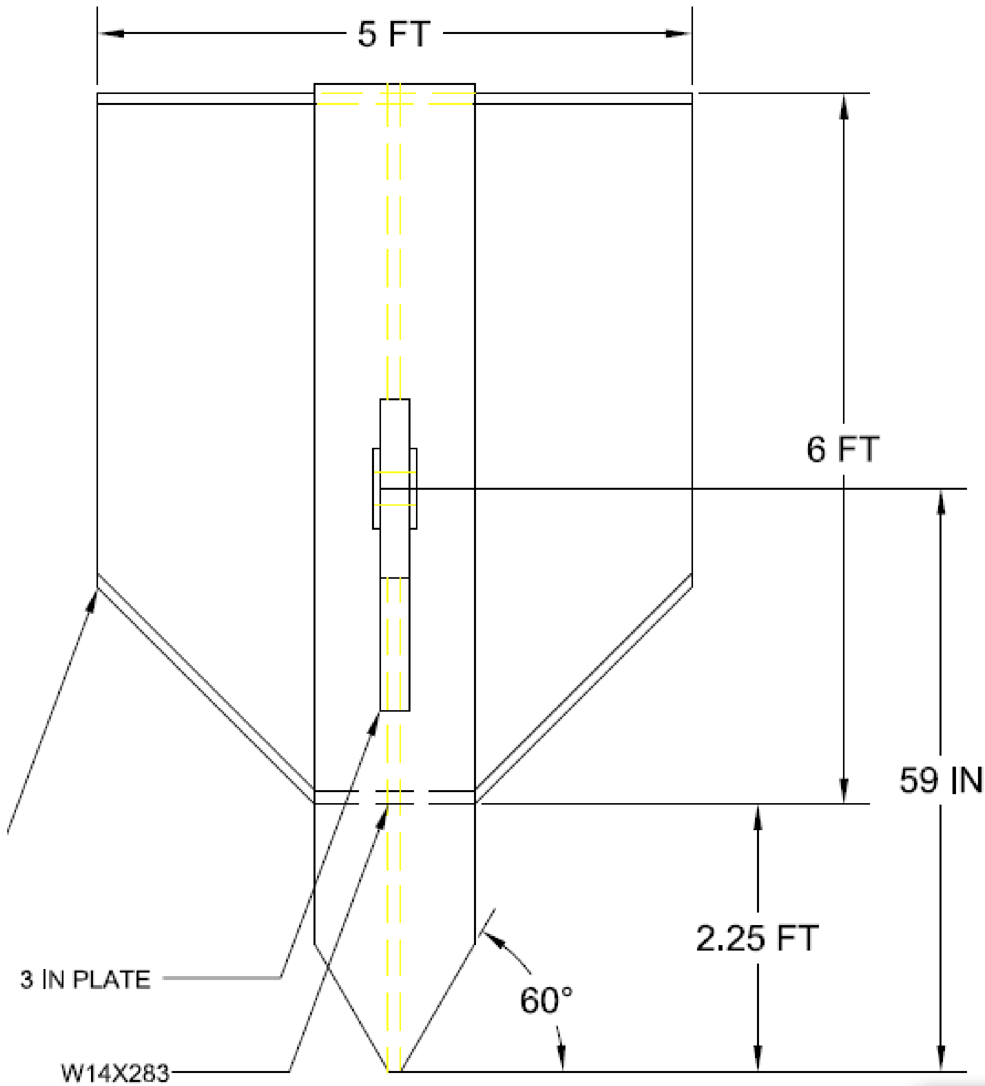

Figure 1-4: Plan View of a Plate Anchor

For each of the two plate anchors that will be installed in front of the new breakwater, it is anticipated that the conservative maximum total time for driving/extraction would be approximately 1 hour and 15 minutes of vibratory hammer operation and less than 30 minutes of active impact hammer operation for a total of 2 hours for each plate anchor. The two plate anchors for mooring locations OSCAR 4 and OSCAR 8 would be the only pile driving/extraction locations with the potential to have a sound field that exceeds the MMPA regulatory threshold for behavioral harassment from vibratory driving/extraction (120 decibels [dB] Sound Pressure Level [SPL] referenced to 1 micropascal [re 1 µPa]) outside of the jetties forming Anaheim Bay. Additional discussion is found in Section 6.3.3 (Impacts on Marine Mammals).

1.4.5 Pile Installation/Extraction Summary

Table 1-1 summarizes the in-water types, sizes, and number of piles scheduled to be installed or removed during the timeframe covered by this LOA application.

Table 1-1: Summary of Piles to be Installed and Removed

Project Description	Pile Type	Size (inches)	Number	Method
Pile Installation				
Indicator Pile Program	Concrete octagonal	24	15	Impact
Indicator Pile Program	Concrete square	24	2	Impact
New Pier	Concrete octagonal	24	728	Impact
New Pier	Concrete square	24	119	Impact
New Pier	Concrete filled fiberglass	16	53	Impact
New Mooring Buoys (seaward of new breakwater: OSCAR 4 & OSCAR 8 locations)	Steel I-beam follower	12	2*	Impact/Vibratory
New Mooring Buoys (landward of south mole: Echo location)	Steel I-beam follower	12	3*	Impact/Vibratory
Total piles installed			**922**	
Pile Extraction/Removal				
Existing Wharf (if demolition necessary)	Concrete	24	84	Cutting
Exisiting Navigation Piles	Steel pipe	24	3	Cutting/Vibratory
Exisiting Navigation Piles	Timber	24	20	Cutting/Vibratory
Indicator Pile Program	Concrete octagonal	24	15	Cutting
New Mooring Buoys (seaward of new breakwater: OSCAR 4 & OSCAR 8 locations)	Steel I-beam follower	12	2*	Vibratory
New Mooring Buoys (landward of south mole: Echo location)	Steel I-beam follower	12	3*	Vibratory
Total piles removed			**127**	
Total piles removed with vibratory methods			**28**	

*Used to drive the anchor plate under the sediment, and removed after installation of the anchor plate.

Pile driving and any extraction activities would be conducted in the Action Area between January 2020 through 2025, without limitations on time of year or season. Pile driving and extraction activity would only occur from Monday through Friday during typical working hours (7:00 a.m. to 4:00 p.m. or 7:00 p.m. depending on the time of year [only during daylight hours]). Pile driving and extraction activities would not take place on weekends or federal holidays, unless unforeseen circumstances have caused a significant delay in the project requiring that construction be accelerated to maintain the project schedule. The Navy estimates that all construction activities would be conducted within the five-year timeframe of the LOA. Pile driving would be completed over a two-and-a-half to three-year period that is not necessarily consecutive over a total five-year period, and any extraction/removal for the existing wharf fendering system would be completed within two years after the construction of the new pier during the five year authorization of the LOA. Removal of the existing wharf fendering system would consist of cutting the existing piles (84 in total) at the mudline. The specific region where pile driving and extraction would occur within Anaheim Bay is shown on Figure 1-2 as the Proposed Ammunition Pier and the existing wharf.

2 Dates, Duration, and Specified Geographic Region

The date(s) and duration of the Proposed Action and the specific geographical region where it would occur.

2.1 Dates and Duration of Activities

The overall duration of the entire project would be close to six years for all activities from contractor notice to proceed to demobilization with pile driving and removal activities occurring between 2020 and 2025. Dredging of the channels and placement of much of the rock (including the breakwater) would occur for the first two years with pile driving and pier construction occurring after those activities. In total, Navy assumes all pile driving/extraction activities would occur within a five-year period.

2.1.1 Pile Driving and Extraction

The analysis assumes that pile driving installation tempo would be at three piles per day and take approximately 308 days to drive approximately 922 piles. For pile extraction/removal for the navigation piles and potential demolition of the wharf primary fendering system, the analysis assumes a tempo of one pile per day of approximately 28 piles. The removal of the existing wharf piles (if necessary) would occur after the completion of the new ammunition pier. Driving and extraction for installation of the two new mooring anchors seaward of the new breakwater should total no more than two days and three days for the three new mooring anchors that will be placed behind the east mole. Therefore, it is assumed that there will be 308 days of pile installation and 28 days of extraction for a total of 336 days of in-water pile driving.

An indicator pile program would be implemented at the beginning of the pier construction project. An indicator pile program is a test program that helps establish pile-driving criteria, such as casting of proper pile lengths and hammer settings for the installation of the production piles. The program would include a total of 17 piles (24 in.): 15 octagonal pier piles would be driven into test locations, and another two square fender piles would be driven in their proposed pile locations. Each pile would take approximately one day to drive. Upon completion of the program, the indicator piles would be cut off near the mudline, and the fender piles would remain in place to be used as part of the fender system.

As planned, the new ammunition pier would consist of a concrete pile-supported system with approximately 900 piles connected to a cast-in-place concrete deck and beams. All piles required for the new pier would be in the water. The piles would include seven hundred and twenty-eight 24-inch (in.) octagonal concrete piles, one hundred and nineteen 24 in. square concrete piles, and fifty-three 16 in. concrete filled fiberglass piles. Piles for the new pier would be spaced 20 ft. by 20 ft., except within the mole region, which would have a spacing of 8 ft. by 8 ft., 8 ft. by 10 ft., or 10 ft. by 10 ft. on center. Piles would be initially driven using a jetting system and then hammer driven for final placement. Jetting uses a tube in the middle of the pile with a connection to a compressor that forces water to the tip. Jetting the piles would last several hours for each pile. Approximately three piles would be driven per day (five days a week) over the course of three years (over the five-year LOA authorization period). For the construction of the new ammunition pier, indicator pile program, and mooring anchors, the analysis assumes that approximately 922 piles would be driven with a pile driving tempo of three piles per day over 308 working days.

For existing navigation piles the analysis assumes worst case scenario (as cutting is the preferred method) of vibratory removal of one pile per day over twenty days for the existing 24-inch timber piles and three additional days for vibratory removal of three steel-pipe piles (24-inch). Vibratory extraction would be expected to take approximately 15–30 minutes per pile, however, a conservative 60 minute duration was used in calculating the zone of influence (ZOI) for removal of navigation piles.

2.2 Description of Project Area

An acoustic ZOI (Chapter 6, Take Estimates for Marine Mammals) further defines the area within Anaheim Bay that would be affected by underwater sound from pile driving and extraction. With the exception of the entrance channel, Anaheim Bay is completely enclosed by rip rap and land. Existing pile extraction would occur within Anaheim Bay near the east mole and pile driving would occur at the existing wharf location and at the new Proposed Ammunition Pier location. All pile driving and extraction would occur after the new breakwater has been constructed, except for two anchor plates for the new mooring bouys.

Characteristics of the bay may influence sound propagation and its general confinement to the bay, including the relatively narrow channel entrance with rock jetties on both sides of the outer bay, the shallow depth of the bay, and soft bottom substrate into which the piles are driven or extracted. The depth of the bay channel varies from 33 to 35 ft., and an approximately 1,300 m long channel spans the distance from the entrance jetties (outer Anaheim Bay) to the existing dock (inner Anaheim bay). The bay floor is composed of soft sand and mud alluvial sediments, which are not conducive to transmission of sound in comparison to other substrates. Based on results shown in Chapter 6 (Take Estimates for Marine Mammals), the acoustic modeling of sound propagation from the proposed pile driving at Seal Beach (Dahl, 2018), and the intensity of the sound producing commercial, industrial, and recreational activity occurring outside Anaheim Bay (McKenna et al., 2012; McKenna et al., 2013), underwater sound levels propagating from pile driving and extraction activities are expected to have negligible effects (if any) on marine mammals outside of Anaheim Bay. Further discussion of this is presented in Chapter 6 (Take Estimates for Marine Mammals).

2.2.1 Ambient Noise and Vessel Traffic

Ambient noise by definition is background noise and has no single source or point (Urick, 1983). Ambient noise varies with location, season, time of day, and frequency. Ambient noise is continuous, but with much variability on time scales ranging from less than 1 second to 1 year (McKenna et al., 2016; Richardson et al., 1995). Ambient underwater noise in an outside of Anaheim Bay is variable throughout the day tied with sunrise and sunset, largely because of anthropogenic noise associated with the adjacent marinas, the ports of Los Angeles/Long Beach, and offshore petroleum extraction platform.

The Ports of Long Beach and Los Angeles are within 5 nautical miles (NM) of Anaheim Bay (Figure 2-1). In 2016, for the Ports of Los Angeles and Long Beach, there were over 8,400 ship transits of the waters offshore in that one-year period. This port complex is the sixth-busiest container port in the world and ship noise is pervasive with daily patterns of ship noise having two temporal peaks (early morning and evening) (Hildebrand et al., 2012; McKenna et al., 2013). These ship departure and arrival times correspond to the likely construction timeframes given both are aimed at making use of daylight hours. For container ships and commercial ships transiting to and from the Ports of Los Angeles and Long Beach, estimated source levels from the vessels range from 177 dB to 194 dB re 1 μPa^2 @ 1 m (20−1,000 Hertz [Hz]) (McKenna et al., 2013). This is consistent with measurements and modeling at various locations subject to commercial vessel traffic (Bassett et al., 2012; Erbe et al., 2012; Erbe et al., 2014; Jones et al., 2017; McKenna et al., 2012; McKenna et al., 2013; Pine et al., 2016). Given that the waters off Anaheim Bay are subject to the sixth busiest commercial vessel traffic in the world, ambient sound outside of Anaheim Bay should be dominated by vessel noise. In addition to the broadband noise from commercial vessels and pleasure craft out of the adjacent Alamitos Bay Marina, underwater noise from operation of *Platform Esther* (approximately 1.4 kilometers [km] straight out from the Anaheim Bay channel) would also likely contribute to potential masking of any sound that may propagate from pier construction within Anaheim Bay.

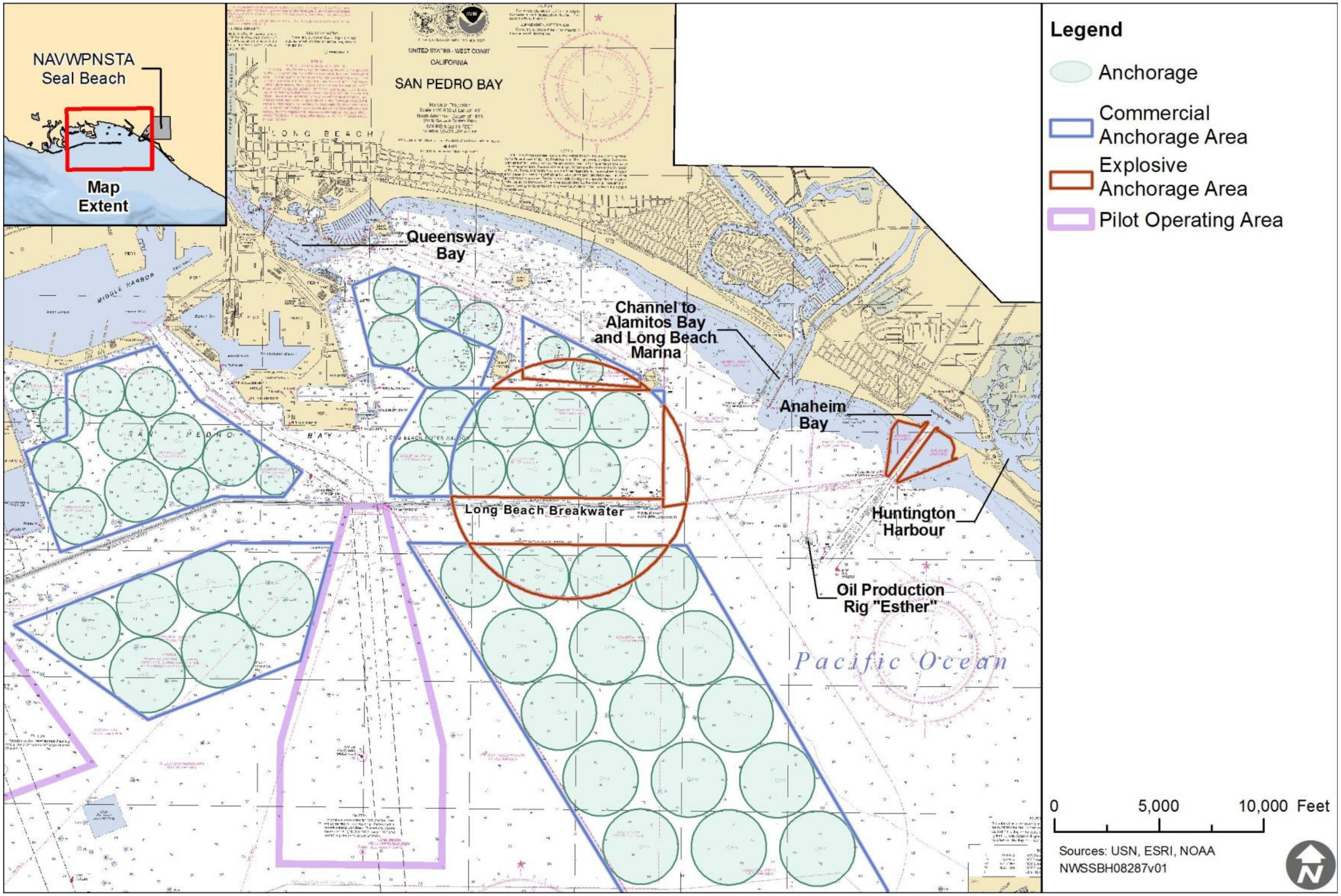

Figure 2-1: Commercial, Industrial, and Recreational Areas Outside of Anaheim Bay

3 Species and Numbers of Marine Mammals

The species and abundance of marine mammals likely to be found within the Action Area.

Since underwater noise resulting from construction activities would be confined to Anaheim Bay or otherwise masked by other ambient anthropogenic noise as presented in Section 6.2.2 (Ambient Noise), only those marine mammals likely to be present within Anaheim Bay have a potential to be impacted by the Proposed Action. Six marine mammal species may be occasionally present within Anaheim Bay based on survey observations and the habitat preferences of these species: common dolphin (long and short beaked common dolphins [*Delphinus capensis* and *Delphinus delphis*]), common bottlenose dolphin (*Tursiops truncatus*, hereafter referred to as "bottlenose dolphin"), California sea lion (*Zalophus californianus*), harbor seal (*Phoca vitulina*), and gray whale (*Eschrichtius robustus*) (Bredvik et al., 2017. Unpublished Data; Merkel & Associates Inc., 2019). These species and the stocks to which they belong are managed by the National Marine Fisheries Service (NMFS). Abundance estimates and occurrence information for these species are presented in Table 3-1. Surveys undertaken to document marine mammal sightings in and around Anaheim Bay from August 2016 to January 2017, and in 2019 during maintenance dredging activities have been used to derive the estimated species occurrence and number of individuals present in the action area (Bredvik et al., 2017. Unpublished Data; Merkel & Associates Inc., 2019). In a broader context for each species and stock present in the waters off Seal Beach, relevant information on their status, distribution, population trends, and ecology is presented in Chapter 4 (Affected Species Status and Distribution) and incorporates the best available science in addition to the analyses provided in the most recent U.S. Pacific and Alaska Marine Mammal Stock Assessments (Carretta et al., 2017b; Carretta et al., 2018; Muto et al., 2017), which cover those marine mammal stocks present in the waters offshore of Seal Beach.

Sound from pile driving and extraction is not expected to travel outside of Anaheim Bay at levels exceeding the masking of ambient anthropogenic noise. As detailed in modeling of the proposed activities (Dahl, 2018), the bay is almost completely surrounded by rip rap, the entrance to the bay consists of relatively narrow rock jetties on both sides of the channel angled inward, the maximum depth of the bay is relatively shallow (varies from 33 to 35 ft.), and the bottom substrate consists of soft alluvial sediment and sand that absorbs sound and is less likely than harder substrates to reflect or transmit sound outside of the jetties.

As detailed in (Calambokidis et al., 2015), gray whales (Eastern North Pacific stock and Western North Pacific stock) seasonally migrate through southern California waters. Navy does not expect any possible presence of Western North Pacific gray whales to overlap in time and space with any activities associated with the Proposed Action because according to NMFS, only about 18 individual Western North Pacific gray whales out of approximately 21,000 migrating whales may seasonally migrate through Southern California waters (National Marine Fisheries Service, 2014). However, it is possible that a migrating Eastern North Pacific gray whale might enter Anaheim Bay, albiet such occurrence would likely be a rare event.

Additional marine mammal species that could potentially occur in Southern California waters outside of the Anaheim Bay Action Area include humpback whale (*Megaptera novaeangliae*; Mexico and Central America Distinct Population Segments), blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), Guadalupe fur seal

(*Arctocephalus townsendi*), sea otter (*Enhydra lutris neris*), Bryde's whale (*Balaenoptera brydei/edeni*), minke whale (*Balaenoptera acutorostrata*), killer whale (*Orcinus orca*), short-finned pilot whale (*Globicephala macrorhynchus*), striped dolphin (*Stenella coeruleoalba*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), northern right whale dolphin (*Lissodelphis borealis*), Risso's dolphin (*Grampus griseus*), northern fur seal (*Callorhinus ursinus*), and northern elephant seal (*Mirounga angustirostris*). These species are not expected to be present and exposed to or affected by any project activities occurring in Anaheim Bay, and have been excluded from subsequent analysis.

