INCIDENTAL HARASSMENT AUTHORIZATION APPLICATION

HARMONY PLATFORM

Santa Ynez Production Unit

Submitted to

Office of Protected Resources
National Marine Fisheries Service, NOAA
Silver Spring, MD 20910

Submitted by

ExxonMobil Production Company
Houston, TX 77210

April 28, 2014
Revision 0.4

Prepared by

Maxon Consulting, Inc.
San Diego, CA 92122

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ACRONYMS AND ABBREVIATIONS

%	percent
<	less than
>	greater than
°	degrees
µPa	micro-Pascal
BSEE	Bureau of Safety and Environmental Enforcement
ca.	approximately
C	Celsius
cm^{-3}	cubic centimeter
CV	coefficient of variation
d	density
dB	decibel
dBA	decibel with A-weighting filter
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Study
ESA	Endangered Species Act
ft	feet
FWRAM	Full Waveform Range-dependent Acoustic Model
g	gram
GDEM	Global Elevation Digital Map
Hz	Hertz
IAGC	The International Association of Geophysical Contractors
IHA	Incidental Harassment Authorization
IUCN	International Union for Conservation of Nature
JIP	Joint Industry Program
kg	kilogram
kHz	kilohertz
kJ	kilojoule
km	kilometer
km^2	square kilometer
lbs	pounds
m	meter
m^2	square meter
m^3	cubic meter
mi	mile
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
N	North
nm	nautical mile
NMFS	National Marine Fisheries Services
NOAA	National Oceanic and Atmospheric Administration
OGP	Oil and Gas Producers
RAM	Range-dependent Acoustic Model
rms	root-mean-square

ROV	remotely operated vehicle
s^{-1}	per second
SEL	Sound Exposure Level
SPL_{rms}	root-mean-square sound pressure level
USGS	U.S. Geological Survey
W	West
ZOI	Zone of Influence

1 INTRODUCTION AND DESCRIPTION OF ACTIVITIES

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals.

- Pile driving of 6 conductor pipes at Harmony platform with 90 kJ hydraulic hammer
- Potential noise harassment of marine mammals from impulsive hammer driving only

1.1 Introduction

In accordance with the Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. § 1361 et seq.), as amended, ExxonMobil U.S. Production Company (ExxonMobil) is applying for an Incidental Harassment Authorization (IHA) to install six conductor pipes at Harmony platform, located 10 kilometers (km) off the California coast, between Point Conception and the city of Santa Barbara (**Figure 1-1**). Conductor pipes are required for drilling operations. They provide protection, stability, structural support for the well loads, and a conduit for the return of drill muds and cuttings to the platform for treatment. They also prevent unconsolidated sediment from caving into the wellbore. Conductor pipe hydraulic hammering is the only activity with the potential to harass marine mammals, defined at two levels as potential injury (Level A) and potential behavioral disturbance (Level B) in the 1994 and 2007 amendments to the MMPA. This IHA application is organized into 14 sections (excluding references), corresponding with 14 reporting requirements defined by NOAA National Marine Fisheries Service (NMFS) (see http://www.nmfs.noaa.gov/pr/permits/incidental.htm#iha; accessed 01/29/14).

Harmony is one of three offshore platforms in ExxonMobil's Santa Ynez Production Unit, and is located in the Hondo field (Lease OCS-P 0190) at a water depth of 366 m (ca. 1200 ft). Harmony platform was installed on 21 Jun 1989 with the sole purpose of producing crude oil and gas condensate, which it began on 30 Dec 1993. The platform jacket structure, depicted in **Figure 1-2**, currently has conductors installed in 51 out of 60 slots. Addition of eight straight conductors at Harmony was approved by the Bureau of Safety and Environmental Enforcement (BSEE) on February 11, 2013 to maintain current production levels from the existing platform. Conductor installation with a hydraulic hammer is consistent with approved development plans, and is the same method that was used to install conductors on all three Santa Ynez platforms from 1981 (Hondo) through 1993 (Harmony and Heritage). Conductor driving is the only proven installation method that enables management of potential interferences with the existing platform infrastructure that will also reach the target depth. Non-drive conductor installation methods are not deemed feasible at this time due to increased risk to platform structural integrity, offset well collision, and shallow-hole broaching.