Table 3-1: Marine Mammals within the Action Area

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance (CV)/min[4]	Occurrence in Action Area[5]
Common Dolphin	*Delphinus spp.*	Long-beaked = California Short-beaked= California, Oregon, and Washington	N/A	Long-beaked = 101,305 (0.49)/68,432 Short-beaked = 969,861 (0.17)/839,325	Observed individuals and groups ranging from two to nine animals 31 times during the daily dredge monitoring of Anaheim Bay in from March to June 2019. Two individuals were observed once during U.S. Navy monthly surveys of Anaheim Bay in 2016.
Bottlenose Dolphin	*Tursiops truncatus*	California coastal	N/A	323 (0.13)/290	Observed groups of two individuals four times during U.S. Navy monthly surveys of Anaheim Bay in 2016. Observed groups of between two and ten individuals 17 times during the daily dredge monitoring of Anaheim Bay from March to June 2019.
California Sea Lion	*Zalophus californianus*	United States	N/A	296,750 n/a/153,337	Most frequently observed marine mammal in the waters of Anaheim Bay Action Area. Observed one to three individuals 24 times during U.S. Navy monthly surveys of Anaheim Bay in 2016. Observed between one and six individuals 67 times during the daily dredge monitoring of Anaheim Bay from March to June 2019. There are no known or observed haul outs in Anaheim Bay.
Pacific Harbor Seal	*Phoca vitulina richardsii*	California	N/A	30,968 n/a/27,348	Observed single individuals four times during U.S. Navy monthly surveys of Anaheim Bay in 2016. Observed single harbor seals three time during the daily dredge monitoring of Anaheim Bay from March to June 2019. There are no known or observed haul outs in Anaheim Bay.

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance (CV)/min[4]	Occurrence in Action Area[5]
Gray Whale	*Eschrichtius robustus*	Eastern North Pacific	N/A	26,960 (0.05)/25,849	Observed single individuals four times during daily monitoring for maintenance dredging of Anaheim Bay from March to June 2019. No gray whales were observed during the monthly 2016 survey effort.

[1]Taxonomy follows (Committee on Taxonomy, 2015).

[2]Stock designations for the U.S. Exclusive Economic Zones are from the Pacific Stock Assessment Report prepared by National Marine Fisheries Service (Carretta et al., 2017b).

[3]Populations or stocks defined by the MMPA as “strategic” because: the level of direct human-caused mortality exceeds the potential biological removal level; or, based on the best available scientific information, are declining and are likely to be listed as a threatened species under the ESA within the foreseeable future; or are listed as a threatened or endangered species under the ESA; or are designated as depleted under the MMPA.

[4]Stock Abundance, Coefficient of variation (CV), and minimum population (min) are numbers provided by the Stock Assessment Reports (Carretta et al., 2017b). The stock abundance is an estimate of the number of animals within the stock. The CV is a statistical metric used as an indicator of the uncertainty in the abundance estimate. The minimum population estimate is either a direct count (e.g., pinnipeds on land) or the lower 20th percentile of a statistical abundance estimate.

[5] Action Area is shown in Figure 1-2 and includes the proposed ammunition pier where pile driving would occur, dredge area for turning basin, and public navigation channel.

Notes: CV = coefficient of variation, DPS = Distinct Population Segment, ESA = Endangered Species Act, MMPA = Marine Mammal Protection Act, N/A = not applicable, NWR = National Wildlife Refuge, U.S. = United States

4 Affected Species Status and Distribution

A description of the status, distribution, and population trends of species or stocks of marine mammals likely to be affected by the proposed activities.

There are six marine mammal species, two of which are discussed as one group the common dolphin (*Delphinus spp*.), bottlenose dolphin (*Tursiops truncatus*), California sea lion (*Zalophus californianus*), Pacific harbor seal (*Phoca vitulina*), and the gray whale (*Eschrichtius robustus*) that are known to occur in sufficient proximity to the Action Area and that are likely or have the potential to be affected by project activities. Relevant information on their status, distribution, and population trends is presented in this chapter, as well as additional information about the numbers of these marine mammals likely to be found within the Action Area. The Navy began monthly surveys of the Seal Beach Study Area in 2016, and used the daily dredge monitoring reports from 2019 to determine the abundance and distribution of marine mammals in the area (Bredvik et al., 2017. Unpublished Data; Merkel & Associates Inc., 2019). Information on the general biology and ecology of marine mammals is beyond the scope of this application and can be found in the following sources: Berta et al. (2006); Hoelzel (2002); Jefferson et al. (2015); Reynolds and Rommel (1999); Rice (1998); and Twiss and Reeves (1999). In addition, the NMFS annually publishes stock assessment reports for all marine mammals in U.S. Exclusive Economic Zone waters, including stocks that may occur within the Action Area (Allen & Angliss, 2014; Carretta et al., 2012; Carretta et al., 2014; Carretta et al., 2016b; Carretta et al., 2017b).

4.1 Common Dolphin (*Delphinus spp.*)

4.1.1 Long-beaked Common Dolphin (*Delphinus capensis*)

4.1.1.1 Habitat and Geographic Range

The long-beaked common dolphin primarily occur inshore of the 250 meter isobath in waters relatively close to shore (Carretta et al., 2017b; Jefferson & Van Waerebeek, 2002; Perrin, 2008), apparently preferring shallower and warmer water than the short-beaked common dolphin (Becker et al., 2016a; Perrin, 2008). This species is found off Southern California year-round, but it may be more abundant there during the warm-water months (May to October) (Barlow & Forney, 2007; Douglas et al., 2014; Henderson et al., 2014; Heyning & Perrin, 1994). Stranding data and sighting records suggest that this species' abundance fluctuates seasonally and from year-to-year off California (Carretta et al., 2011; Douglas et al., 2014; Henderson et al., 2014). Southern California waters represent the northern limit to this species' range and the seasonal and inter-annual changes in abundance off California are assumed to reflect the shifts in the movements of animals between U.S. and Mexican waters (Carretta et al., 2016c). Monitoring has encountered small cetaceans identified as "common dolphin" in Anaheim Bay on a number of occasions in association with dredging activities and Navy survey efforts (Bredvik et al., 2017. Unpublished Data; Merkel & Associates Inc., 2019).

4.1.1.2 Population Trends

There appears to be an increasing trend in the abundance of long-beaked common dolphin in Southern California waters over the last 30 years (Carretta et al., 2016c; Jefferson et al., 2014b).

4.1.1.3 Species-Specific Threats

Long-beaked common dolphins are particularly susceptible to fisheries interactions. From 2011-2015, the total estimated bycatch from the California gillnet fishery was an estimated 9.5 long-beaked common dolphins (Carretta et al., 2016a; Carretta et al., 2017a). Additionally, along California's coast mortality has been documented due to domoic acid toxicity, which is a neurotoxin associated with algal blooms (Carretta et al., 2015a).

4.1.2 Short-beaked Common Dolphin (*Delphinus delphis*)

4.1.2.1 Habitat and Geographic Range

Historically along the U.S. West Coast, short-beaked common dolphins were sighted primarily south of Point Conception (Dohl et al., 1983), but now they are commonly encountered as far north as 42° N (Hamilton et al., 2009a), and occasionally as far north as 48° N (Forney, 2007). Seasonal distribution shifts are pronounced, with a significant southerly shift south of Point Arguello in the winter (Becker et al., 2014; Becker et al., 2016b; Campbell et al., 2014; Forney & Barlow, 1998b; Forney et al., 2012; Henderson et al., 2014). . Short-beaked common dolphins are generally distributed between the coast and waters out to at least 300 NM from shore (Barlow & Forney, 2007; Barlow, 2016; Carretta et al., 2017b; Forney & Barlow, 1998b). Monitoring has encountered small cetaceans identified as "common dolphin" in Anaheim Bay on a number of occasions in association with dredging activities and Navy survey efforts (Bredvik et al., 2017. Unpublished Data; Merkel & Associates Inc., 2019). Based on multiple line-transect studies conducted by NMFS, the short-beaked common dolphin is the most abundant cetacean species off Southern California (Barlow & Forney, 2007; Barlow, 2016; Campbell et al., 2014; Carretta et al., 2011; Douglas et al., 2014; Forney et al., 1995; Jefferson et al., 2014a).

4.1.2.2 Population Trends

Short-beaked common dolphin abundance off California has increased dramatically since the late 1970s, along with a smaller decrease in abundance in the eastern tropical Pacific, suggesting a large-scale northward shift in the distribution of this species in the eastern North Pacific (Carretta et al., 2016c; Forney et al., 1995; Forney & Barlow, 1998b). Based on an analysis of sighting data collected during quarterly surveys off Southern California from 2004 to 2013, short-beaked common dolphins showed annual variations in density, but there was no significant trend evident during the period of study (Campbell et al., 2014) or as a result of any other data (Carretta et al., 2016c). However, (Barlow, 2016) noted a nearly monotonic increase in the abundance of short-beaked common dolphins from 1991 to 2014 off the U.S. West Coast, and suggested that a future trend analysis is appropriate.

4.1.2.3 Species-Specific Threats

Short-beaked common dolphins are particularly susceptible to fisheries interactions and entanglement. From 2007 to 2011, there were 20 known short-beaked common dolphin deaths attributed to human-related causes along the U.S. West Coast (primarily gillnet fishery entanglement; (Carretta et al., 2013). Between 2010 and 2014, there were 24 observed fishery-related mortalities to short-beaked common dolphins along the U.S. West Coast (Carretta et al., 2016a).

4.2 Bottlenose Dolphin (*Tursiops truncatus*)

4.2.1 Status and Management

The bottlenose dolphin is protected under the MMPA and is not listed under the Endangered Species Act (ESA). For the MMPA stock assessment reports, bottlenose dolphins within the Pacific U.S. Exclusive Economic Zone are divided into seven stocks: (1) Kauai and Niihau; (2) Oahu; (3) the 4-Island Region; (4) Hawaii Island; (5) the Hawaii Pelagic stock; (6) California Coastal stock; and (7) the California, Oregon and Washington Offshore stock (Carretta et al., 2017b).

4.2.2 Habitat and Geographic Range

Bottlenose dolphins typically are found in coastal and continental shelf waters of tropical and temperate regions of the world (Jefferson et al., 2008; Wells & Scott, 2009). Bottlenose dolphins are known to occur year-round in both coastal and off-shore waters of Monterey Bay, Santa Monica Bay, San Diego Bay, and San Clemente Island, California (Bearzi, 2005a; Bearzi et al., 2009; Carretta et al., 2016b; Carretta et al., 2017b; Henkel & Harvey, 2008; Maldini-Feinholz, 1996).

During surveys off California, off-shore bottlenose dolphins were generally found at distances greater than 1.9 mi. from the coast and throughout the waters of Southern California (Barlow & Forney, 2007; Bearzi et al., 2009; Hamilton et al., 2009b). Sighting records off California and Baja California suggest a continuous distribution of off-shore bottlenose dolphins in these regions (Mangels & Gerrodette, 1994). Analyses of sighting data collected during winter aerial surveys in 1991–1992 and summer shipboard surveys in 1991 indicated no significant seasonal shifts in distribution (Forney & Barlow, 1998a). Based on habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. West Coast, off-shore bottlenose dolphins exhibit a disjunctive longitudinal distribution, suggesting that there may be two separate populations in this area, although additional genetic data are required for confirmation (Becker et al., 2016b).

California coastal bottlenose dolphins are found within about 0.6 mi. of shore, generally from Point Conception to as far south as San Quintin, Mexico (Carretta et al., 1998; Defran & Weller, 1999; Hwang et al., 2014). Bottlenose dolphins also have been consistently sighted off central California and as far north as San Francisco since the 1982–1983 El Niño, when they apparently traveled further north tracking prey due to the northern extent of warmer waters and continued using those more northern waters after that El Niño had ended (Hwang et al., 2014). Off Southern California, animals are found within 500 m of the shoreline 99 percent of the time and within 250 m of the shoreline 90 percent of the time (Hanson & Defran, 1993; Hwang et al., 2014). The dolphins in the nearshore waters of San Diego, California, differ somewhat from other coastal populations of this species in distribution, site fidelity, and school size (Bearzi, 2005a, 2005b; Carretta et al., 2016b; Carretta et al., 2017b; Defran & Weller, 1999; Defran et al., 2015). Photo identification analyses suggest that there may be two separate stocks of coastal bottlenose dolphins that exhibit limited integration, a California Coastal stock and a Northern Baja California stock (Defran et al., 2015), but this is not yet reflected in the Pacific Stock Assessment Report (Carretta et al., 2017b). The results from relatively contemporaneous surveys at Ensenada, San Diego, Santa Monica Bay, and Santa Barbara between 1996 and 2001 provided samples of the speed and distances individual coastal bottlenose dolphins routinely traveled, from a sample size of 246 animals (Hwang et al., 2014). The minimum travel speed observed was 53 km per day and the maximum was 95 km per day, while the total distances traveled between points was between 104 km and 965 km (Hwang et al., 2014).

Bottlenose dolphins have been sighted several times within Anaheim Bay and the Seal Beach National Wildlife Refuge (Kirk Gilligan; Refuge Manager; Seal Beach National Wildlife Refuge, 2016). During the 2016–2017 surveys of Anaheim Bay, there were five sightings of bottlenose dolphins and one sighting of an unidentified dolphin species, which was most likely a bottlenose dolphin (Bredvik et al., 2017. Unpublished Data). Three of the six sightings were inside Anaheim Bay, the other three sightings were beyond the mouth of the bay. Monitoring associated with dredging in the spring of 2019 also idenitified bottlenose dolphins within Anaheim Bay on a number of occasions (Merkel & Associates Inc., 2019). It is therefore likely that bottlenose dolphins may be present in Anaheim Bay during the proposed construction activities.

4.2.3 Population Trends

The California Coastal stock bottlenose dolphin population size has remained stable over the period for which data is available (Carretta et al., 2016b; Carretta et al., 2017b; Dudzik et al., 2006). For the California, Oregon, and Washington Offshore stock, there has been no trend analysis for the population (Carretta et al., 2017b).

4.3 California Sea Lion (*Zalophus californianus*)

4.3.1 Status and Management

The California sea lion is protected under the MMPA and is not listed under the ESA. The California sea lion is managed by NMFS as the designated U.S. Stock (Carretta et al., 2017b).

4.3.2 Habitat and Geographic Range

The California sea lion occurs in the eastern north Pacific from Puerto Vallarta, Mexico, through the Gulf of California and north along the West Coast of North America to the Gulf of Alaska (Barlow et al., 2008; Jefferson et al., 2008; Maniscalco et al., 2004). Typically, during the summer, California sea lions congregate near rookery islands and specific open-water areas. The primary rookeries off the coast of the United States are on San Nicolas, San Miguel, Santa Barbara, and San Clemente Islands (Carretta et al., 2000; Le Boeuf & Bonnell, 1980; Lowry et al., 1992; Lowry & Forney, 2005). Haulout sites are also found on Santa Catalina Island in the Southern California Bight (Le Boeuf, 2002), which is approximately 50 km from Seal Beach and is the closest haulout site to the action area. This species is prone to invade human-modified coastal sites that provide good hauling substrate, such as marinas, buoys, bait barges, and rip-rap tidal control structures.

In the nonbreeding season, beginning in late summer, adult and subadult males migrate northward along the coast of California to Washington and return south the following spring (Lowry & Forney, 2005). Females and juveniles also disperse somewhat, but tend to stay in the Southern California area, although north and west of the Channel Islands (Thomas et al., 2010). California sea lions from the West Coast of the Baja California peninsula also migrate to Southern California during the fall and winter (Lowry & Forney, 2005) and sea lions from San Clemente Island tend to remain in Southern California (Melin, 2015). There is a general distribution shift northwest in fall and southeast during winter and spring, probably in response to changes in prey availability (Carretta et al., 2010).

California sea lions can be found in California open ocean and coastal waters (Barlow et al., 2008; Jefferson et al., 2008; Lander et al., 2010). California sea lions are usually found in waters over the continental shelf and slope; however, they are also known to occupy locations far offshore in deep, oceanic waters, such as Guadalupe Island, Alijos Rocks off Baja California (Jefferson et al., 2008; Melin et al., 2008; Urrutia & Dziendzielewski, 2012; Zavala-Gonzalez & Mellink, 2000). California sea lions are the most frequently sighted pinnipeds offshore of Southern California during the spring, and peak abundance is during the May through August breeding season (Green et al., 1992; Keiper et al., 2005).

Tagged California sea lions from Monterey Bay and San Nicolas Island, California demonstrated that adult males can travel more than 450 km from shore during longer foraging bouts (Weise et al., 2006; Weise et al., 2010); however, rehabilitated females and subadults normally stay mostly within 65 km of the coast (Thomas et al., 2010). Most individuals stay within 50 km of the rookery islands during the breeding season (Melin & DeLong, 2000). Females breeding and pupping on the Channel Islands typically feed over the continental shelf and generally remain within 150 km north and west of the islands (Kuhn & Costa, 2014; Melin & DeLong, 2000; Melin et al., 2008; Melin et al., 2012). Tagging results showed that lactating females foraging along the coast would travel as far north as Monterey Bay and offshore to the 1,000 m depth (Henkel & Harvey, 2008; Kuhn & Costa, 2014; Melin & DeLong, 2000; Melin et al., 2008). During the nonbreeding season, most locations of occurrence are over the slope or offshore; during the breeding season, most locations of occurrence are over the continental shelf (Melin & DeLong, 2000; Melin et al., 2008). Lowry and Forney (2005) estimated that 47 percent of sea lions would potentially be at-sea during the cold seasons.

Dive durations range from 1.4 to 5.0 minutes with longer dives during El Niño events; surface intervals range from 0.7 to 17.0 minutes with sea lions diving about 32–47 percent of the time at sea (Feldkamp et al., 1989; Kuhn & Costa, 2014; Melin et al., 2008; Melin et al., 2012). Adult females alternate between nursing their pup on shore and foraging at sea, spending approximately 67–77 percent of time at sea (Kuhn & Costa, 2014; Melin & DeLong, 2000).

The California sea lion is the most-often sighted marine mammal species within Anaheim Bay and the Seal Beach National Wildlife Refuge (Kirk Gilligan; Refuge Manager; Seal Beach National Wildlife Refuge, 2016). Individual sea lions may also occasionally haul out on the rock jetties or other areas within the Seal Beach Action Area, but have not been observed hauling out frequently.

This species was sighted at least once in Anaheim Bay during almost every survey in the 2016–2017 effort with 28 sightings (Bredvik et al., 2017. Unpublished Data). All sightings of the California sea lion were in water. Monitoring associated with dredging in the spring of 2019 also routinely encountered California sea lions within Anaheim Bay (Merkel & Associates Inc., 2019).

4.3.3 Population Trends

The California sea lion is the most abundant pinniped along the California coast. Overall, the California sea lion population is abundant and generally increasing (Carretta et al., 2010; Jefferson et al., 2008).

In spite of the robustness of the overall species population, the abundance of California sea lions has declined over the last decade in Mexican waters in the Gulf of California, (Urrutia & Dziendzielewski, 2012).

4.4 Harbor Seal (*Phoca vitulina*)

4.4.1 Status and Management

The harbor seal is protected under the MMPA and is not listed under the ESA. Harbor seals are distributed in temperate to cold water regions in the North Pacific. The Society of Marine Mammalogy's Committee on Taxonomy (2015) has determined that all harbor seals in the North Pacific should be recognized as a single subspecies (*Phoca vitulina richardii*) until the subspecies limits of various populations are better known. There are six stocks of harbor seal along the U.S. West Coast, with the California stock occurring in the Action Area.

4.4.2 Habitat and Geographic Range

The harbor seal is one of the most widely distributed seals, found in nearly all temperate coastal waters of the northern hemisphere (Jefferson et al., 2008). Harbor seals are generally not present in the open ocean.

Harbor seals, while primarily aquatic, also use the coastal terrestrial environment, where they haul out of the water periodically. Harbor seals are a coastal species, rarely found more than 12.4 mi. (20 km) from shore, and frequently occupying bays, estuaries, and inlets (Baird, 2001). Individual seals have been observed several kilometers upstream in coastal rivers (Baird, 2001). Harbor seals are not considered migratory (Burns, 2009; Jefferson et al., 2008).

Ideal harbor seal habitat includes suitable haulout sites, shelter from high surf during the breeding periods, and sufficient food near haulout sites to sustain the population throughout the year (Bjorge, 2002). Haulout sites vary, but include intertidal and subtidal rock outcrops, sandbars, sandy beaches, estuaries, mudflats, and even peat banks in salt marshes (Burns, 2009; Gilbert & Guldager, 1998; Prescott, 1982; Schneider & Payne, 1983; Wilson, 1978).

In California, approximately 400 to 600 harbor seal haulout sites are widely distributed along the mainland and on off-shore islands (Lowry et al., 2008). The harbor seal haulout sites include all of the Channel Islands, including Santa Barbara, Santa Catalina, and San Nicolas Islands (Lowry et al., 2008). Although individuals have also been observed hauled out and foraging in the nearshore waters of the Seal Beach Action Area, the nearest designated haulout site for this species is approximately 50 km from Seal Beach at Santa Catalina Island. A total of 15 harbor seals were sighted off the coast during 18 aerial surveys conducted between 2008 and 2013 in the Southern California waters south of Santa Catalina Island (Jefferson et al., 2014a).

Harbor seals are likely to occur within the Seal Beach Action Area and are the second-most sighted marine mammal species after sea lions.

During surveys in 2016 and 2017, there were three in-water sightings of harbor seals in Anaheim Bay (Bredvik et al., 2017. Unpublished Data). Monitoring associated with dredging in the spring of 2019 also encountered harbor seals once within Anaheim Bay (Merkel & Associates Inc., 2019).

4.4.3 Population Trends

A 2015 survey of California harbor seal rookeries resulted in the highest recorded pup count since 1975 (Carretta et al., 2015b). In the short term, this trend may be affected by the pinniped Unusual Mortality Event that has been ongoing on the U.S. West Coast since 2013.

4.5 Gray Whale (*Eschrichtius robustus*)

4.5.1 Status and Management

The gray whale is protected under the MMPA. In 1994, due to steady increases in population abundance, the Eastern North Pacific stock of gray whales was removed from listing under the ESA. There are two stocks of gray whale along the U.S. West Coast, with the Eastern North Pacific stock potentially occurring in the Action Area.

4.5.2 Habitat and Geographic Range

Gray whales of the Eastern North Pacific stock primarily occur in shallow waters over the continental shelf of North America and Mexico and are considered to be one of the most coastal of the great whales (Jefferson et al., 2008; Jones & Swartz, 2009). Feeding grounds are generally less than 225 ft. deep (Jones & Swartz, 2009) and the main feeding areas are located in the Chukchi Sea, Bering Sea, Gulf of Alaska, the Pacific Northwest, and Northern California. The main breeding grounds consist of subtropical lagoons in Baja California, Mexico (Jones & Swartz, 2009; Urban-Ramirez et al., 2003). Gray whales migrate along the Pacific coast twice a year between October and July (Calambokidis et al., 2015) and would only potentially be present within the Action Area while migrating through those waters. Although they generally remain mostly over the shelf during migration, some gray whales may be found in more off-shore waters to the west of San Clemente Island and the Channel Islands further to the North (Calambokidis et al., 2015; Smultea & Jefferson, 2014; Sumich & Show, 2011).

Gray whales are not likely to occur within the Seal Beach Action Area. During surveys in 2016 and 2017, there were no sightings of gray whales in Anaheim Bay (Bredvik et al., 2017. Unpublished Data). Monitoring associated with dredging in March of 2019 encountered one gray whale within Anaheim Bay (Merkel & Associates Inc., 2019).

4.5.3 Population Trends

The Eastern North Pacific stock has continued to increase at rate of approximately 3.3% per year on average, with the most recent estimate of abundance being 26,960 individuals. Gray whales can occur near the mouth of Anaheim Bay, and infrequently enter the bay (Merkel & Associates Inc., 2019). However, their occurrence in Anaheim Bay is sporadic and unpredictable.

5 Type of Incidental Take Authorization Requested

The type of incidental take authorization that is being requested (i.e., takes by harassment only; takes by harassment, injury, and/or death) and the method of incidental taking.

In this application, the U.S. Navy requests one five-year LOA for the take of marine mammals incidental to the Proposed Action in the NAVWPNSTA Seal Beach Action Area for the period from January 2020 through 2025. The term "take," as defined in Section 3 (16 U.S.C. section 1362 (13)) 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 disturbance).

The Final EA considered all construction activities proposed that have the potential to result in the MMPA defined take of marine mammals. The Navy determined that impact hammering and vibratory pile driving and any extraction of concrete and wooden piles associated with pier construction could potentially result in the incidental taking by Level B harassment of six marine mammal species in the Action Area. The proposed activities are not anticipated to result in Level A harassment.

5.1 Incidental Take Request for Pile Driving and Extraction

A detailed analysis of effects on marine mammal exposures from pile driving and extraction in the Action Area is presented in Chapter 6 (Take Estimates for Marine Mammals). The data used for this analysis are from two different survey efforts, a monthly survey from 2016 to 2017 (Bredvik et al., 2017. Unpublished Data) and daily surveys from March to June 2019 (Merkel & Associates Inc., 2019). Prior to 2016, dedicated marine mammal surveys have not been conducted in the area; only opportunistic sightings during other monitoring or survey studies had occurred. However, there were too few sightings between these two monitoring efforts to calculate marine mammal densities.that could be classified as Level B harassment under MMPA. The Navy's mitigation procedures, presented in Section 11 (Mitigation Measures to Protect Marine Mammals and Their Habitat), include monitoring of mitigation zones prior to the initiation of pile driving. The Navy believes that these mitigation measures will be effective in avoiding marine mammal exposures to sound levels that would constitute Level A harassment.

Table 5-1 summarizes the Navy's final take request for pile driving and extraction by species per year and over the five-year authorization. Installation and extraction of all piles required for the project would be completed within the five-year timeframe allotted in the authorization. The estimated takes account for a conservative scenario where all of the activities would occur in a short, concentrated amount of time.

This analysis predicts 4,054 exposures (see Chapter 6, Take Estimates for Marine Mammals) from pile installation and removal activities that could be classified as Level B harassment under MMPA. The Navy's mitigation procedures, presented in Section 11 (Mitigation Measures to Protect Marine Mammals and Their Habitat), include monitoring of mitigation zones prior to the initiation of pile driving. The Navy believes that these mitigation measures will be effective in avoiding marine mammal exposures to sound levels that would constitute Level A harassment.

Table 5-1: Species-Specific Take Requests from Effects for Pile Driving and Extraction

Species	Stock	Number of Takes per Year			Total Over the 5-Year Authorization		
		Level B	Level A	Mortality	Level B	Level A	Mortality
Common dolphin	Long-beaked = California Short-beaked= California, Oregon, and Washington	336	0	0	1,008	0	0
Bottlenose dolphin	California coastal	224	0	0	672	0	0
California sea lion	U.S. Stock	672	0	0	2,016	0	0
Harbor seal	California	112	0	0	336	0	0
Gray whale	Eastern North Pacific	7	0	0	22	0	0
Total	-	**1,351**	**0**	**0**	**4,054**	**0**	**0**

Note: Assumes annual takes over a concentrated three year period of construction, see Section 6.3.3.2 (Estimated Effects to Marine Mammals in Anaheim Bay from Pile Driving and Extraction) for details on calculations.

6 Take Estimates for Marine Mammals

Derivation of take estimates for Level B harassment takes in the Action Area.

6.1 Estimated Take of Marine Mammals by Pile Driving and Extraction

The NMFS application for a LOA requires applicants to determine the number of marine mammals that are expected to be incidentally harassed by an action and the nature of the harassment (Level A or Level B). Section 5 defines MMPA Level A and Level B and the sections below present how these definitions were relied on to develop the quantitative acoustic analysis methodologies used to assess the potential for the Proposed Action to affect marine mammals.

The project construction and operation, as outlined in Sections 1 and 2, have the potential to take marine mammals by harassment only, through construction activities involving in-water pile driving and extraction. Other activities are not expected to result in take as defined under the MMPA.

In-water pile driving and extraction would temporarily increase the local underwater noise environment in the Action Area. Research suggests that increased noise may impact marine mammals in several ways and depends on many factors. The method for estimating the number and types of take is described in the sections below, beginning with presentation of the criteria used for each type of take followed by the method for quantifying exposures of marine mammals to sources of energy exceeding those threshold values.

Given the current state of the science regarding marine mammals in the Action Area, there is no known method to determine or predict the age, sex, or reproductive condition of the various species of marine mammals predicted to be taken as a result of the project. There are six marine mammal species that may occur in the Action Area, and these species are managed by NMFS, as presented in Table 3-1.

The two common dolphin species (long-beaked and short-beaked common dolphins) are difficult to distinguish during surveys and monitoring. Given the overlap of the two species in nearshore waters, the Navy assumed the reported common dolphin sightings in Anaheim Bay (Bredvik et al., 2017. Unpublished Data; Merkel & Associates Inc., 2019) could be either long-beaked or short-beaked common dolphins. Therefore, the request for take of long-beaked and short-beaked common dolphins in this application area combined as common dolphin species (*Delphinus* spp.).

6.1.1 Conceptual Framework for Assessing Effects from Sound-Producing Activities

This conceptual framework describes the different types of effects that are possible and the potential relationships between sound stimuli and long-term consequences for the individual and population. The conceptual framework is central to the assessment of acoustic-related effects and is consulted multiple times throughout the process. It describes potential effects and the pathways by which an acoustic stimulus or sound-producing activity can potentially affect animals. The conceptual framework qualitatively describes costs to the animal (e.g., expended energy or missed feeding opportunity) that may be associated with specific reactions. Finally, the conceptual framework outlines the conditions that may lead to long-term consequences for the individual and population if the animal cannot fully recover from the short-term effects.

An animal is considered "exposed" to a sound if the received sound level at the animal's location is above the background ambient noise level within a similar frequency band. A variety of effects may result from exposure to sound-producing activities. The severity of these effects can vary greatly between minor effects that have no real cost to the animal, to more severe effects that may have lasting consequences. Whether a marine animal is significantly affected must be determined from the best available scientific data regarding the potential physiological and behavioral responses to sound-producing activities and the possible costs and long-term consequences of those responses.

The major categories of potential effects are:

- Direct trauma
- Auditory fatigue
- Auditory masking
- Physiological stress
- Behavioral reactions

Direct trauma refers to injury to organs or tissues of an animal as a direct result of an intense sound wave or shock wave impinging upon or passing through its body. Potential impacts on an animal's internal tissues and organs are assessed by considering the characteristics of the exposure and the response characteristics of the tissues. Trauma can be mild and fully recoverable, with no long-term repercussions to the individual or population, or more severe, with the potential for lasting effects or, in some cases, mortality.

Auditory fatigue may result from over-stimulation of the delicate hair cells and tissues within the auditory system. The most familiar effect of auditory fatigue is hearing loss, also called a noise-induced threshold shift, meaning an increase in the hearing threshold. This can be described as not being able to hear your complete sound range for one to two hours after exposure.

Audible natural and artificial sounds can potentially result in auditory masking, a condition that occurs when noise interferes with an animal's ability to hear other sounds. Masking occurs when the perception of a sound is interfered with by a second sound, and the probability of masking increases as the two sounds increase in similarity and the masking sound increases in level. It is important to distinguish auditory fatigue, which persists after the sound exposure, from masking, which only occurs during the sound exposure.

Marine animals naturally experience physiological stress as part of their normal life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with conspecifics (members of the same species), and interactions with predators all contribute to the stress a marine animal naturally experiences. The physiological response to a stressor, often termed the stress response, is an adaptive process that helps an animal cope with changing external and internal environmental conditions. However, too much of a stress response can be harmful to an animal, resulting in physiological dysfunction. In some cases, naturally occurring stressors can have profound impacts on animals. Sound-producing activities have the potential to provide additional stress, which must be considered, not only for its direct impact on an animal's behavior but also for contributing to an animal's chronic stress level.

A sound-producing activity can cause a variety of behavioral reactions in animals ranging from very minor and brief, to more severe reactions such as aggression or prolonged flight. The acoustic stimuli can cause a stress reaction (i.e., startle or annoyance); they may act as a cue to an animal that has experienced a stress reaction in the past to similar sounds or activities, or that acquired a learned behavioral response to the sounds from conspecifics. An animal may choose to deal with these stimuli or ignore them based on the severity of the stress response, the animal's past experience with the sound, and the other stimuli that are present in the environment. If an animal chooses to react to the acoustic stimuli, then the behavioral responses fall into two categories: alteration of natural behavior patterns or avoidance. The specific type and severity of these reactions helps determine the costs and ultimate consequences to the individual and population.

6.1.1.1 Flowchart

Figure 6-1 is a flowchart that diagrams the process used to evaluate the potential effects on marine animals from sound-producing activities. The shape and color of each box on the flowchart represent either a decision point in the analysis (green diamonds); specific processes such as responses, costs, or recovery (blue rectangles); external factors to consider (purple parallelograms); and final outcomes for the individual or population (orange ovals and rectangles) (Figure 6-1).

Each box is labeled for reference throughout the following sections. For simplicity, sound is used here to include not only acoustic waves but also shock waves generated from pile driving. The supporting text clarifies those instances where it is necessary to distinguish between the two phenomena.

Box A1, the Sound-Producing Activity, is the source of the sound stimuli and therefore the starting point in the analysis. Each of the five major categories of potential effects (i.e., direct trauma, auditory fatigue, masking, behavioral response, and stress) are presented as pathways that flow from left to right across the diagram. Pathways are not exclusive, and each must be followed until it can be concluded that an animal is not at risk for that specific effect. The vertical columns show the steps in the analysis used to examine each of the effects pathways. These steps proceed from the Stimuli, to the Physiological Responses, to any potential Behavioral Responses, to the Costs to the Animal, to the Recovery of the animal, and finally to the Long-Term Consequences for the Individual and Population.

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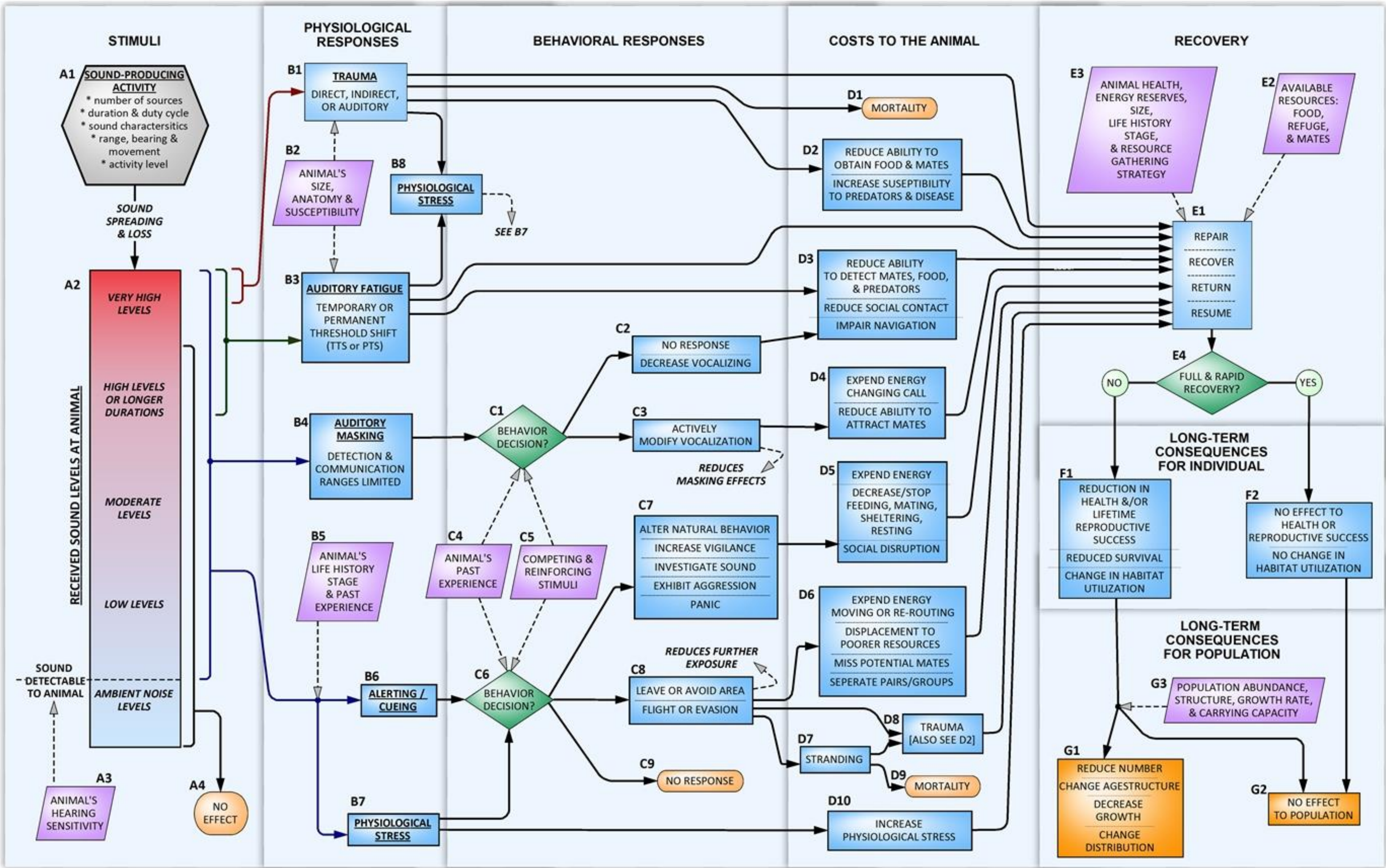

Figure 6-1: Flowchart of the Evaluation Process of Sound-Producing Activities

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6.1.1.2 Stimuli

The first step in predicting whether a sound-producing activity is capable of causing an effect on a marine animal is to define the Stimuli experienced by the animal. The Stimuli include the Sound-Producing Activity, the surrounding acoustical environment, the characteristics of the sound when it reaches the animal, and whether the animal can detect the sound.

Sounds emitted from a sound-producing Activity (Box A1) travel through the environment to create a spatially variable sound field. There can be any number of individual sound sources in a given activity, each with its own unique characteristics. For example, pile driving is either underwater vibratory sound or underwater impact sound; both are impulsive sources. Each source also has a range, depth/altitude, bearing and directionality, and movement relative to the animal. Environmental factors such as temperature, salinity, bathymetry, bottom type, and sea state all impact how sound spreads through the environment and how sound decreases in amplitude between the source and the receiver (individual animal). Mathematical calculations and computer models are used to predict how the characteristics of the sound change between the source and the animal under a range of realistic environmental conditions for the locations where sound-producing activities occur.

The details of the overall activity may also be important to place the potential effects into context and help predict the range of severity of the probable reactions. The overall activity level (e.g., number of piles driven in a day); the number of sound sources within the activity; the activity duration; and the range, bearing, and movement of the activity relative to the animal are all considered.

The received sound at the animal and the number of times the sound is experienced (i.e., repetitive exposures) (Box A2 and C5) determines the range of possible effects. Sounds that are higher than the ambient noise level and within an animal’s hearing sensitivity range (Box A3) have the potential to cause effects. Very high exposure levels may have the potential to cause trauma; high-level exposures, long-duration exposures, or repetitive exposures may potentially cause auditory fatigue; lower-level exposures may potentially lead to masking; all perceived levels may lead to stress; and many sounds, including sounds that are not detectable by the animal, have no effect (Box A4).

6.1.1.3 Physiological Responses

Physiological responses include direct trauma, auditory fatigue (hearing loss), auditory masking, and physiological stress. The magnitude of the involuntary response is predicted based on the characteristics of the acoustic stimuli and the characteristics of the animal (species, susceptibility, life history stage, size, and past experiences).

6.1.1.3.1 Trauma

Physiological responses to sound stimulation may range from mechanical vibration of the inner organs (with no resulting adverse effects) to tissue trauma (injury). Direct trauma (Box B1) refers to the direct injury of tissues and organs by sound waves impinging upon or traveling through an animal's body. Marine animals’ bodies, especially their auditory systems, are well adapted to large hydrostatic pressures and large, but relatively slow, pressure changes that occur with changing depth. However, mechanical trauma may result from exposure to very-high-amplitude sounds when the elastic limits of the auditory system are exceeded or when animals are exposed to intense sounds with very rapid rise times, such that the tissues cannot respond adequately to the rapid pressure changes. Trauma to marine animals from sound exposure requires the animal to be exposed to high received levels of sound. Trauma effects therefore normally only occur with very high-amplitude, often impulsive, sources, and at relatively close range, which limits the number of animals likely exposed to trauma-inducing sound levels.

Direct trauma includes both auditory and non-auditory trauma. Auditory trauma is the direct mechanical injury to hearing-related structures, including tympanic membrane rupture, separation 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 differs from auditory fatigue in that the latter involves the overstimulation of the auditory system at levels below those capable of causing direct mechanical damage. Auditory trauma is always injurious but can be temporary. One of the most common consequences of auditory trauma is hearing loss (see Section 6.1.1.3.2, Auditory Fatigue).

Non-auditory trauma can include hemorrhaging of small blood vessels and the rupture of gas-containing tissues such as the lung, swim bladder, or gastrointestinal tract. After the ear (or other sound-sensing organs), these are usually the most sensitive organs and tissues to acoustic trauma. An animal's size and anatomy are important in determining its susceptibility to trauma (Box B2), especially non-auditory trauma. Larger size indicates more tissue to protect vital organs that might be otherwise susceptible (i.e., there is more attenuation of the received sound before it impacts non-auditory structures). Therefore, larger animals should be less susceptible to trauma than smaller animals. In some cases, acoustic resonance of a structure may enhance the vibrations resulting from noise exposure and result in an increased susceptibility to trauma. Resonance is a phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration, or the particular frequency at which the object vibrates most readily. The size, geometry, and material composition of a structure determine the frequency at which the object resonates. The potential for resonance is determined by comparing the sound frequencies with the resonant frequency and damping of the tissues. Because most biological tissues are heavily damped, the increase in susceptibility from resonance is limited.