1.2 Description of Activities

The total length of a single conductor pipe is approximately 505 m. Each conductor consists of multiple sections of 26-inch diameter steel pipe that will be sequentially welded end-to-end from an upper deck of the platform (see Figure 1-2), and lowered into the 366-m water column through metal rings (conductor guides) affixed to the jacket structure that orient and guide the conductor. Once the conductor reaches the sediment surface, gravity-based penetration (i.e., the conductor will penetrate the seabed under its own weight) is expected to reach approximately 30 m below the seabed. A hydraulic hammer (S-90 IHC) with a manufacturer's specified maximum energy of 90 kilojoules (kJ) (i.e., 66.4 kft · lbf) will be located on the drill deck and used to drive the conductor to a target depth of 90 ± 1 m

below the seabed; therefore, only roughly 60 m of each 505-m long conductor pipe will require hydraulic driving.

The portion of a complete conductor that must be actively driven (hammered) into the seafloor consists of five to seven sections, which are sequentially welded end to end. Setup and welding will take 3.5 to 7.3 hours per section, mostly depending on the type of welding equipment used (e.g., automated welder). Hammer driving will take an estimated 2.5 to 3.3 hours for each section, depending primarily on sediment physical properties, which affect penetration rate. Complete installation of each conductor is estimated at approximately 14 days based on 24-hour (continuous) operations. **Table 1-1** presents a summary of driving activities and estimated number of joints (requiring welding) for each conductor pipe**.** **Figure 1-3** shows the estimated time in days for each of these activities that are required to install a single conductor pipe. The timeline for the installation of all six conductor pipes over the project duration is presented in Section 2.

For the purpose of sound exposure calculations (see Section 6), a conservative approach was taken that assumes active hammering of 3.3 hours, followed by 7.3 hours of hammer downtime over approximately 53 hours (2.2 days) of the approximately 14 days required to install one conductor pipe. This schedule produces 4.125 days (99 hours) of cumulated hammer driving for all six conductors over the project duration.

Figure 1-4 depicts the 3.3 hour drive/7.3 hour downtime cycle for an isolated 24-hour period, showing a maximum of 9.4 hours of hammer driving. In the event that efficiencies produce a 2.5 hour drive/3.5 hour downtime cycle, a maximum of 10.0 hours of hammer driving could occur in a single 24-hour period.