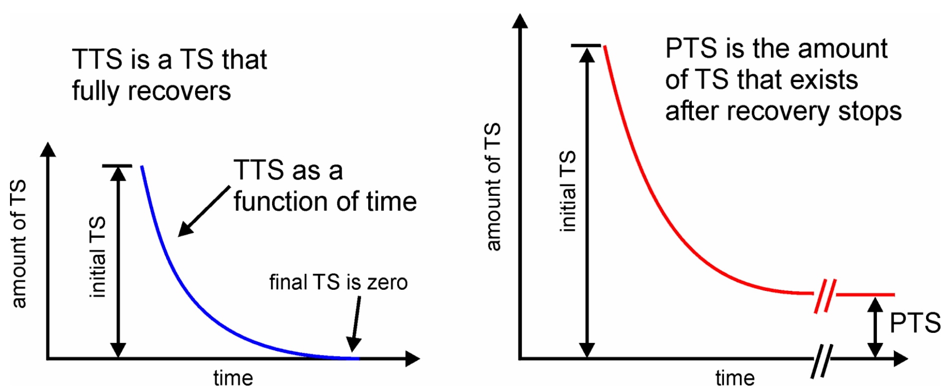
Vascular and tissue bubble formation resulting from sound exposure is a hypothesized mechanism of indirect trauma to marine animals. The risk of bubble formation from one of these processes, called rectified diffusion, is based on the amplitude, frequency, and duration of the sound (Crum & Mao, 1996) and an animal's tissue nitrogen gas saturation at the time of the exposure. Rectified diffusion is the growth of a bubble that fluctuates in size because of the changing pressure field caused by the sound wave. An alternative, but related, hypothesis has also been suggested: stable microbubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of gas-supersaturated tissues. Bubbles have also been hypothesized to result from changes in the dive behavior of marine mammals as a result of sound exposure (Jepson et al., 2003). Vascular bubbles produced by this mechanism would not be a physiological response to the sound exposure, but a cost to the animal because of the change in behavior (Section 6.1.1.5, Costs to the Animal). Under either of these hypotheses, several things could happen: (1) bubbles could grow to the extent that vascular blockage (emboli) and tissue hemorrhage occur, (2) bubbles could develop to the extent that a complement immune response is triggered or the nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs, or (3) the bubbles could be cleared by the lung without negative consequence to the animal. Although rectified diffusion is a known phenomenon, its applicability to diving marine animals exposed to sound is questionable; animals would need to be highly supersaturated with gas and very close to a high-level sound source (Crum et al., 2005). The other two hypothesized phenomena are largely theoretical and have not been demonstrated under realistic exposure conditions.

6.1.1.3.2 Auditory Fatigue

Auditory fatigue is a reduction in hearing ability resulting from overstimulation to sounds and can be temporary or permanent. The mechanisms responsible for auditory fatigue differ from auditory trauma and may consist of a variety of mechanical and biochemical processes, including physical damage or distortion of the tympanic membrane and cochlear hair cell stereocilia, oxidative stress-related hair cell death, changes in cochlear blood flow, and swelling of cochlear nerve terminals resulting from glutamate excitotoxicity (Henderson et al., 2006; Kujawa & Liberman, 2009). Although the outer hair cells are the most prominent target for fatigue effects, severe noise exposures may also result in inner hair cell death and loss of auditory nerve fibers (Henderson et al., 2006). Auditory fatigue is possibly the best studied type of effect from sound exposures in marine and terrestrial animals, including humans. The characteristics of the received sound stimuli are used and compared to the animal's hearing sensitivity and susceptibility to noise (Box A3) to determine the potential for auditory fatigue.

Auditory fatigue manifests itself as hearing loss, called a noise-induced threshold shift. A threshold shift may be either permanent threshold shift (PTS) or temporary threshold shift (TTS). Note that the term "auditory fatigue" is often used to mean a TTS; however, in this analysis, a more general meaning to differentiate fatigue mechanisms (e.g., metabolic exhaustion and distortion of tissues) from auditory trauma mechanisms (e.g., physical destruction of cochlear tissues occurring at the time of exposure) is used.

The distinction between PTS and TTS is based on whether there is a complete recovery of hearing sensitivity following a sound exposure. If the threshold shift eventually returns to zero (the animal's hearing returns to pre-exposure value), the threshold shift is a TTS. If the threshold shift does not return to zero but leaves some finite amount of threshold shift, then that remaining threshold shift is a PTS. Figure 6-2 shows one hypothetical threshold shift that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.



TTS – temporary threshold shift
TS – threshold shift
PTS – permanent threshold shift

Figure 6-2: Two Hypothetical Threshold Shifts

The relationship between TTS and PTS is complicated and poorly understood, even in humans and terrestrial mammals, where numerous studies failed to delineate a clear relationship between the two. Relatively small amounts of TTS (e.g., less than 40–50 dB measured two minutes after exposure) recover with no apparent long-term effects; however, terrestrial mammal studies revealed that large amounts of TTS (e.g., approximately 40 dB measured 24 hours after exposure) can result in permanent neural degeneration, despite the hearing thresholds returning to normal (Kujawa & Liberman, 2009). The amounts of TTS induced by Kujawa and Liberman were described as being "at the limits of reversibility." It is unknown whether smaller amounts of TTS can result in similar neural degeneration, or if effects would translate to other species such as marine animals.

The amplitude, frequency, duration, and temporal pattern of the sound exposure are important parameters for predicting the potential for auditory fatigue. Duration is particularly important because auditory fatigue is exacerbated with prolonged exposure time. The frequency of the sound also plays an important role in susceptibility to hearing loss. Experiments show that animals are most susceptible to fatigue (Box B3) within their most sensitive hearing range. Sounds outside of an animal's audible frequency range do not cause fatigue.

The greater the degree of threshold shift, the smaller the ocean space within which an animal can detect biologically relevant sounds and communicate. This is referred to as reducing an animal's "acoustic space." This reduction can be estimated given the amount of threshold shift incurred by an animal.

6.1.1.3.3 Auditory Masking

Auditory masking occurs if the noise from an activity interferes with an animal's ability to detect, understand, or recognize biologically relevant sounds of interest (Box B4). "Noise" refers to unwanted or unimportant sounds that mask an animal's ability to hear "sounds of interest." A sound of interest refers to a sound that is potentially being detected. Sounds of interest include those from conspecifics such as offspring, mates, and competitors; echolocation clicks; sounds from predators; natural, abiotic sounds that may aid in navigation; and reverberation, which can give an animal information about its location and orientation within the ocean.

The frequency, received level, and duty cycle of the sound determine the potential degree of auditory masking. Similar to hearing loss, the greater the degree of masking, the smaller the ocean space within which an animal can detect biologically relevant sounds.

6.1.1.3.4 Physiological Stress

If a sound is detected (i.e., heard or sensed) by an animal, a stress response can occur (Box B7); or the sound can cue or alert the animal (Box B6) without a direct, measurable stress response. If an animal suffers trauma or auditory fatigue, a physiological stress response occurs (Box B8). A stress response is a physiological change resulting from a stressor that is meant to help the animal deal with the stressor. The generalized stress response is characterized by a release of hormones (Reeder & Kramer, 2005); however, it is now acknowledged that other chemicals produced in a stress response (e.g., stress markers) exist. For example, a release of reactive oxidative compounds, as occurs in noise-induced hearing loss (Henderson et al., 2006), occurs in response to some acoustic stressors. Stress hormones include those produced by the sympathetic nervous system, norepinephrine and epinephrine (i.e., the catecholamines), which produce elevations in the heart and respiration rate, increase awareness, and increase the availability of glucose and lipid for energy. Other stress hormones are the glucocorticoid steroid hormones cortisol and aldosterone, which are produced by the adrenal gland. These hormones are classically used as an indicator of a stress response and to characterize the magnitude of the stress response (Hennessy et al., 1979). Oxidative stress occurs when reactive molecules, called reactive oxygen species, are produced in excess of molecules that counteract their activity (i.e., antioxidants).

An acute stress response is traditionally considered part of the startle response and is hormonally characterized by the release of the catecholamines. Annoyance type reactions may be characterized by the release of either or both catecholamines and glucocorticoid hormones. Regardless of the physiological changes that make up the stress response, the stress response may contribute to an animal's decision to alter its behavior. Alternatively, a stimulus may not cause a measurable stress response but may act as an alert or cue to an animal to change its behavior. This response may occur because of learned associations; the animal may have experienced a stress reaction in the past to similar sounds or activities (Box C4), or it may have learned the response from conspecifics (e.g., seals may learn not to fear calls from fish-eating killer whales based on how their kin respond). The severity of the stress response depends on the received sound level at the animal (Box A2); the details of the sound-producing activity (Box A1); the animal's life history stage (e.g., juvenile or adult; breeding or feeding season) (Box B5); and the animal's past experience with the stimuli (Box B5). These factors are subject to individual variation, as well as variation within an individual over time.

An animal's life history stage is an important factor to consider when predicting whether a stress response is likely (Box B5). An animal's life history stage includes its level of physical maturity (i.e., larva, infant, juvenile, sexually mature adult) and the primary activity in which it is engaged, such as mating, feeding, or rearing/caring for young. Animals engaged in a critical life activity such as mating or feeding may have a lesser stress response than an animal engaged in a more flexible activity such as resting or migrating (i.e., an activity that does not necessarily depend on the availability of resources). The animal's past experiences with the stimuli or similar stimuli are another important consideration. Prior experience with a stressor may be of particular importance because repeated experience with a stressor may dull the stress response via acclimation (St. Aubin & Dierauf, 2001) or increase the response via sensitization.

6.1.1.4 Behavioral Responses

Any number of behavioral responses can result from a physiological response. An animal "decides" how it behaves in response to the stimulus based on a number of factors in addition to the severity of the physiological response. An animal's experience with the sound (or similar sounds), the context of the acoustic exposure, and the presence of other stimuli contribute to determining its reaction from a suite of possible behaviors.

Behavioral responses fall into two major categories: alterations in natural behavior patterns and avoidance. These types of reactions are not mutually exclusive, and many overall reactions may be combinations of behaviors or a sequence of behaviors. Severity of behavioral reactions can vary drastically between minor and brief reorientations of the animal to investigate the sound, to severe reactions such as aggression or prolonged flight. The type and severity of the behavioral response determines the cost to the animal.

6.1.1.4.1 Trauma and Auditory Fatigue

Direct trauma and auditory fatigue increases the animal's physiological stress (Box B8), which feeds into the stress response (Box B7). Direct trauma and auditory fatigue increase the likelihood or severity of a behavioral response and increase an animal's overall physiological stress level (Box D10).

6.1.1.4.2 Auditory Masking

A behavior decision is made by the animal when the animal detects increased background noise, or possibly when the animal recognizes that biologically relevant sounds are being masked (Box C1). An animal's past experience with the sound-producing activity or similar acoustic stimuli can affect its choice of behavior during auditory masking (Box C4). Competing and reinforcing stimuli may also affect its decision (Box C5).

An animal can choose a passive behavioral response when coping with auditory masking (Box C2). It may simply not respond and keep conducting its current natural behavior. An animal may also decide to stop calling until the background noise decreases. These passive responses do not present a direct energetic cost to the animal; however, auditory masking would continue, depending on the acoustic stimuli.

An animal can choose to actively compensate for auditory masking (Box C3). An animal can vocalize more loudly to make its signal heard over the masking noise. An animal may also shift the frequency of its vocalizations away from the frequency of the masking noise. This shift can actually reduce the masking effect for the animal and other animals that are "listening" in the area. For example, in marine mammals, vocalization changes have been reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying. Changes included mimicry of the sound, cessation of vocalization, increases and decreases in vocalization length, increases and decreases in vocalization rate, and increases in vocalization frequency and level, while other animals showed no significant changes in the presence of anthropogenic sound.

An animal's past experiences can be important in determining what behavior decision it may make when dealing with auditory masking (Box C4). Past experience can be with the sound-producing activity itself or with similar acoustic stimuli. For example, an animal may learn over time the best way to modify its vocalizations to reduce the effects of masking noise.

Other stimuli present in the environment can influence an animal's behavior decision (Box C5). These stimuli can be other acoustic stimuli not directly related to the sound-producing activity; they can be visual, olfactory, or tactile stimuli; the stimuli can be conspecifics or predators in the area; or the stimuli can be the strong drive to engage in a natural behavior. Competing stimuli tend to suppress any potential behavioral reaction. For example, an animal involved in mating or foraging may not react with the same degree of severity as it may have otherwise. Reinforcing stimuli reinforce the behavioral reaction caused by acoustic stimuli. For example, awareness of a predator in the area coupled with the acoustic stimuli may illicit a stronger reaction than the acoustic stimuli itself otherwise would have. The visual stimulus of seeing ships and aircraft, coupled with the acoustic stimuli, may also increase the likelihood or severity of a behavioral response.

6.1.1.4.3 Physiological Stress

A physiological stress response (Box B7) such as an annoyance or startle reaction, or a cueing or alerting reaction (Box B6) may cause an animal to make a behavior decision (Box C6). Any exposure that produces an injury or auditory fatigue is also assumed to produce a stress response (Box B7) and increase the severity or likelihood of a behavioral reaction. Both an animal's past experience (Box C4) and competing and reinforcing stimuli (Box C5) can affect an animal's behavior decision. The decision can result in three general types of behavioral reactions: no response (Box C9), area avoidance (Box C8), or alteration of a natural behavior (Box C7).

Little data exist that correlate specific behavioral reactions with specific stress responses. Therefore, in practice the likely range of behavioral reactions is estimated from the acoustic stimuli instead of the magnitude of the stress response. It is assumed that a stress response must exist to alter a natural behavior or cause an avoidance reaction. Estimates of the types of behavioral responses that could occur for a given sound exposure can be determined from the literature.

An animal's past experiences can be important in determining what behavior decision it may make when dealing with a stress response (Box C4). Past experience can be with the sound-producing activity itself or with similar sound stimuli. Habituation is the process by which an animal learns to ignore or tolerate stimuli over some period of time and return to a normal behavior pattern, perhaps after being exposed to the stimuli with no negative consequences. A habituated animal may have a lesser behavioral response than the first time it encountered the stimuli. Sensitization is when an animal becomes more sensitive to a set of stimuli over time, perhaps as a result of a past, negative experience with the stimuli or similar stimuli. A sensitized animal may have a stronger behavioral response than the first time it encountered the stimuli.

Other stimuli (Box C5) present in the environment can influence an animal's behavior decision (Box C6). These stimuli can be other acoustic stimuli not directly related to the sound-producing activity, such as visual stimuli; the stimuli can be conspecifics or predators in the area, or the stimuli can be the strong drive to engage or continue in a natural behavior. Competing stimuli tend to suppress any potential behavioral reaction. For example, an animal involved in mating or foraging may not react with the same degree of severity as an animal involved in less-critical behavior. Reinforcing stimuli reinforce the behavioral reaction caused by acoustic stimuli. For example, the awareness of a predator in the area coupled with the acoustic stimuli may elicit a stronger reaction than the acoustic stimuli themselves otherwise would have.

An animal may reorient or become more vigilant if it detects a sound-producing activity (Box C7). Some animals may investigate the sound using other sensory systems (e.g., vision), and perhaps move closer to the sound source. Reorientation, vigilance, and investigation all require the animal to divert attention and resources and therefore slow or stop their presumably beneficial natural behavior. This can be a very brief diversion, after which the animal continues its natural behavior, or an animal may not resume its natural behaviors until after a longer period when the animal has habituated to the sound or the activity has concluded. An attentional change via an orienting response represents behaviors that would be considered mild disruption. More severe alterations of natural behavior would include aggression or panic.

An animal may choose to leave or avoid an area where a sound-producing activity is taking place (Box C8). Avoidance is the displacement of an individual from an area. A more severe form of this comes in the form of flight or evasion. A flight response is a dramatic change in normal movement to a directed and rapid movement away from the detected location of a sound source. Avoidance of an area can help the animal avoid further acoustic effects by avoiding or reducing further exposure.

An animal may choose not to respond to a sound-producing activity (Box C9). The physiological stress response may not rise to the level that would cause the animal to modify its behavior. The animal may have habituated to the sound or simply learned through past experience that the sound is not a threat. In this case a behavioral effect would not be predicted. An animal may choose not to respond to a sound-producing activity in spite of a physiological stress response. Some combination of competing stimuli may be present such as a robust food patch or a mating opportunity that overcomes the stress response and suppresses any potential behavioral responses. If the noise-producing activity persists over long periods or reoccurs frequently, the acute stress felt by animals could increase their overall chronic stress levels.

6.1.1.5 Costs to the Animal

The potential costs to a marine animal from an involuntary or behavioral response include no measurable cost, expended energy reserves, increased stress, reduced social contact, missed opportunities to secure resources or mates, displacement, and stranding or severe evasive behavior (which may potentially lead to secondary trauma or death). Animals suffer costs on a daily basis from a host of natural situations such as dealing with predator or competitor pressure. If the costs to the animal from an acoustic-related effect fall outside of its normal daily variations, then individuals must recover from significant costs to avoid long-term consequences.

6.1.1.5.1 Trauma

Trauma or injury to an animal may reduce its ability to secure food by reducing its mobility or the efficiency of its sensory systems, make the injured individual less attractive to potential mates, or increase an individual’s chances of contracting diseases or falling prey to a predator (Box D2). A severe trauma can lead to the death of the individual (Box D1).

6.1.1.5.2 Auditory Fatigue and Auditory Masking

Auditory fatigue and masking can impair an animal’s ability to hear biologically important sounds (Box D3), especially fainter and distant sounds. Sounds could belong to conspecifics such as other individuals in a social group (i.e., pod, school, etc.), potential mates, potential competitors, or parents/offspring. Biologically important sounds could also be an animal’s own biosonar echoes used to detect prey, predators, and the physical environment. Therefore, auditory masking or a hearing loss could reduce an animal's ability to contact social groups, offspring, or parents; and reduce opportunities to detect or attract more distant mates. Animals may also use sounds to gain information about their physical environment by detecting the reverberation of sounds in the underwater space or sensing the sound of crashing waves on a nearby shoreline. These cues could be used by some animals to migrate long distances or navigate their immediate environment. Therefore, an animal's ability to navigate may be impaired if the animal uses acoustic cues from the physical environment to help identify its location. Auditory masking and fatigue both effectively reduce the animal’s acoustic space and the ocean volume in which detection and communication are effective.

An animal that modifies its vocalization in response to auditory masking could incur a cost (Box D4). Modifying vocalizations may cost the animal energy from its finite energy budget. Additionally, shifting the frequency of a call can make an animal appear to be less-fit to conspecifics. Animals that are larger are typically capable of producing lower-frequency sounds than smaller conspecifics. Therefore, lower-frequency sounds are usually an indicator of a larger and presumably more fit and experienced potential mate.

Auditory masking or auditory fatigue may also lead to no measurable costs for an animal. Masking could be of short duration or intermittent such that biologically important sounds that are continuous or repeated are received by the animal between masking noise. Auditory fatigue could also be inconsequential for an animal if the frequency range affected is not critical for that animal to hear within, or the auditory fatigue is of such short duration (e.g., a few minutes) that there are no costs to the individual.

As discussed in Section 6.2.2 (Ambient Noise), and Section 2.2.1 (Ambient Noise and Vessel Traffic), the existing anthropogenic noise from acoustic monitoring record for the region that reflects the presence of commercial ports and recreational marinas (Hildebrand et al., 2011; Hildebrand et al., 2012; McKenna et al., 2012; McKenna et al., 2015; Redfern et al., 2017), as well as presence of industrial activities (e.g., petroleum extraction), and hardened acoustically reflective infrastructure such as breakwaters and jetties which affect sound propagation (see Figure 2-1), unassociated with the Proposed Action, are already causing masking effects to marine mammal communications in the area.

6.1.1.5.3 Physiological Stress

An animal that alters its natural behavior in response to stress or an auditory cue may slow or cease its presumably beneficial natural behavior and instead expend energy reacting to the sound-producing activity (Box D5). Beneficial natural behaviors include feeding, breeding, sheltering, and migrating. The cost of feeding disruptions depends on the energetic requirements of individuals and the potential amount of food missed during the disruption. Alteration in breeding behavior can result in delaying reproduction. The costs of a brief interruption to migrating or sheltering are less clear. Most behavior alterations also require the animal to expend energy for a nonbeneficial behavior. The amount of energy expended depends on the severity of the behavioral response.

An animal that avoids a sound-producing activity may expend additional energy moving around the area, be displaced to poorer resources, miss potential mates, or have social interactions affected (Box D6). Avoidance reactions can cause an animal to expend energy. The amount of energy expended depends on the severity of the behavioral response. Missing potential mates can result in delaying reproduction. Social groups or pairs of animals, such as mates or parent/offspring pairs, could be separated during a severe behavioral response such as flight. Offspring that depend on their parents may die if they are permanently separated. Splitting up an animal group can result in a reduced group size, which can have secondary effects on individual foraging success and susceptibility to predators.

Some severe behavioral reactions can lead to stranding (Box D7) or secondary trauma (Box D8). Animals that take prolonged flight, a severe avoidance reaction, may injure themselves or strand in an environment for which they are not adapted. Some trauma is likely to occur to an animal that strands (Box D8). Trauma can reduce the animal's ability to secure food and mates, and increase the animal's susceptibility to predation and disease (Box D2). An animal that strands and does not return to a hospitable environment quickly will likely die (Box D9).

Elevated stress levels may occur whether or not an animal exhibits a behavioral response (Box D10). Even while undergoing a stress response, competing stimuli (e.g., food or mating opportunities) may overcome an animal's initial stress response during the behavior decision. Regardless of whether the animal displays a behavioral reaction, this tolerated stress could incur a cost to the animal. Reactive oxygen species produced during normal physiological processes are generally counterbalanced by enzymes and antioxidants; however, excess stress can result in an excess production of reactive oxygen species, leading to damage of lipids, proteins, and nucleic acids at the cellular level (Sies, 1997; Touyz, 2004).

6.1.1.5.4 Recovery

The predicted recovery of the animal (Box E1) is based on the cost of any masking or behavioral response and the severity on any involuntary physiological reactions (e.g., direct trauma, hearing loss, or increased chronic stress). Many effects are fully recoverable upon cessation of the sound-producing activity, and the vast majority of effects are completely recoverable over time, although a few effects may not be fully recoverable. The availability of resources and the characteristics of the animal play a critical role in determining the speed and completeness of recovery.

Available resources fluctuate by season, location, and year and can play a major role in an animal's rate of recovery (Box E2). Plentiful food can aid in a quicker recovery, whereas recovery can take much longer if food resources are limited. If many potential mates are available, an animal may recover quickly from missing a single mating opportunity. Refuge or shelter is also an important resource that may give an animal an opportunity to recover or repair after an incurred cost or physiological response.

An animal's health, energy reserves, size, life history stage, and resource gathering strategy affect its speed and completeness of recovery (Box E3). Animals that are in good health and have abundant energy reserves before an effect will likely recover more quickly. Adult animals with stored energy reserves (e.g., fat reserves) may have an easier time recovering than juveniles that expend their energy growing and developing and have less in reserve. Large individuals and large species may recover more quickly, also due to having more potential for energy reserves. Animals that gather and store resources, perhaps fasting for months during breeding or offspring rearing seasons, may have a more difficult time recovering from being temporarily displaced from a feeding area than an animal that feeds year round.

Damaged tissues from mild to moderate trauma may heal over time. The predicted recovery of direct trauma is based on the severity of the trauma, availability of resources, and characteristics of the animal. After a sustained injury an animal's body attempts to repair tissues. The animal may also need to recover from any potential costs due to a decrease in resource gathering efficiency and any secondary effects from predators or disease (Box E1). Moderate to severe trauma that does not cause mortality may never fully heal.

As recovery pertains to hearing loss, small to moderate amounts of hearing loss may recover over a period of minutes to days, depending on the nature of the exposure and the amount of initial threshold shift. Severe noise-induced hearing loss may not fully recover, resulting in some amount of permanent hearing loss.

Auditory masking only occurs when the sound source is operating; therefore, direct masking effects stop immediately upon cessation of the sound-producing activity (Box E1). Natural behaviors may resume shortly after or even during the acoustic stimulus after an initial assessment period by the animal. Any energetic expenditures and missed opportunities to find and secure resources incurred from masking or a behavior alteration may take some time to recover.

Animals displaced from their normal habitat due to an avoidance reaction may return over time and resume their natural behaviors, depending on the severity of the reaction and how often the activity is repeated in the area. In areas of repeated and frequent acoustic disturbance, some animals may habituate to the new baseline or fluctuations in noise level. More sensitive species, or animals that may have been sensitized to the stimulus over time due to past negative experiences, may not return to an area. Other animals may return but not resume use of the habitat in the same manner as before the acoustic-related effect. For example, an animal may return to an area to feed or navigate through it to get to another area, but that animal may no longer seek that area as refuge or shelter.

Frequent milder physiological responses to an individual may accumulate over time if the time between sound-producing activities is not adequate to give the animal an opportunity to fully recover. An increase in an animal's chronic stress level is also possible if stress caused by a sound-producing activity does not return to baseline between exposures. Each component of the stress response is variable in time, and stress hormones return to baseline levels at different rates. For example, adrenaline is released almost immediately and is used or cleared by the system quickly, whereas glucocorticoid and cortisol levels may take long periods (i.e., hours to days) to return to baseline.

6.1.1.6 Long-Term Consequences to the Individual and the Population

The magnitude and type of effect and the speed and completeness of recovery must be considered in predicting long-term consequences to the individual animal and its population (Box E4). Animals that recover quickly and completely from explosive or acoustic-related effects will likely not suffer reductions in their health or reproductive success, or experience changes in habitat utilization (Box F2). No population-level effects would be expected if individual animals do not suffer reductions in their lifetime reproductive success or change their habitat utilization (Box G2).

Animals that do not recover quickly and fully could suffer reductions in their health and lifetime reproductive success; they could be permanently displaced or change how they utilize the environment; or they could die (Box F1). Severe injuries can lead to reduced survivorship (longevity), elevated stress levels, and prolonged alterations in behavior that can reduce an animal's lifetime reproductive success. An animal with decreased energy stores or a lingering injury may be less successful at mating for one or more breeding seasons, thereby decreasing the number of offspring produced over its lifetime.

An animal whose hearing does not recover quickly and fully could suffer a reduction in lifetime reproductive success (Box F1). An animal with decreased energy stores or a PTS may be less successful at mating for one or more breeding seasons, thereby decreasing the number of offspring it can produce over its lifetime.

The involuntary reaction of masking ends when the acoustic stimuli conclude. The direct effects of auditory masking could have long-term consequences for individuals if the activity was continuous or occurred frequently enough; however, if activities are infrequent (such as pile driving), then minimization and monitoring should ensure that activities are not conducted in the presence of marine mammals.

Missed mating opportunities can have a direct effect on reproductive success. Reducing an animal's energy reserves over longer periods can directly reduce its health and reproductive success. Some species may not enter a breeding cycle without adequate energy stores, and animals that do breed may have a decreased probability of offspring survival. Animals that are displaced from their preferred habitat, or that utilize it differently, may no longer have access to the best resources. Some animals that leave or flee an area during a noise-producing activity, especially an activity that is persistent or frequent, may not return quickly or at all. This can further reduce an individual's health and lifetime reproductive success.

Frequent disruptions to natural behavior patterns may not allow an animal to fully recover between exposures, which increases the probability of causing long-term consequences to individuals. Elevated chronic stress levels are usually a result of a prolonged or repeated disturbance. Excess stress produces reactive molecules in an animal's body that can result in cellular damage (Sies, 1997; Touyz, 2004). Chronic elevations in the stress levels (e.g., cortisol levels) may produce long-term health consequences that can reduce lifetime reproductive success.

These long-term consequences to the individual can lead to consequences for the population (Box G1). Population dynamics and abundance play a role in determining how many individuals would need to suffer long-term consequences before there was an effect on the population (Box G1). Long-term abandonment or a change in the utilization of an area by enough individuals can change the distribution of the population. Death has an immediate effect in that no further contribution to the population is possible, which reduces the animal's lifetime reproductive success.

Carrying capacity describes the theoretical maximum number of animals of a particular species that the environment can support. When a population nears its carrying capacity, the lifetime reproductive success in individuals may decrease due to finite resources or predator-prey interactions. Population growth is naturally limited by available resources and predator pressure. If one or a few animals in a population are removed or gather fewer resources, then other animals in the population can take advantage of the freed resources and potentially increase their health and lifetime reproductive success. Abundant populations that are near their carrying capacity (theoretical maximum abundance) that suffer effects on a few individuals may not be affected overall.

Populations that are reduced well below their carrying capacity may suffer greater consequences from any lasting effects on even a few individuals. Population-level consequences can include a change in the population dynamics, a decrease in the growth rate, or a change in geographic distribution. Changing the dynamics of a population (the proportion of the population within each age/growth) or their geographic distribution can also have secondary effects on population growth rates.

6.1.2 Analysis Background and Framework

The pile driving is estimated to result in Level B harassment of California sea lions, Pacific harbor seals, common dolphins, and bottlenose dolphins in the Action Area. In this analysis, species are grouped based on their taxonomic relationship and discussed as follows: odontocetes (toothed whales [common dolphins and bottlenose dolphins]), and pinnipeds (seals and sea lions).

Methods used to predict acoustic effects on California sea lions, Pacific harbor seals, common dolphins, bottlenose dolphins, and gray whales build on the Conceptual Framework for Assessing Effects from Sound-Producing Activities (Section 6.1.1, Conceptual Framework for Assessing Effects from Sound-Producing Activities). Additional research specific to California sea lions, Pacific harbor seals, common dolphin, and bottlenose dolphins is presented where available.

6.1.2.1 Hearing Loss

The most familiar effect of exposure to high intensity sound is hearing loss, meaning an increase in the hearing threshold.

Hearing loss due to auditory fatigue in marine mammals was studied by numerous investigators (Finneran et al., 2000; Finneran et al., 2002; Finneran et al., 2005; Finneran et al., 2007; Finneran et al., 2010b; Kastak et al., 2007; Lucke et al., 2009; Mann et al., 2010; Mooney et al., 2009; Nachtigall et al., 2003; Nachtigall et al., 2004; Popov et al., 2011; Schlundt et al., 2000; Southall et al., 2007). The studies of marine mammal auditory fatigue were all designed to determine relationships between TTS and exposure parameters such as level, duration, and frequency. In these studies, hearing thresholds were measured in trained marine mammals before and after exposure to intense sounds. The difference between the pre-exposure and post-exposure thresholds indicates the amount of TTS. Species studied include the bottlenose dolphin (total of nine individuals), California sea lion (three), and harbor seal (one). 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).

Primary findings of the marine mammal TTS studies discussed above (unless otherwise cited) are:

- The growth and recovery of TTS are analogous to those in terrestrial mammals. This means that, as in terrestrial mammals, threshold shifts primarily depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure.
- The amount of TTS increases with exposure SPL and the exposure duration.
- For continuous sounds, exposures of equal energy lead to approximately equal effects (Ward, 1997). For intermittent sounds, less hearing loss occurs than from a continuous exposure with the same energy (some recovery occurs during the quiet period between exposures) (Kryter et al., 1965; Ward, 1997).
- The sound exposure level (SEL) is correlated with the amount of TTS and is a good predictor for onset-TTS from single, continuous exposures with similar durations. This agrees with human TTS data presented by Ward et al. (1958; 1959). However, for longer duration sounds, beyond 1632 seconds, the relationship between TTS and SELs breaks down and duration becomes a more important contributor to TTS (Finneran et al., 2010b).
- The maximum TTS after tonal exposures occurs one-half to one octave above the exposure frequency (Finneran et al., 2007; Schlundt et al., 2000). Thus, TTS from tonal exposures can extend over a large (greater than one octave) frequency range.
- For bottlenose dolphins, non-impulsive sounds with frequencies above 10 kilohertz are more hazardous than those at lower frequencies (i.e., lower SEL required to affect hearing) (Finneran et al., 2010a).
- The amount of observed TTS tends to decrease at differing rates following noise exposure; however, the relationship is not monotonic. The amount of time required for complete recovery of hearing depends on the magnitude of the initial shift; for relatively small shifts, recovery may be complete in a few minutes, while large shifts (e.g., 40 dB) require several days for recovery.
- TTS can accumulate across multiple exposures, but the resulting TTS is less than the TTS from a single, continuous exposure with the same SEL. This means that predictions based on total, cumulative SEL overestimate the amount of TTS from intermittent exposures.

Although there have been no marine mammal studies designed to measure PTS, the potential for PTS in California sea lions, Pacific harbor seals, common dolphins, and bottlenose dolphins can be estimated based on known similarities between the inner ears of marine and terrestrial mammals. Experiments with marine mammals have revealed similarities to terrestrial mammals for features such as TTS, age-related hearing loss, ototoxic drug-induced hearing loss, masking, and frequency selectivity. Therefore, in the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated by assuming some upper limit of TTS that equates to the onset of PTS, then using TTS growth relationships from marine and terrestrial mammals to determine the exposure levels capable of producing this amount of TTS.

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

6.1.2.2 Auditory Masking

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

Critical ratios, the lowest ratio of signal-to-noise at which a signal can be detected, were determined for pinnipeds (e.g., seals and sea lions) (Southall et al., 2000, 2003). Detections of signals under varying masking conditions were determined for active echolocation and passive listening tasks in odontocetes (e.g., common dolphins and bottlenose dolphins) (Au & Pawloski, 1989; Erbe, 2000; Johnson, 1971). These studies provide baseline information from which the probability of masking can be estimated. Clark et al. (2009) developed a method for estimating masking effects on communication signals for low-frequency cetaceans, including calculating the cumulative impact of multiple noise sources. For example, their technique calculates that in Stellwagen Bank National Marine Sanctuary, when two commercial vessels pass through a right whale's optimal communication space (estimated as a sphere of water with a diameter of 10.8 NM), that space is decreased by 84 percent. This method relies on empirical data on source levels of calls (which is unknown for many species) and requires many assumptions about ancient ambient noise conditions and simplifications of animal behavior, but it is an important step in determining the impact of anthropogenic noise on animal communication.

Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Vocalization changes may result from a need to compete with an increase in background noise. In cetaceans, vocalization changes were reported from exposure to anthropogenic noise sources such as vessel noise, and seismic surveying.

Differential vocal responses in marine mammals were documented in the presence of seismic survey noise. An overall decrease in vocalization during active surveying was noted in large marine mammal groups (Potter et al., 2007), while blue whale feeding/social calls increased when seismic exploration was underway (Di Lorio & Clark, 2010), indicative of a compensatory response to the increased noise level. At present it is not known if these changes in vocal behavior corresponded to changes in foraging or any other behaviors.

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 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.

6.1.2.3 Physiological Stress

Marine mammals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with members of the same species, and interactions with predators all contribute to the stress a marine mammal experiences. In some cases, naturally occurring stressors can have profound impacts on marine mammals; for example, chronic stress, as observed in stranded animals with long-term debilitating conditions (e.g., disease), was 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 beyond those that occur naturally. Although sample sizes are small, the data collected to date suggest that different types of sounds potentially cause variable degrees of stress in marine mammals. Belugas demonstrated no catecholamine (hormones released in situations of stress) response to the playback of oil drilling sounds (Thomas et al., 1990) but showed an increase in catecholamines following exposure to impulsive sounds produced from a seismic water gun (Romano et al., 2004). A bottlenose dolphin exposed to the same seismic water gun signals did not demonstrate a catecholamine response, but did demonstrate an elevation in aldosterone, a hormone suggested as being a significant indicator of stress in odontocetes (St. Aubin & Dierauf, 2001; St. Aubin & Geraci, 1989). Increases in heart rate were observed in bottlenose dolphins to which conspecific calls were played, although no increase in heart rate was observed when tank noise was played back (Miksis et al., 2001). Collectively, these results suggest a variable response that depends on the characteristics of the received signal and prior experience with the received signal.

Other types of stressors include the presence of vessels, fishery interactions, acts of pursuit and capture, the act of stranding, and pollution. In contrast to the limited amount of work performed on stress responses resulting from sound exposure, a considerably larger body of work exists on stress responses associated with pursuit, capture, handling and stranding. Many cetaceans exhibit an apparent vulnerability in the face of these particular situations when taken to the extreme. A recent study compared pathological changes in organs/tissues of odontocetes stranded on beaches or captured in nets over a 40-year period (Cowan & Curry, 2008). The type of changes observed indicate harm to multiple systems caused in part by an overload of catecholamines into the system, as well as a restriction in blood supply capable of causing tissue damage or tissue death. This extreme response to a major stressor(s) is thought to be mediated by the over activation of the animal's normal physiological adaptations to diving or escape. Pursuit, capture, and short-term holding of belugas resulted in a decrease in thyroid hormones (St. Aubin & Geraci, 1989) and increases in epinephrine (St. Aubin & Dierauf, 2001). In bottlenose dolphins, the trend is more complicated with the duration of the handling time potentially contributing to the magnitude of the stress response (Ortiz & Worthy, 2000; St. Aubin et al., 1996; St. Aubin, 2002). Male gray seals subjected to capture and short-term restraint showed an increase in cortisol levels accompanied by an increase in testosterone (Lidgard et al., 2008). This result may be indicative of a compensatory response that enables the seal to maintain reproduction capability in spite of stress. Elephant seals demonstrate an acute cortisol response to handling but do not demonstrate a chronic response; on the contrary, adult females demonstrate a reduction in the adrenocortical response following repetitive chemical immobilization (Engelhard et al., 2002). Similarly, no correlation between cortisol levels and heart or respiration rate changes were seen in harbor porpoises during handling for satellite tagging (Eskesen et al., 2009). Taken together, these studies illustrate the wide variations in the level of response that can occur when faced with these stressors.

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

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

6.1.2.4 Behavioral Reactions

The response of a marine mammal to an anthropogenic sound depends on the frequency, duration, temporal pattern, and amplitude of the sound as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). The distance from the sound source and whether it is perceived as approaching or moving away can also affect the way an animal responds to a sound (Wartzok et al., 2003). For marine mammals, a review of responses to anthropogenic sound was first conducted by Richardson and others (Richardson et al., 1995). More recent reviews (Nowacek et al., 2007; Southall et al., 2007) address studies conducted since 1995 and focus on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated.

Except for some vocalization changes in response to auditory masking, all behavioral reactions are assumed to occur due to a preceding stress or cueing response; however, stress responses cannot be predicted directly due to a lack of scientific data (see preceding section). Responses can overlap; for example, an increased respiration rate is likely to be coupled to a flight response. Differential responses between and within species are expected since hearing ranges vary across species and the behavioral ecologies of individual species are unlikely to completely overlap.

Southall et al. (2007) synthesized data from many past behavioral studies and observations to determine the likelihood of behavioral reactions at specific sound levels. While in general, the louder the sound source the more intense the behavioral response, it was clear that the proximity of a sound source and the animal's experience, motivation, and conditioning were also critical factors influencing the response (Southall et al., 2007). After examining all of the available data, the authors felt that the derivation of thresholds for behavioral response based solely on exposure level was not supported because context of the animal at the time of sound exposure was an important factor in estimating response. Nonetheless, in some conditions, consistent avoidance reactions were noted at higher sound levels depending on the marine mammal species or group allowing conclusions to be drawn. Most low-frequency cetaceans (mysticetes) observed in studies usually avoided sound sources at levels of less than or equal to 160 dB re 1 µPa. Published studies of mid-frequency cetaceans analyzed include sperm whales, belugas, bottlenose dolphins, and river dolphins. These groups showed no clear tendency, but for non-impulsive sounds, captive animals tolerated levels in excess of 170 dB re 1 µPa before showing behavioral reactions, such as avoidance, erratic swimming, and attacking the test apparatus. High-frequency cetaceans (observed from studies with harbor porpoises) exhibited changes in respiration and avoidance behavior at levels between 90 and 140 dB re 1 µPa, with profound avoidance behavior noted for levels exceeding this. Phocid seals showed avoidance reactions at or below 190 dB re 1 µPa; thus, seals may actually receive levels adequate to produce TTS before avoiding the source. Recent studies with beaked whales have shown them to be particularly sensitive to noise, with animals during three playbacks of sound breaking off foraging dives at levels below 142 dB SPL, although acoustic monitoring during actual sonar exercises revealed some beaked whales continuing to forage at levels up to 157 dB SPL (Tyack et al., 2011).

6.1.2.5 Repeated Exposures

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

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

Marine mammals exposed to high levels of human activities may leave the area, habituate to the activity, or simply tolerate the disturbance. Marine mammals that are more tolerant may stay in a disturbed area, whereas individuals that are more sensitive may leave for areas with less human disturbance. Terrestrial examples of this abound as human disturbance and development displace more sensitive species, and tolerant animals move in to exploit the freed resources and fringe habitat. Longer-term displacement can lead to changes in abundance or distribution patterns of the species in the affected region if they do not become acclimated to the presence of the sound (Bejder et al., 2006b; Blackwell et al., 2004; Teilmann et al., 2006). Gray whales in Baja California abandoned a historical breeding lagoon in the mid-1960s due to an increase in dredging and commercial shipping operations. Whales did repopulate the lagoon after shipping activities had ceased for several years (Bryant et al., 1984). Over a shorter time scale, studies on the Atlantic Undersea Test and Evaluation Center instrumented range in the Bahamas have shown that some Blainville's beaked whales may be resident during all or part of the year in the area, and that individuals may move off the range for several days during and following a sonar event. However, animals are thought to continue feeding at short distances (a few kilometers) from the range out of the louder sound fields (less than 157 dB re 1 µPa) (McCarthy et al., 2011; Tyack et al., 2011). Mysticetes in the northeast tended to adjust to vessel traffic over a number of years, trending towards more neutral responses to passing vessels (Watkins, 1986), indicating that some animals may habituate or otherwise learn to cope with high levels of human activity. Nevertheless, the long-term consequences of these habitat utilization changes are unknown, and likely vary depending on the species, geographic areas, and the degree of acoustic or other human disturbance.

6.1.2.6 Long-Term Consequences for the Individual and the Population

Long-term consequences to a population are determined by examining changes in the population growth rate. Individual effects that could lead to a reduction in the population growth rate include mortality or injury (that removes animals from the reproductive pool), hearing loss (which depending on severity could impact navigation, foraging, predator avoidance, or communication), chronic stress (which could make individuals more susceptible to disease), displacement of individuals (especially from preferred foraging or mating grounds), and disruption of social bonds (due to masking of conspecific signals or displacement) (Section 6.1.1.1 [Flowchart] and Figure 6-1 [Flowchart]). However, the long-term consequences of any of these effects are difficult to predict because individual experience and time can create complex contingencies, especially for intelligent, long-lived animals like marine mammals. While a lost reproductive opportunity could be a "measurable" cost to the individual, the outcome for the animal, and ultimately the population, can range from insignificant to significant. Any number of factors, such as maternal inexperience, years of poor food supply, or predator pressure, could produce a cost of a lost reproductive opportunity, but these events may be "made up" during the life of a normal healthy individual. The same holds true for exposure to human-generated sound sources. These biological realities must be taken into consideration when assessing risk, uncertainties about that risk, and the feasibility of preventing or recouping such risks. All too often, the long-term consequence of relatively trivial events like short-term masking of a conspecific's social sounds, or a single lost feeding opportunity, is exaggerated beyond its actual importance by focus on the single event and not the important variable, which is the individual and its lifetime parameters of growth, reproduction, and survival.

The linkage between a stressor such as sound and its immediate behavioral or physiological consequences for the individual, the subsequent effects on that individual's vital rates (growth, survival and reproduction), and the consequences, in turn, for the population have been reviewed in National Research Council (2005). The Population Consequences of Acoustic Disturbance (PCAD) model National Research Council, (2005) proposes a quantitative methodology for determining how changes in the vital rates of individuals (i.e., a biologically significant consequence to the individual) translates into biologically significant consequences to the population. Population models are well known from many fields in biology including fisheries and wildlife management. These models accept inputs for the population size and changes in vital rates of the population such as the mean values for survival age, lifetime reproductive success, and recruitment of new individuals into the population. The time-scale of the inputs in a population model for long-lived animals such as marine mammals is on the order of seasons, years, or life stages (e.g., neonate, juvenile, reproductive adult), and are often concerned only with the success of individuals from one-time period or stage to the next. Unfortunately, for acoustic and explosive impacts on marine mammal populations, many of the inputs required by population models are not known.

The best assessment of long-term consequences from pile driving activities is to monitor the populations over time within the Action Area. A recent U.S. workshop on Marine Mammals and Sound (Fitch et al., 2011), indicated a critical need for baseline biological data on marine mammal abundance, distribution, habitat, and behavior over sufficient time and space to evaluate impacts from human-generated activities on long-term population survival.

6.1.3 Summary of Observations during Previous Pile Driving and Extraction Activities

There have been no pile driving or extraction activities associated with the Navy's pier infrastructure in Anaheim Bay in recent years.

6.2 Thresholds and Criteria for Predicting Acoustic Impacts on Marine Mammals

If proposed Navy activities introduce sound or energy into the marine environment, a quantitative estimate of effects to marine mammals is generally conducted. To do this, information about the numerical sound and energy levels that are likely to elicit certain types of physiological and behavioral reactions is needed.

6.2.1 Pile Driving and Extraction

Under the MMPA, NMFS has defined levels of harassment for marine mammals. Level A harassment is defined as "Any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild." Level B harassment is defined as "Any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding or sheltering." Since 1997, NMFS has used generic sound exposure thresholds to determine when an activity in the ocean that produces sound might result in impacts to a marine mammal such that a take by harassment might occur (National Marine Fisheries Service, 2005). Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to sounds at or above 160 dB rms for impulse sounds (e.g., impact pile driving) and 120 dB rms for continuous noise (e.g., vibratory pile driving or extraction), but below injurious thresholds. Behavioral harassment may or may not result in a stress response. The criteria for vibratory pile driving would also be applicable to the use of a pneumatic chipper.

NMFS guidance for exposure of cetaceans and pinnipeds exposed to impulsive sounds has previously been 180 and 190 dB rms or above, respectively, for Level A (injurious) harassment. NMFS (2016) introduced new threshold criteria for Level A injury permanent threshold shifts that are specific to marine mammal functional groups (Southall et al., 2007) and include both a peak sound threshold criteria and a cumulative sound threshold criteria. Level A Harassment has the potential to injure a marine mammal or marine mammal stock in the wild.

In addition to injury such as permanent threshold shifts, Level A harassment is assumed to result in a secondary reaction or "stress response." A "stress response" refers to an increase in energetic expenditure that results from exposure to the stressor (i.e., Level A harassment) (Reeder & Kramer, 2005). The presence and magnitude of a stress response in an animal depends on the animal's life history stage, environmental conditions, reproductive state, and experience with the stressor (U.S. Department of the Navy, 2010).

Potential impacts to marine mammals due to exposure to pile driving or extraction sounds (at or below 160 dB rms) include hearing loss, behavioral reactions, physiological stress, and masking. Sounds from an impact hammer are impulsive, broadband, and dominated by lower frequencies. The impulses are within the hearing range of marine mammals. Sounds produced from a vibratory hammer are similar in frequency to the impact hammer, except the levels are much lower than the impact hammer and the sound is continuous while operating. The application of the continuous noise (e.g., vibratory pile driving) threshold at 120 dB rms can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. As a result, these threshold levels are considered precautionary (National Marine Fisheries Service, 2009). The current Level A (injury) and current Level B (disturbance) thresholds are provided in Table 6-1.

NMFS threshold criteria for injury or behavioral disturbance have been applied to predict effects on marine mammals from sound generated by pile driving used in the Action Area (Figure 1-2). The analysis assumes that impact hammer pile driving would be conducted; however, in the event that vibratory pile driving or extraction is necessary due to construction requirements or conditions, it is included in the estimation of acoustic impacts on marine mammals as a result of the Proposed Action. Vibratory pile driving and extraction produce continuous, non-impulsive noise, and impact pile driving produces impulsive noise. The two types of sound affect marine mammals in different ways and require different thresholds for assessing effects.

Table 6-1: Injury and Behavioral Disturbance Thresholds for Underwater Pile Driving Sounds for Marine Mammal Species that May Occur within the Action Area

Marine Mammal Functional Groups	Species in the Action Area	NMFS Threshold Criteria			
		Underwater Vibratory Pile Driving Criteria (Sound Pressure Level dB re 1 µPa)		Underwater Impact Pile Driving Criteria (Sound Pressure Level dB re 1 µPa)	
		Level A (injury)	Level B (disturbance)	Level A (injury)	Level B (disturbance)
Low-Frequency Cetaceans	Gray Whale	199 rms	120 rms	183 rms	160 rms
Mid-Frequency Cetaceans	Common Dolphin and Bottlenose Dolphin	198 rms	120 rms	185 rms	160 rms
Otariids	California Sea Lion	219 rms	120 rms	203 rms	160 rms
Phocids	Pacific Harbor Seal	201 rms	120 rms	185 rms	160 rms

Notes: rms = root mean squared, dB re 1 µPa = decibels reference to 1 micropascal

6.2.2 Limitations of Existing Noise Criteria

There is currently no research or data supporting a response by pinnipeds or odontocetes to continuous sounds from vibratory pile driving as low as the 120 dB threshold. The 120 dB rms threshold level for continuous noise originated from research conducted by Malme et al. (1984; 1986) for California gray whale response to continuous industrial sounds such as drilling operations. The 120 dB continuous sound threshold should not be confused with the 120 dB pulsed sound criterion established for migrating bowhead whales in the Arctic as a result of research in the Beaufort Sea (Miller et al., 1999; Richardson et al., 1995). Southall et al. (2007) reviewed studies conducted to document behavioral responses of harbor seals and northern elephant seals to continuous sounds under various conditions, and concluded that those limited studies suggest that exposures between 90 dB and 140 dB re 1 µPa rms generally do not appear to induce strong behavioral responses.

6.2.3 Ambient Noise

To understand the potential for impact of pile driving/extraction on marine mammals in the waters outside the jetties forming Anaheim Bay, it is necessary to factor in the presence of anthropogenic noise that should be the dominate source of underwater ambient sound in the area. This assessment of the ambient sound is based on the acoustic monitoring record for the region that reflects the presence of commercial ports and recreational marinas (Hildebrand et al., 2011; Hildebrand et al., 2012; McKenna et al., 2012; McKenna et al., 2015; Redfern et al., 2017), as well as presence of industrial activities (e.g., petroleum extraction), and hardened acoustically reflective infrastructure such as breakwaters and jetties which affect sound propagation (see Figure 2-1).

Data gathered between 2009 and 2012 from an acoustic monitoring site near Santa Barbara Island (approximately 100 km west southwest of Anaheim Bay), provides an indication of the types and regularity of sounds contributing to ambient noise in the region (Hildebrand et al., 2012). Even that far from entrance the channels at Los Angeles/Long Beach, ship noise was dominant at frequencies below 100 Hz as a common anthropogenic sound (Hildebrand et al., 2012). Echosounder pings, most often used in the area for fish detection or as a depth-finder to aid navigation, were also present in the acoustic record (Hildebrand et al., 2012). Vessel noise was continuous but varied within each day at this offshore monitoring location. The trend noted was for increasing noise in the morning until a peak at approximately 0600, dropping off back in the afternoon, and then increasing again at approximately 1800, which reflected the preference in ship arrival and departure times at the Los Angeles/Long Beach ports located to the east northeast of the monitoring site (Hildebrand et al., 2012).

Unlike the deep water monitoring site next to Santa Barbara Island where distant low frequency vessel noise dominates ambient noise levels, in nearshore locations it is the much closer proximity to vessels and enhanced local sound propagation conditions (including shallow water and hardened marine infrastructure) that are important (McKenna et al., 2012). The Ports of Los Angeles/Long Beach together form the sixth busiest container port in the world, the entrance channels are within 5 NM of Anaheim Bay, and there are numerous associated ship anchorages arrayed around the entrance to Anaheim Bay (see Figure 2-1). In 2016 there were 4,277 ship port visits with over 8,400 ship transits of these nearshore waters (U.S. Army Corps of Engineers, 2017), which has varied from year to year (McKenna et al., 2012; McKenna et al., 2015), but not substantively. Vessels transiting the channels likely require the services of pilot vessels and tug boats, another source of noise. At the anchorages, it is reasonable to assume that temporarily moored ships would continue to be sources of noise given the need for electrical power generation as well as possible ship husbandry activities and cargo handling prior to docking.

Hydrophone recordings from October–November 2008 and March–October 2009 for 593 container ships transiting in the Traffic Separation Scheme (TSS) lanes for large commercial vessels going to and from the Ports of Los Angeles and Long Beach, were used to estimate the source levels for vessels using those ports (McKenna et al., 2013). Source levels from vessels were found to range from 177 dB to 194 dB re 1 micropascal squared at one meter (μPa^2 @ 1 m) over the frequency spectrum of 20−1,000 Hz (McKenna et al., 2013). These measured vessel source levels documented off Los Angeles and Long Beach are consistent with similar measurements and modeling of vessel source levels at various locations subject to intense commercial vessel traffic (Bassett et al., 2012; Erbe et al., 2012; Erbe et al., 2014; Jones et al., 2017; McKenna et al., 2012; Pine et al., 2016).

Redfern et al. (2017) combined Automated Identification System data from transiting vessels and hydrophone recordings to model the extent of the noise from vessel traffic in the TSS lanes leading into and out of Los Angeles/Long Beach. Although Redfern et al. (2017) did not provide results for the nearshore shallow waters closest to Anaheim Bay, Los Angeles, and Long Beach, they did predict a loss of communication space for blue, fin, and humpback whales in the waters between the Channel Islands National Marine Sanctuary and the coast. Given the proximity of Anaheim Bay to commercial vessels going into and out of the channels of Los Angeles/Long Beach, shallower water, and acoustically reflective infrastructure, the sound levels in the nearshore waters next to Anaheim Bay should be higher than those recorded offshore. In the nearshore waters adjacent to Anaheim Bay, this should include the vessel noise in the mid and high frequency range[1] that do not otherwise show or are not generally recorded in acoustic monitoring in deep offshore sites given the shorter propagation distances for those frequencies. As a result and in comparison to the loss of mysticete communication space in broader area between the Channel Islands and the coast (Redfern et al., 2017), the acoustic masking of all other quieter underwater sound by vessel noise (Erbe et al., 2016) and loss of communication space should be more pronounced around Anaheim Bay due to higher levels of proximate ambient anthropogenic sound sources as has been documented for other Navy pier replacement pile driving activity (U.S. Department of the Navy, 2015).

In addition to vessel noise associated with the ports of Los Angeles/Long Beach, other sources of underwater anthropogenic noise are present in and around Anaheim Bay. These include operations associated with an offshore petroleum extraction platform, *Platform Esther*, on the north side of the marked channel approximately 1.4 km from the jetties (straight out from the Anaheim Bay channel), and the presence of recreational vessels in Huntington Beach and Alamitos/Long Beach marinas, which have more than 2,000 boat slips.

Given that the waters off Anaheim Bay are subject to the sixth busiest commercial vessel traffic in the world, ambient sound outside of Anaheim Bay should be dominated by vessel noise. In addition to the broadband noise from commercial vessels and pleasure craft out of the adjacent Alamitos Bay Marina and Hunting Beach Marina, underwater noise from operation of *Platform Esther* would also likely contribute to potential masking of any sound that may propagate from plate anchor installation within Anaheim Bay. It is reasonable to assume that acoustically reflective structures (i.e., jetties and breakwaters), shallower water, petroleum extraction, adjacent marinas, and a greater density of large vessel activities adjacent to Anaheim Bay would result in more ambient noise than estimated for the broader area TSS lanes by Redfern et al. (2017).

6.3 Quantitative Modeling

The presence of marine mammal species in the nearshore coastal waters outside of and within Anaheim Bay is influenced by many variable natural factors such as seasonal ocean temperatures, prey distribution and availability and by anthropogenic factors such as disturbance and noise from vessel traffic associated with the Port of Los Angeles and Long Beach, Huntington Harbor, the adjacent Long

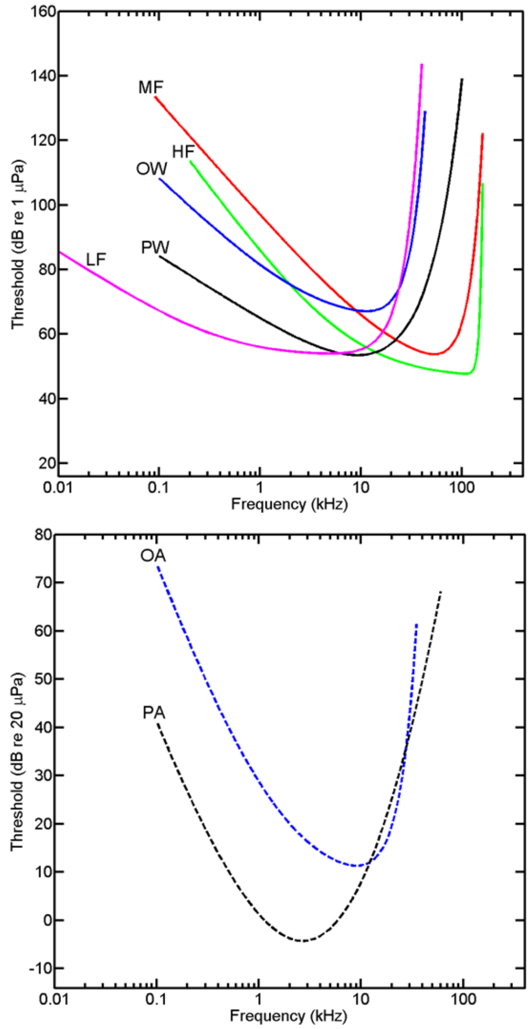
[1] Underwater acoustic monitoring in nearshore areas (Bassett et al., 2012; Erbe, 2002; Erbe et al., 2012; Erbe et al., 2014; Erbe et al., 2016; McKenna et al., 2012; McKenna et al., 2013; McKenna et al., 2016; Williams et al., 2009) have generally included a broader frequency spectrum than at deep water sites and, as a result, provide a record that includes the mid and high frequency range of sound associated with vessel noise.

Beach Marina, and oil production activities outside the entrance to Anaheim Bay (McKenna et al., 2012; McKenna et al., 2013). Prior to 2016, no marine mammal surveys had been conducted in the area; only opportunistic sightings during other monitoring or survey studies had occurred. The Navy initiated a monthly marine mammal survey between 2016 and 2017 within the Anaheim Bay Action Area to better estimate the variability and likely presence (or absence) of marine mammal species in the Action Area, (Bredvik et al., 2017. Unpublished Data). Additionally, daily marine mammal monitoring occurred during maintenance dredging in Anaheim Bay from March to June 2019, (Merkel & Associates Inc., 2019), however, there were too few sightings between these two monitoring efforts to calculate marine mammal densities. The standard acoustic marine mammal exposure modeling cannot be conducted for the Anaheim Bay Action Area because there is insufficient information from which to derive a density for each of the six marine mammal species that are likely to occur there. In addition, the documented highly variable presence and absence of these species cannot be accurately represented by modeling assuming static densities. It is therefore assumed that the species, maximum number, and frequency of marine mammals detected in Anaheim Bay during the daily and or monthly surveys represents the number of animals assumed to be present and exposed to acoustic effects from the Proposed Action on a daily basis. In short, all marine mammals previously observed within Anaheim Bay are assumed to be taken by Level B harassment at their expected rate of occurrence in the bay.

6.3.1 Hearing and Vocalization as a Consideration

The typical terrestrial mammalian ear (which is ancestral to that of marine mammals) consists of an outer ear that collects and transfers sound to the tympanic membrane and then to the middle ear (Rosowski, 1994). The middle ear contains ossicles that amplify and transfer acoustic energy to the sensory cells (called hair cells) in the cochlea, which transforms acoustic energy into electrical neural impulses that are transferred by the auditory nerve to high levels in the brain.

For this analysis, the marine mammals anticpated to be present in Anaheim Bay are arranged into the following functional hearing groups based on their generalized hearing sensitivities: low-frequency cetaceans (group LF: gray whales), mid-frequency cetaceans (group MF: common dolphins and bottlenose dolphins), otariids and other non-phocid marine carnivores in water and air (groups OW and OA: California sea lions), and phocids in water and air (group PW and PA: Pacific harbor seals). For this analysis, a single representative composite audiogram is shown in Figure 6-3 for each functional hearing group using audiograms from published literature. For discussion of all marine mammal functional hearing groups and their derivation, see the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects* (U.S. Department of the Navy, 2017).



Notes: For hearing in the water (top) and in air (bottom, phocids and otariids only).
LF = low frequency, MF = mid frequency, HF = high frequency, OW = otariids in water, PW = phocids in water, OA = otariids in air, PA = phocids in air.

Figure 6-3: Non-Normalized Composite Audiograms for Species Groups Likely Found in the Action Area

In general, frequency ranges of vocalization and hearing within a species show a good degree of correspondence. This is best demonstrated by the ultrasonic hearing ranges of odontocete (e.g., common dolphin and bottlenose dolphins) species that allow them to resolve fine-scale features of targets based on the high-frequency acoustic content of returning echoes. Likewise, the lack of specialized biosonar in other species is reflected in their lower-frequency hearing capabilities (Schusterman et al., 2000). As previously noted, the frequency range of vocalization in a species can logically be used to infer some characteristics of their auditory system. It is important to note, however, that aspects of vocalization and hearing sensitivity are subject to evolutionary pressures that are not solely related to detecting communication signals. For example, hearing plays an important role in detecting threats (Deecke et al., 2002), and high-frequency hearing is advantageous to animals with small heads in that it facilitates sound localization based on differences in sound levels at each ear

(Heffner & Heffner, 1992). This may be partially responsible for the difference in best hearing thresholds and dominant vocalization frequencies in some marine mammal species (e.g., Steller sea lions) (Mulsow & Reichmuth, 2010). Although there is a general alignment of hearing and vocalization frequency ranges, some caution must be taken when considering vocalization frequencies alone in predicting the hearing capabilities of species for which no data exist.

6.3.1.1 Sound Sources

Underwater sound levels are comprised of multiple sources, including physical noise, biological noise, and anthropogenic noise. Physical noise includes waves at the surface, earthquakes, ice, and atmospheric noise. Biological noise includes sounds produced by marine mammals, fish, and invertebrates. Anthropogenic noise consists of vessels (small and large), dredging, aircraft overflights, and construction noise. Known noise levels and frequency ranges associated with anthropogenic sources similar to those that would be used for this project are summarized in Table 6-2. Details of each of the sources are described in the following text.

Table 6-2: Representative Noise Levels of Anthropogenic Sources

Noise Source	Frequency Range (Hz)[1]	Underwater Noise Level (dB re 1 µPa)[2]	Reference
Small vessels	250 – 1,000	151 dB rms at 1 meter (m)	Richardson et al. 1995
Large vessels	20 – 1,500	170 – 180 dB rms at 1 m	Richardson et al. 1995
Tug docking gravel barge	200 – 1,000	149 dB rms at 100 m	Blackwell and Greene 2002

[1]These are the dominant frequency ranges but there is often considerable energy outside these ranges.
[2] These are average source SPLs at a particular location; site-specific bathymetry and substrate will affect SPLs.

In-water construction activities associated with the Proposed Action would include impact pile driving; however, some vibratory pile extraction could also occur. The sounds produced by these activities fall into one of two sound types: pulsed and non-pulsed. Impact pile driving produces pulsed sounds, while vibratory pile driving produce non-pulsed (or continuous) sounds. The distinction between these two general sound types is important because the potential to cause physical effects in each type is different, particularly with regard to hearing (e.g., Ward (1997) as cited in Southall et al. (2007); National Marine Fisheries Service (2016)).

Pulsed sounds (e.g., explosions, gunshots, sonic booms, seismic airgun pulses, and impact pile driving) are brief, broadband, atonal transients (Harris, 1998) and occur either as isolated events or repeated in some succession (Southall et al., 2007). Pulsed sounds are all characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures (Southall et al., 2007). Pulsed sounds generally have an increased capacity to induce physical injury as compared with sounds that lack these features (Southall et al., 2007).

Non-pulse (intermittent or continuous sounds) can be tonal, broadband, or both (Southall et al., 2007). Some of these non-pulse sounds can be transient signals of short duration but without the essential properties of pulses (e.g., rapid rise time) (Southall et al., 2007). Examples of non-pulse sounds include vessels, aircraft, machinery operations such as drilling or dredging, and vibratory pile driving (Southall et al., 2007). The duration of such sounds, as received at a distance, can be greatly extended in highly reverberant environments (Southall et al., 2007).

6.3.1.2 Submergence

Cetaceans spend their entire lives in the water and spend most of their 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 sound receiving structures (acoustic windows in the jaw) 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" (resting out of the water on land or structures) periods. Within the bay, harbor seals and sea lions would be most likely to occur in the water. When not actively diving, pinnipeds at the surface often orient their bodies vertically in the water column and often hold their heads above the water surface. Consequently, pinnipeds may not be exposed to underwater sounds to the same extent as cetaceans occurring in the same location but would be subject to airborne noise to a greater degree. There are no haulout sites within the Action Area and, at the sound of a first strike of impact pile driving, a harbor seal would likely dive and swim away from the sound. Sea lions may show the same behavior or rapidly swim away, alternating short dives with short surfacing (porpoising). Both species would likely dive or move away from the sound source, minimizing their exposure.

6.3.2 Distance to Sound Thresholds

All pile driving/extraction related underwater sound associated with the wharf will be contained within Anaheim Bay except for the installation of two anchors for the mooring bouys (OSCAR 4 and OSCAR 8) (Dahl, 2018). This is due to the sound being blocked by adjacent land, existing jetties, and phasing wherein all pile driving/extraction activities will be occurring after construction of a new breakwater (see Figure 1-2). The NMFS 2018 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (National Oceanic and Atmospheric Administration Technical Memorandum 2018) and the Optional User Spreadsheet (Version 2.0) provided by NMFS, were both used to calculate ZOIs for Level A impacts. Level B impacts were determined from a site-specific model was developed for transmission loss from pile driving for most pile types and sizes at a central point at the project site for the new pier and at three representative locations for the mooring bouys (Dahl, 2018). The model incorporated shadowing and diffraction of pile driving sound by the new breakwater. The Dahl (2018) approach is innovative and conservative as it allows for some sound to emerge on the outside of the breakwater barrier based on work on the diffraction of underwater sound by barriers (Kuramoto et al., 1994) as opposed to the common assumption that there is complete shadowing from barriers and that no sound emerges on the outside of the barrier.

The Dahl (2018) model did not include vibratory timber pile removal. The Level B impacts were determined using practical spreading loss (15logR) for vibratory extraction of timber piles. Transmission loss parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water depth, water chemistry, and bottom composition and topography. The general formula for transmission loss is:

$$TL = B * \log10(R) + C * R, \text{ where}$$

B = logarithmic (predominantly spreading) loss

C = linear (scattering and absorption) loss

R = ratio of receiver distance to source reference distance (usually 1 m or 10 m)

The C term is strongly dependent on frequency, temperature, and depth, but is conservatively assumed to equal zero for pile driving. The B term has a value of 10 for cylindrical spreading and 20 for spherical spreading. A practical spreading value of 15 is often used in shallow water conditions where spreading may start out spherically but then end up cylindrically as the sound in constrained by the surface and the bottom.

Table 6-3 identifies the sound source levels that were used in evaluating acoustic transmission from impact and vibratory pile driving in the current application. The assumptions regarding source levels for various types of pilings being driven correspond to the published values from the *California Department of Transportation (Caltrans) Compendium of Pile Driving Sound Data Update* (2015), *Compendium of Underwater and Airborne Sound Data from Pile Driving and Demolition Activities in San Diego Bay* (NAVFAC SW 2018), and *Washington Department of Transportation Technical Memorandum (WSDOT)* (Washington State Department of Transportation, 2011); all in water depths of approximately 15 meters or greater.

Table 6-3: Representative Sound Pressure Levels from Pile Driving/Removal

Pile Size & Type	Method	Average RMS dB re 1µPa	Absolute Peak dB re 1µPa	Average SEL dB re 1µPa	Reference
24-inch concrete piles and 16-inch concrete-filled fiberglass piles	Impact	175	193	160	Caltrans (2015) Table 2-2
12-inch steel I-beam follower all locations	Impact	181	194	171	Caltrans (2015) Figure I.4-8
12-inch steel I-beam follower all locations	Vibratory	170	N/A	N/A	NAVFAC SW (2018)
24-inch steel pipe piles[1]	Vibratory	170	N/A	N/A	NAVFAC SW (2018)
24-inch timber piles	Vibratory	152	N/A	N/A	Modified from WSDOT (2011)

[1]Source level used as a conservative proxy for vibratory removal of 24-inch steel pipe piles is based on 30-inch steel pipe piles

Table 6-4 provides the calculated areas of ZOIs associated with the maximum sound levels for the maximum impulsive and continuous sounds that are anticipated during project activities. It should be noted that the ZOI for Level A harassment would be closely monitored and subject to shutdowns if a marine mammal approaches the area. The ZOI areas and maximum distances for the pile driving and extraction activities are shown in Figure 6-4 through Figure 6-7. If calculated Level A values were less than 10 m (33 ft), the regulatory requirement of a minimum monitoring distance of 10 m (33 ft) was used.

Table 6-4: Modeled/Estimated Distances and Areas of Zones of Influence

Activity	Modeled/Estimated Distances to Thresholds and Areas of ZOIs					
	Level A[1]				Level B	
	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	Phocids	Otariids	All Marine Mammals	
					Impact Threshold	Vibratory Threshold
24-inch concrete piles and 16-inch concrete filled fiberglass piles (impact driving)	47 m 6921 m^2	10 m 313 m^2	25 m 1954 m^2	10 m 313 m^2	100 m 0.028 km^2	N/A
12-inch steel I-beam follower (impact driving)	47 m 6921 m^2	10 m 313 m^2	46 m 6629 m^2	10 m 313 m^2	Echo Location: 424 m (0.12 km^2) OSCAR 4 Location: 439 m (0.32 km^2) OSCAR 8 Location: 430 m (0.32 km^2)	N/A
12-inch steel I-beam follower (vibratory driving/extraction)	32 m 3204 m^2	10 m 313 m^2	20 m 1250 m^2	10 m 313 m^2	N/A	Echo Location: 821 m (0.263 m^2) OSCAR 4 Location: 1496 m (0.943 km^2) OSCAR 8 Location: 1498 m (1.72 km^2)
24-inch steel pipe piles[2] (vibratory extraction)	28 m 2452 m^2	10 m 313 m^2	17 m 903 m^2	10 m 313 m^2	N/A	770 m 0.54 km^2
24-inch timber piles (vibratory extraction)	10 m 313 m^2	10 m 313 m^2	10 m 313 m^2	10 m 313 m^2	N/A	1360 m 1.11 km^2

[1]If modeled/calculated value thresholds are less than 10 m (33 ft), the regulatory requirement of a minimum monitoring distance of 10 m (33 ft) was utilized
[2]Source level used as a conservative proxy for vibratory removal of 24-inch steel pipe piles is based on 30-inch steel pipe piles

Figure 6-4: Underwater Sound Zones of Influence for Pile Activities at the New Pier (24-inch concrete and 16-inch concrete filled fiberglass piles) and Existing Navigation Piles (24-inch timber and steel pipe piles)

Figure 6-5: Underwater Sound Zones of Influence for Installation of Mooring Buoys at the Echo Locations (12-inch steel I-beam follower).

Figure 6-6: Underwater Sound Zones of Influence for Installation of Mooring Buoy Anchor at the OSCAR 4 Location (12-inch steel I-beam follower).

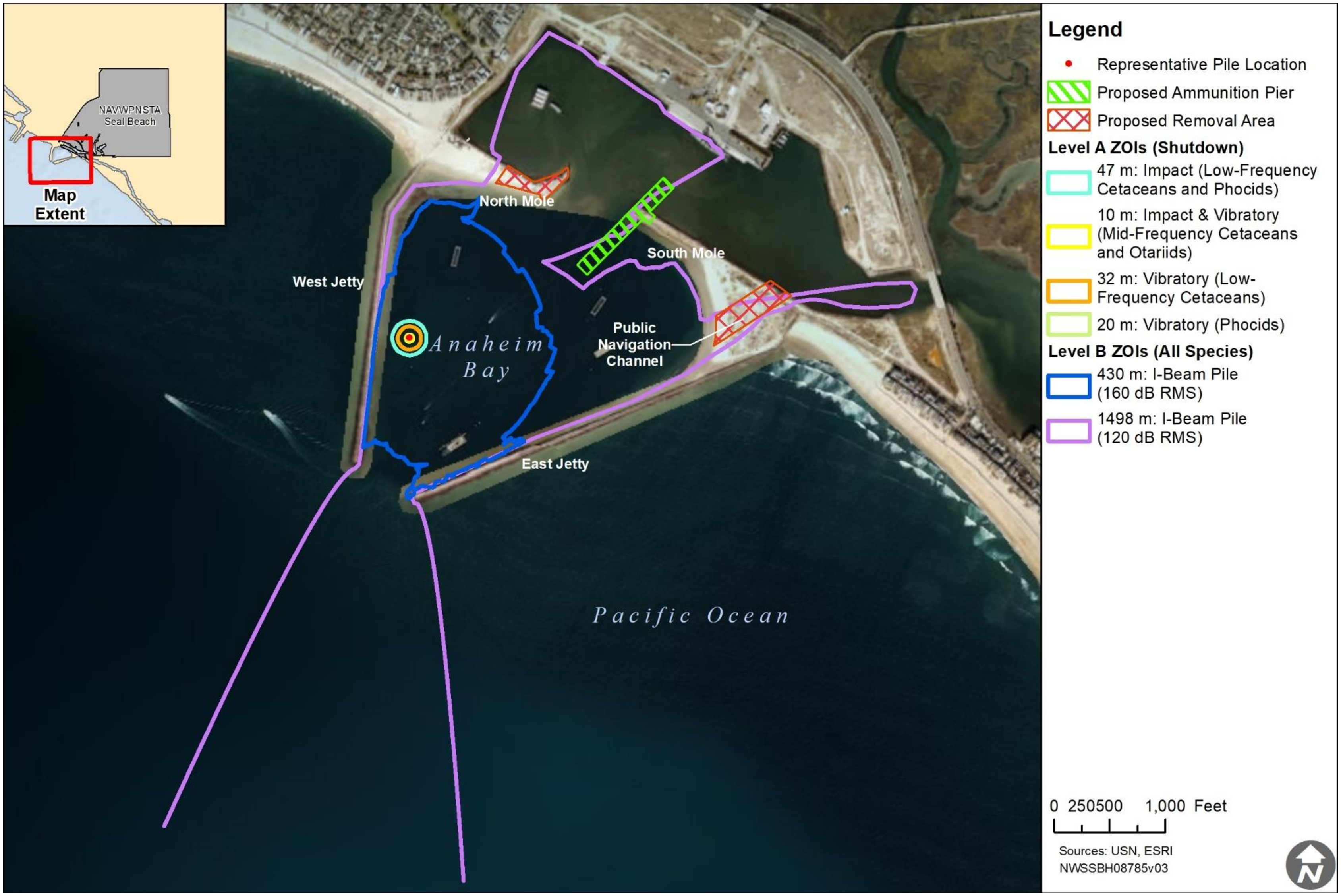


Figure 6-7: Underwater Sound Zones of Influence for Installation of Mooring Buoy Anchor at the OSCAR 8 Location (12-inch steel I-beam follower).

6.3.2.1 Implementing Conservation Measures to Reduce Sound Exposures

The Navy implements conservation measures (described in Chapter 11, Mitigation Measures to Protect Marine Mammals and Their Habitat) during sound-producing activities, including halting or delaying use of a sound source when marine mammals are observed entering the Level A shutdown zones. Sound-producing activities would not begin or resume until the shutdown zone is observed to be free of marine mammals.

The effectiveness of conservation measures depends on two factors: (1) the extent to which the type of conservation measure proposed allows for observation of Anaheim Bay prior to and during pile driving (probability of detection), and (2) the sightability of each species that may be present in the area (availability bias).

Implementation of conservation measures employed by the Navy, including a “soft start” to pile driving and use of qualified monitors to delay or stop pile driving when a marine mammal enters Anaheim Bay or nears the entrance channel, would reduce potential impacts to marine mammals to less than significant levels.

6.3.3 Impacts on Marine Mammals

Noise associated with pile driving would occur in the waters of Anaheim Bay at the NAVWPNSTA Seal Beach. An impact hammer method would be used to install piles; the analysis assumes that pile driving tempo would be at approximately three piles per day and take approximately 308 days to drive approximately 922 piles. The analysis assumes that pile extraction for the existing navigation piles would be at one pile per day and take approximately 28 days to remove up to 28 piles. Included in the number of days of pile driving is the installation of each of the five mooring buoy plate anchors. Installation would take approximately 2 hours for each mooring, but is assumed to occur over five days. According to standard operating procedures, best management practices, and minimization and monitoring measures, pile driving and extraction would occur during normal working (daytime) hours, and would not occur earlier than 45 minutes after sunrise or later than 45 minutes before sunset (81 Federal Register [FR] 52645).

The available scientific literature suggest that introduction of pile driving into the marine environment could result in short-term behavioral or physiological marine mammal impacts such as: altered headings; increased swimming rates; changes in dive, surfacing, respiration, feeding, and vocalization patterns; masking; and hormonal stress production (Southall et al., 2007). However, some field studies also suggest marine mammals may or may not observably respond to construction type sounds such as drilling and pile driving (California Department of Transportation, 2001; Moulton et al., 2005; Richardson & McGillvary, 1991; Richardson et al., 1990). Individual animal responses are likely to be highly variable depending on situational state, and prior experience or habituation. Southall et al. (2007) points out that careful distinction must be made of brief minor, biologically unimportant reactions as compared to profound, sustained, or biologically meaningful responses related to growth, survival, and reproduction.

Due to the installation of the new breakwater, sound from pile driving and extraction activities will mostly be confined to Anaheim Bay. Although it appears from Figure 6-4 that sound from vibratory removal of timber piles will extend beyond the Anaheim Bay jetties, it is not likely this will be the case. Since the acoustic impact of timber piles was not modeled, the practical spreading loss formula was utilized which does not account for the presence of the new breakwater which will prevent a majority, if not all, sound from moving beyond the mouth of Anaheim Bay. However, there are two locations where pile driving will occur for two mooring anchors beyond (seaward) of the new breakwater. During installation of the mooring anchors, only sound from vibratory pile driving activities will have the potential to travel outside of the jetties. It is anticipated that the likelihood of a behavioral impact to marine mammals outside of Anaheim Bay due vibratory driving at these two locations is extremely low. As discussed in Section 6.2.2 (Ambient Noise), shipping channel noise data (Hildebrand et al., 2012) indicates timing of arrivals and departures of ships to and from Los Angeles/Long Beach ports located to the east northeast of the project site, correspond to a preference for daylight operations. The 75-minute maximum for the use of vibratory driving/extraction would correspond to the documented peak vessel noise from vessels arriving and departing the adjacent commercial ports. It is reasonable to assume that if there are any marine mammals present in the waters outside Anaheim Bay during the maximum 75 minutes of construction-related vibratory driving/extraction for each of only two days, those marine mammals would not be behaviorally impacted by the proposed vibratory noise in any event since noise from installation of the plate anchors in Anaheim Bay should not exceed the level of sound marine mammals are exposed to in the area from a variety of sources as described.

6.3.3.1 Assumptions for Estimating Take of Marine Mammals by Pile Driving and Extraction

In the past, the Navy has used predictive modeling to analyze acoustic effects for other activities, including activities that use pile driving and extraction; however, a lack of marine mammal density data for Anaheim Bay precludes the use of a model. The estimated effects on marine mammals from pile driving in Anaheim Bay were based on the following assumptions:

1. The Level B ZOI for pile driving associated with the new pier would not extend outside of Anaheim Bay due to the construction of a new breakwater, configuration of the bay, and existence of the rock jetties, shallow depth and soft, sound absorbent substrate type in the bay.
2. Sound from vibratory pile installation and extraction at two of the mooring anchor locations could potentially extend beyond the Anaheim Bay entrance; however, given the short 75-minute duration for each of two installations and the location of the adjacent Los Angeles/Long Beach port complex, it is unlikely that any sound from vibratory pile installation and extraction that might extend outside of the bay would be distinguishable from other existing ambient noise, that marine mammals would be present in the area in the 75-minute period, or if marine mammals were present that the vibratory sound would result in reactions constituting a Level B behavioral take.
3. Scientific data on known habitats and available anecdotal and survey data for Anaheim Bay provides an estimate for the likely marine mammal species that may be present in Anaheim Bay.
4. The marine mammal species observed during surveys in Anaheim Bay are assumed to be present during pile driving and extraction activities and quantified as Level B takes at the observed survey encounter rate (Bredvik et al., 2017. Unpublished Data).
5. Level A takes are not expected due to the short distances calculated and the single point entrance into the bay through the Level B harassment zone and the construction shutdown procedures.
6. Given there are no haulout sites around Anaheim Bay, pinnipeds are only analyzed for impacts that may result from underwater sound.

6.3.3.2 Estimated Effects to Marine Mammals in Anaheim Bay from Pile Driving and Extraction

For assessing impacts from underwater sound in the Action Area, it is assumed that both cetaceans and pinnipeds that occur in the vicinity would be submerged and would thereby experience the maximum received SPLs predicted to occur underwater at a given distance from the pile being driven or extracted. As described in Section 4 (Affected Species Status and Distribution), insufficient occurrence data are available to support a quantitative analysis using the Navy's acoustic effects model.

For this analysis, the Navy predicted that common dolphins, bottlenose dolphins, California sea lions, harbor seals, and gray whales may be exposed to sound that would result in a Level B behavioral take from pile driving and any extraction.

Assumptions used to arrive at take estimates are:

1. Pile driving/extraction activities would take place over no more than five years. For the purposes of obtaining the maximum annual take number, the Navy assumes that construction would be concentrated to three years, even though it may be spread out over five years.
2. Pile driving for the new ammunition pier is estimated to occur at a tempo of three piles per day and timeframe of 308 days to drive approximately 922 piles.
3. Pile removal for the existing navigation piles is estimated to occur at a tempo of one pile per day over 28 days to remove up to 28 piles.
4. Vibratory driving and extraction for each of the mooring buoy plate anchor installations would take approximately 75 minutes, but is assumed to occur over five days (one day per anchor).
5. Total days of pile driving/extraction per year is 112; (336 total days [308 days of pile driving, 28 days of extraction/3 years).
6. Six California sea lions would be present in the Action Area every day for each pile driving or removal day based on the average seen over the surveys and monitoring data (Bredvik et al., 2017. Unpublished Data; Merkel & Associates Inc., 2019).
7. One harbor seal would be present in the Action Area every day of pile driving or removal (Bredvik et al., 2017. Unpublished Data; Merkel & Associates Inc., 2019).
8. Ten bottlenose dolphins would be present in the Action Area 6 days per month of pile driving or removal (Bredvik et al., 2017. Unpublished Data; Merkel & Associates Inc., 2019).
9. Nine common dolphins would be present in the Action Area 10 days per month (Merkel & Associates Inc., 2019).
10. One gray whale would be present in the Action Area 2 days per month (Merkel & Associates Inc., 2019).

If the Navy assumes a total of up to 112 days of pile driving/extraction per year, then the MMPA Level B behavioral harassment would be as follows:

- <u>California sea lions</u>: 6 sea lions x 112 pile driving days = 672 takes annually, and 2016 takes total within the five-year authorization over three years (672 x 3 years = 2016)
- <u>Harbor seals</u>: 1 harbor seal x 112 pile driving days = 112 takes annually, and 336 takes total within the five-year authorization over three years (112 x 3 years = 336)
- <u>Bottlenose dolphins</u>: 10 bottlenose dolphins x 22 pile driving days (112 pile driving days/30 days per month x 6 days per month) = 224 takes annually, and 672 takes total within the five-year authorization over three years (224 x 3 years = 672)

- Common dolphins: 9 common dolphins x 37 pile driving days (112 pile driving days/30 days per month x 10 days per month) = 336 takes annually, and 1008 within the five-year authorization over three years (336 x 3 years = 1008)
- Gray whales: 1 gray whale x 7 pile driving days (112 pile driving days/30 days per month x 2 days per month) = 7 takes annully, and 22 within the five-year authorization over three years (7 x 3 years = 22)

6.3.3.3 Limitations and Conservative Nature of the Pile Driving and Extraction Effects Assessment

The effects predicted from the pile driving and extraction assessment generally rely on many factors but are influenced greatly by assumptions, methods, and criteria used. Navy has furthermore assumed that the presence of marine mammals in Anaheim Bay during construction would be the same as observed in surveys of the area undertaken when no construction activities were present, which is believed to have resulted in a conservative overestimate of potential impacts to marine mammals.

7 Anticipated Impact of the Activity

The anticipated impact of the activity upon the species or stock of marine mammal.

Overall, the conclusions in this analysis find that impacts on marine mammal species and stocks would be negligible for the following reasons, and the following predicted annual exposures from impact analysis conducted for this LOA application are included:

1. As described in Section 6.2.1 (Pile Driving and Extraction), all acoustic harassments are within the non-injurious TTS or behavioral effects zones (Level B harassment).
2. Although the incidental take numbers presented in Table 5-1 represent estimated harassment under the MMPA, the calculations used for quantifying harassment did not take into consideration the likely behavioral avoidance of the increased anthropogenic activity related to construction within Anaheim Bay.
3. It is likely that marine mammals would avoid the locus of construction within Anaheim Bay and may therefore avoid approaching even the Level B harassment acoustic effects zone.
4. Additionally, the mitigation and monitoring measures described in Chapter 11 (Mitigation Measures to Protect Marine Mammals and Their Habitat) are designed to reduce sound exposure on marine mammals to levels below those that may cause “behavioral disruptions” and to achieve the least practicable adverse effect on marine mammal species or stocks.
5. The Proposed Action would not have any impacts at the level of marine mammal populations or stocks; only individual minor and inconsequential behavioral harassments are anticipated based on the history of similar construction activities undertaken by the Navy (U.S. Department of the Navy, 2013b, 2013c, 2015).

This LOA application assumes that short-term non-injurious SELs predicted to cause onset-TTS or temporary behavioral disruptions (non-TTS) qualify as Level B harassment. This overestimates reactions qualifying as harassment under MMPA because there is no established scientific correlation between pile driving and long-term abandonment or significant alteration of behavioral patterns in marine mammals. Consideration of negligible impact is required for NMFS to authorize incidental take of marine mammals. By definition, an activity has a “negligible impact” on a species or stock when it is determined that the total taking is not likely to reduce annual rates of adult survival or recruitment (i.e., offspring survival, birth rates).

Behavioral reactions of marine mammals to sound are known to occur but are difficult to predict. Recent behavioral studies indicate that reactions to sounds, if any, are highly contextual and vary between species and individuals within a species (Moretti et al., 2010; Southall et al., 2011; Tyack, 2009; Tyack et al., 2011). If a marine mammal does react to an underwater sound by changing its behavior or moving a small distance, the impacts of the change may not be important to the individual. On the other hand, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period and they do not have an alternate equally desirable area, impacts on the marine mammal could be negative because the disruption has biological consequences. Biological parameters or key elements having greatest importance to a marine mammal relate to its ability to mature, reproduce, and survive.

The importance of the disruption and degree of consequence for individual marine mammals often has much to do with the frequency, intensity, and duration of the disturbance. Isolated acoustic disturbances such as pile driving events within the Action Area usually have minimal consequences or no lasting effects for marine mammals. Marine mammals regularly cope with occasional disruption of their activities by predators, adverse weather, and other natural phenomena. It is reasonable to assume that they can tolerate occasional or brief disturbances by anthropogenic sound without significant consequences.

7.1 The Context of Behavioral Disruption and TTS – Biological Significance to Populations

The exposure estimates calculated by predictive models currently available reliably predict propagation of sound and received levels and measure a short-term, immediate response of an individual using applicable criteria. Consequences to populations are much more difficult to predict, and empirical measurement of population effects from anthropogenic stressors is limited (National Research Council, 2005). To predict indirect, long-term, and cumulative effects, the processes must be well understood and the underlying data available for models. In response to the National Research Council of the National Academies (2005) review, the Office of Naval Research (ONR) founded a working group to formalize the PCAD framework. The long-term goal is to improve the understanding of how effects of marine sound on marine mammals transfer between behavior and life functions and between life functions and vital rates. This understanding facilitates assessment of the population level effects of anthropogenic sound on marine mammals. This field and development of a state-space model is ongoing.

Conclusion – The Navy concludes that pile driving occurring in the Action Area would result in Level B behavioral takes only, as summarized in Table 5-1. Based on the best available science, the Navy concludes that exposures of marine mammals due to acoustic effects from pile driving would result in only short-term effects to individuals and would not affect annual rates of recruitment or survival for the following reasons:

1. All acoustic exposures are expected to be non-injurious TTS or behavioral effects zones (Level B harassment).
2. Incidental take presented in Table 5-1 represent conservative estimates of behavioral disturbance harassment, and do not take into consideration the Navy's standard operating procedures and mitigation measures, which should serve to reduce the probability of exposures (see Chapter 11, Mitigation Measures to Protect Marine Mammals and Their Habitat).
3. Anaheim Bay is a relatively small, confined bay with one inlet to the Pacific Ocean that is less than approximately 245 m wide and bounded by two jetties. This configuration aids in monitoring for the presence of marine mammals entering the Bay.

Consideration of negligible impact is required for NMFS to authorize incidental takes of marine mammals. By definition, an activity has a "negligible impact" on a species or stock when it is determined that the total taking is not likely to reduce annual rates of adult survival or recruitment (i.e., offspring survival, birth rates). Based on each species' life history information, the expected behavioral disturbance levels in the Action Area, and an analysis of behavioral disturbance levels in comparison to the overall population, an analysis of the effects of pile driving and extraction on species recruitment or survival is presented in Chapter 6 (Take Estimates for Marine Mammals) for each species or species group. The species-specific analyses, in combination with the mitigation and monitoring measures provided in Chapter 11 (Mitigation Measures to Protect Marine Mammals and Their Habitat), support the conclusion that both impact and vibratory pile driving and extraction activities would have a negligible impact on marine mammals.

8 Anticipated Impacts on Subsistence Uses

The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses.

Potential marine mammal impacts resulting from the Proposed Action in the Action Area would be limited to individuals located in the Action Area, and no subsistence requirements exist in the Action Area. Therefore, no impacts on the availability of species or stocks for subsistence use are considered.

9 Anticipated Impacts on Habitat

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

The habitat in the Action Area is not regularly used by marine mammals as discussed in Chapter 6 (Take Estimates for Marine Mammals). Therefore, temporary impacts and disturbance to marine mammal prey (e.g., krill, squid, fish) are not expected to be significant in terms of impacts on forage species with a wide distribution throughout coastal California, and with known high recruitment and biomass (Allen, 2006). Other sources that may affect marine mammal habitat were considered and potentially include the introduction of fuel, debris, and chemical residues into the water column. The effects of each of these components were considered in the Final EA.

Based on the detailed review within the Final EA, there would be minimal impacts and only negligible short-term effects to marine mammals resulting from loss or modification of marine mammal habitat, including water and sediment quality, food resources, vessel movement, and expended material.

10 Anticipated Effects of Habitat Impacts on Marine Mammals

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The proposed pile driving and extraction activities for the Final EA Action Area are not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations. Based on the discussions in Chapter 9 (Anticipated Impacts on Habitat), there would be minimal impacts and only negligible short-term effects on marine mammals resulting from loss or modification of marine mammal habitat.

11 Mitigation Measures to Protect Marine Mammals and Their Habitat

The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

The Navy recognizes the proposed activities have the potential to impact the environment. Unlike standard operating procedures, which are established for reasons other than environmental benefit, mitigation and monitoring measures are modifications to the proposed activities implemented for the sole purpose of reducing a specific potential environmental impact on a particular resource. Procedures discussed in this chapter are currently or were previously implemented as a result of past environmental compliance documents, ESA biological opinions, MMPA letters of authorization, or other formal or informal consultations with regulatory agencies.

The Navy's overall approach to assessing potential mitigation and monitoring measures is based on two principles: (1) mitigation and monitoring measures will be effective at reducing potential impacts on the resource; and (2) mitigation and monitoring measures are consistent with existing pile driving objectives, procedures, and safety measures.

11.1 Mitigation Zone Procedural Measures

11.1.1 Proposed Measures

The calculations for ZOIs discussed in Section 6.3.2 were used to develop mitigation measures for construction and demolition activities at NAVWPNSTA Seal Beach. The ZOIs effectively represent the shutdown zone that would be established to prevent Level A harassment to marine mammals. A monitoring plan will be developed further and submitted to NMFS for approval well in advance of the start of pile driving or removal activities. The monitoring plan will include visual observations of Level A and Level B ZOIs during pile driving and removal activites as described below.

1. During all pile driving and extraction activities, the Level A (shutdown) ZOI shall include all areas where the underwater SPLs are anticipated to equal or exceed the Level A (acoustic injury) harassment criteria for marine mammals.
2. During in-water activities, the underwater Level B ZOIs shall include areas where the underwater SPLs are anticipated to equal, or exceed, the 160 dB rms isopleths for impulsive noise sources, and the 120 dB rms isopleth for continuous noise sources.
3. Visual monitoring will be conducted within the Level A and B ZOIs before, during, and after all activities with identified Level A and B ZOIs. Monitoring will take place from 30 minutes prior to initiation through 30 minutes post-completion of project-related activities. A new 30 minute monitoring period will be observed at any time pile driving has ceased for more than 30 minutes throughout the day.
4. Prior to the start activities with in-water noise sources, the shutdown zones will be monitored for 30 minutes to ensure that they are clear of marine mammals. The activity will

only commence once observers have declared the shutdown zones clear of marine mammals; animals will be allowed to remain in the Level B ZOI and their behavior will be monitored and documented.

5. If an animal enters the Level A shutdown zones during pile driving/extraction, the activity would be stopped until the individual(s) is observed exiting the shutdown zone, the animal is thought to have exited the shutdown zone based on its course and speed, or the shutdown zone has been clear from any marine mammal sightings for a period of 30 minutes.
6. If a marine mammal is observed entering the Level B ZOI, an exposure would be recorded and behaviors documented; however, that activity would be completed without cessation. If the individual or group of animals approaches, or enters, the shutdown zone the activities will be halted.
7. During all in-water construction or demolition, a minimum shutdown ZOI of 10 m (33 ft) will be in place, regardless of the activity.
8. Monitoring will be conducted by qualified observers. All observers would be trained in marine mammal identification and behaviors, and have experience conducting marine mammal monitoring or surveys. Trained observers will be placed at the best vantage point(s) practicable to monitor for marine mammals and implement shutdown/delay procedures, when applicable, by notifying the hammer operator of a need for a shutdown of construction.
9. During the pile driving start-up period, a minimum of 10 m of visibility is required to commence pile driving activity. If conditions prevent the visual detection of marine mammals within 10 m, such as heavy fog, activities with the potential to result in Level A harassment will not be initiated.
10. Soft start for impact pile driving must be conducted at beginning of day's activity and at any time pile driving has ceased for more than 30 minutes. If vibratory pile driving has been occurring but impact has not for more than 30 minutes, soft start for the impact hammer must occur. The soft-start requires contractors to provide an initial set of three strikes from the impact hammer at 40 percent energy, followed by a 30-second waiting period, then two subsequent 3-strike sets.

12 Monitoring and Reporting

The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities, and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding. Guidelines for developing a site-specific monitoring plan may be obtained by writing to the Director, Office of Protected Resources.

12.1 Overview

The Navy's related, but separate, marine mammal research and development program is described in Chapter 13 (Suggested Means of Coordination). The following monitoring measures would be implemented along with the mitigation measures (Chapter 11, Mitigation Measures to Protect Marine Mammals and Their Habitat) in order to reduce impacts to marine mammals to the lowest extent practicable. A detailed marine mammal monitoring plan would be developed further and submitted to NMFS for approval well in advance of the start of construction.

12.2 Monitoring Plans and Methods

The Navy will monitor all of Anaheim Bay and the entrance channel during pile driving and extraction activities. Observers shall record all incidents of marine mammal occurrence, regardless of distance from activity, and shall document any behavioral reactions in concert with distance from piles being driven or extracted. Animals in the entrance channel beyond the entrance jetties and outside the shutdown zone (Anaheim Bay) will not result in shutdown; that pile segment would be completed without cessation, unless the animal approaches or enters the shutdown zone, at which point all pile driving and extraction activities would be halted. Monitoring will take place a minimum of 30 minutes prior to initiation through 30 minutes post-completion of pile driving and extraction activities. Pile driving and extraction activities include the time to remove a single pile or series of piles, as long as the time elapsed between uses of the pile driving and extraction equipment is no more than 30 minutes.

The following additional measures apply to visual monitoring:

1. Monitoring will be conducted by a minimum of two qualified observers (as described below), however, more observers will likely be used to maintain coverage of the entirety of Anaheim Bay for other non-marine mammal wildlife observations (birds, sea turtles, etc.). Observers will be placed at the best vantage point(s) practicable (as defined in the Monitoring Plan) to monitor for marine mammals and implement shutdown/delay procedures when applicable by calling for the shutdown to the hammer operator (81 FR 52652). Qualified observers are trained biologists, with the following minimum qualifications and requirements:
    - Independent, dedicated observers (i.e., not construction personnel) are required;
    - At least one observer must have prior experience working as an observer;

- Other observers may substitute education (undergraduate degree in biological science or related field) or training for experience;
- Where a team of three or more observers are required, one observer should be designated as lead observer or monitoring coordinator. The lead observer must have prior experience working as an observer;
- Visual acuity in both eyes (correction is permissible) sufficient for discernment of moving targets at the water's surface with ability to estimate target size and distance; use of binoculars may be necessary to correctly identify the target;
- Experience and ability to conduct field observations and collect data according to assigned protocols (this may include academic experience);
- Experience or training in the field identification of marine mammals, including the identification of behaviors;
- Sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations;
- Writing skills sufficient to prepare a report of observations including but not limited to the number and species of marine mammals observed; dates and times when in-water construction activities were conducted; dates and times when in-water construction activities were suspended to avoid potential incidental injury from construction sound of marine mammals observed within a defined shutdown zone; and marine mammal behavior; and
- Ability to communicate orally, by radio or in person, with project personnel to provide real-time information on marine mammals observed in the area as necessary.

2. Prior to the start of pile driving and extraction activity (or if pile driving has not occurred for 30 minutes or more), the shutdown zone will be monitored for 30 minutes to ensure that the action area is clear of marine mammals. Pile driving will only commence once observers have declared the shutdown zone clear of marine mammals; animals will be allowed to remain in the shutdown zone (i.e., must leave of their own volition), and their behavior will be monitored and documented.
3. If a marine mammal enters the shutdown zone during the course of pile driving or extraction operations, activity will be halted and delayed until either the animal has voluntarily left and been visually confirmed beyond the shutdown zone or 30 minutes have passed without re-detection of the animal. Monitoring will be conducted throughout the time required to drive a pile or extract a pile and for 30 minutes following the conclusion of pile driving or extraction (81 FR 52652).
4. Observers will be at the best vantage point(s) in order to properly see the shut down zone.
5. During all observation periods, observers will use binoculars and the naked eye to search continuously for marine mammals.
6. Monitoring distances will be measured with range finders.
7. Distances to animals will be based on the best estimate of the observer, relative to known distances to objects in the vicinity of the observer.
8. Bearing to animals will be determined using a compass.

9. In-water activities will be curtailed under conditions of fog or poor visibility that might obscure the presence of a marine mammal within a 10 m zone.

NMFS requires that observers use NMFS-approved sighting forms. NMFS requires that a minimum, the following information be collected on the sighting forms:

1. Date and time that pile driving or removal begins or ends;
2. Construction activities occurring during each observation period;
3. Weather parameters identified in the acoustic monitoring (e.g., wind, humidity, temperature);
4. Tide state and water currents;
5. Visibility;
6. Species, numbers, and if possible sex and age class of marine mammals;
7. Marine mammal behavior patterns observed, including bearing and direction of travel;
8. Distance from pile driving activities to marine mammals and distance from the marine mammal to the observation point;
9. Locations of all marine mammal observations; and
10. Other human activity in the area.

To the extent practicable, the Navy will record behavioral observations that may make it possible to determine if the same or different individuals are being "taken" as a result of project activities over the course of a day.

A draft report would be submitted to NMFS on an annual basis within 90 calendar days of completion of the annual reporting period (construction start date is currently to be determined). The results would be summarized in graphical form and include summary statistics of sightings and in-water construction activities. A final report would be prepared and submitted to the NMFS within 30 days following receipt of comments on the draft report from NMFS. At a minimum, the report shall include:

- General data:
    1. Date and time of activities;
    2. Water conditions (e.g., sea-state, tidal state);
    3. Weather conditions (e.g., percent cover, visibility);
    4. Pre-activity observational survey-specific data:
        - Dates and time survey is initiated and terminated;
        - Description of any observable marine mammal behavior in the immediate area during monitoring; and
        - Actions performed to minimize impacts to marine mammals.
    5. During-activity observational survey-specific data:
        - Description of any observable marine mammal behavior within monitoring zones or in the immediate area surrounding monitoring zones;
        - Actions performed to minimize impacts to marine mammals; and
        - Times when pile driving/extraction is stopped due to presence of marine mammals within the shutdown zones and time when pile driving resumes.

6. Post-activity observational survey-specific data:
   - Results, which include the detections of marine mammals, species and numbers observed, sighting rates and distances, behavioral reactions within and outside of mitigation and shutdown zones; and
   - A refined take estimate based on the number of marine mammals observed during the course of construction.

12.3 Monitoring Adaptation and Improvement

The following excerpt from the 2010 Update of the Navy Integrated Comprehensive Monitoring Program (ICMP) states the current top-level goals as developed through coordination with NMFS. In essence, the ICMP directs that monitoring measures prescribed in a range or project-specific monitoring plan and Navy-funded research relating to the effects of Navy pile driving activities on marine species should be designed to accomplish one or more of the following top-level goals:

1. An increase in our understanding of the likely occurrence of marine mammals or ESA-listed marine species in the vicinity of the action (e.g., presence, abundance, distribution, and density of species);
2. An increase in our understanding of the nature, scope, or context of the likely exposure of marine mammals or ESA-listed species to any of the potential stressor(s) associated with the action (e.g., tonal and impulsive sound), through better understanding of one or more of the following: (1) the action and the environment in which it occurs (e.g., sound source characterization, propagation, and ambient noise levels); (2) the affected species (e.g., life history or dive patterns); (3) the likely co-occurrence of marine mammals or ESA-listed marine species with the action (in whole or part) associated with specific adverse effects; and/or (4) the likely biological or behavioral context of exposure to the stressor for the marine mammal or ESA-listed marine species (e.g., age class of exposed animals or known pupping, calving or feeding areas);
3. An increase in our understanding of how individual marine mammals or ESA-listed marine species respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible; e.g., at what distance or received level);
4. An increase in our understanding of how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either (1) the long-term fitness and survival of an individual; or (2) the population, species, or stock (e.g., through effects on annual rates of recruitment or survival);
5. An increase in our understanding of the effectiveness of mitigation and monitoring measures;
6. A better understanding and record of the manner in which the authorized entity complies with the Incidental Take Authorization and Incidental Take Statement;
7. An increase in the probability of detecting marine mammals (through improved technology or methods), both specifically within the safety zone (thus allowing for more effective implementation of the mitigation) and in general, to better achieve the preceding goals; and
8. A reduction in the adverse impact of activities to the least practicable level, as defined in the MMPA.

13 Suggested Means of Coordination

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

13.1 Overview

The U.S. Navy is one of the world's leading organizations in assessing the effects of human activities on the marine environment, including marine mammals. Navy scientists work cooperatively with other government researchers and scientists, universities, industry, and non-governmental conservation organizations in collecting, evaluating, and modeling information on marine resources. They also develop approaches to ensure that these resources are minimally impacted by existing and future Navy operations. It is imperative that the Navy's research and development (R&D) efforts related to marine mammals are conducted in an open, transparent manner with validated study needs and requirements. The goal of the Navy's R&D program is to enable collection and publication of scientifically valid research as well as development of techniques and tools for Navy, academic, and commercial use. Historically, R&D programs are funded and developed by the Navy's Chief of Naval Operations Energy and Environmental Readiness (OPNAV N45) and ONR, Code 322 Marine Mammals and Biological Oceanography Program. The primary focus of these programs since the 1990s is understanding the effects of sound on marine mammals, including physiological, behavioral and ecological effects.

ONR's current Marine Mammals and Biology Program thrusts include, but are not limited to, (1) monitoring and detection research; (2) integrated ecosystem research, including sensor and tag development; (3) effects of sound on marine life (such as hearing, behavioral response studies, and physiology [diving and stress]), PCAD; and (4) models and databases for environmental compliance. To manage some of the Navy's marine mammal research programmatic elements, OPNAV N45 developed in 2011 a new Living Marine Resources (LMR) R&D Program. The goal of the LMR R&D Program is to identify and fill knowledge gaps and to demonstrate, validate, and integrate new processes and technologies to minimize potential effects to marine mammals and other marine resources. Key elements of the LMR program include:

- Develop an open and transparent process with a dedicated web site for both project management and public review;
- Provide program management and execution, including inputs from various Navy commands involved in monitoring and research;
- Ensure funding of research and development projects that include internationally respected and authoritative researchers and institutions;
- Establish and validate critical needs and requirements with input from a Navy Regional Advisory Committee;
- Interact with key stakeholders outside of the Navy via the Regional Advisory Committee;
- Identify key enabling capabilities and investment areas with advice and assistance from a Navy Technical Review Committee;
- Maintain close interaction and coordination with the ONR basic and early stage applied research program;
- Develop effective information for Navy environmental planners and operators; and
- Provide effective management of project funding.

13.2 Navy Research and Development

Navy Funded Research – Both the OPNAV N45 and ONR R&D programs have projects ongoing within Southern California. Some data and results from these R&D projects are typically summarized in the Navy's annual range complex Monitoring Reports currently submitted to NMFS each year. In addition, the Navy's Pacific Fleet monitoring is coordinated with the R&D monitoring in a given region to leverage research objectives, assets, and studies where possible under the ICMP (see Chapter 12, Monitoring and Reporting). Public websites that detail some of these efforts include:

- https://navysustainability.dodlive.mil/ environment/lmr/
- https://navysustainability.dodlive.mil/environment/marine-mammals-ocean-resources/marine-mammal-research/
- https://www.onr.navy.mil/task-force-ocean
- https://www.navymarinespeciesmonitoring.us/

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