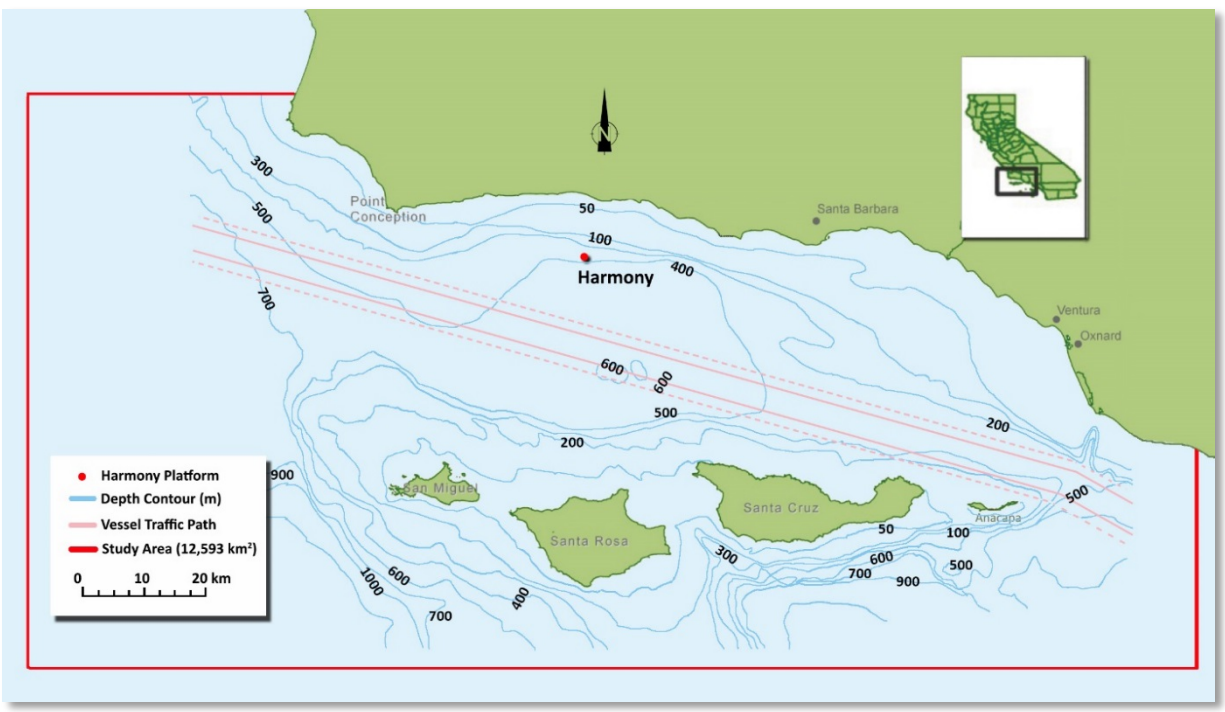

Figure 1-1. Location of Harmony platform, general site bathymetry, and Santa Barbara Channel study area boundaries (modified from Redfern et al. 2013). Total study area estimated at 12,593 km^2.

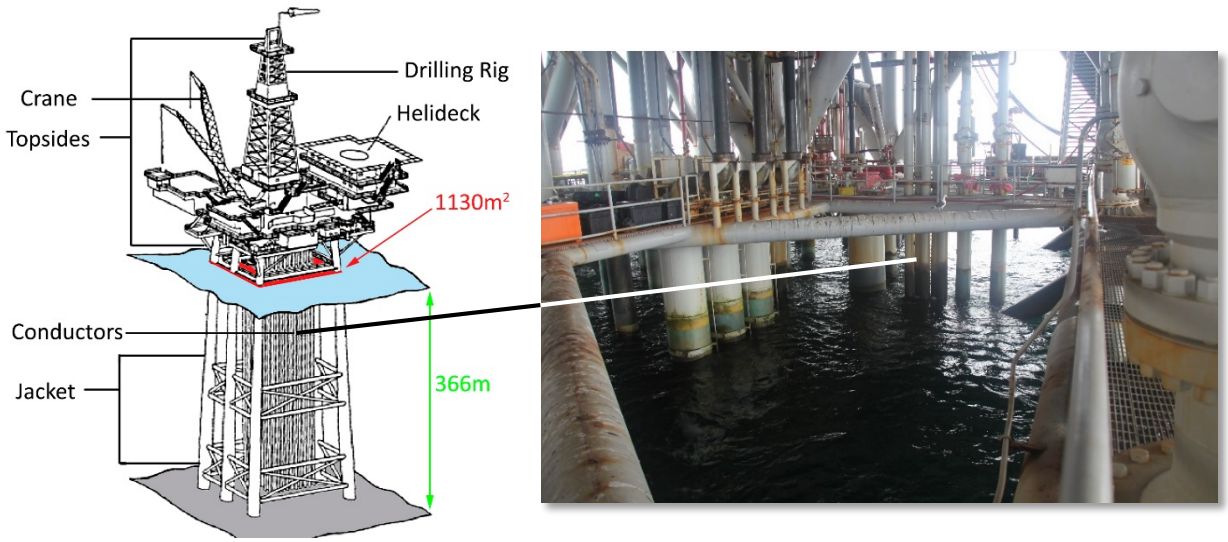

Figure 1-2. Schematic of general platform configuration showing platform area at sea level and water depth (left), and photo showing exposed conductor pipes and Harmony platform infrastructure at sea level (right).

Table 1-1. Summary of installation activities and associated characteristics for each conductor pipe.

Conductor Pipe Activity	Pipe Length (m)	Estimated Number of Joints	Driving Required
Installation level to sea level	49	4	No
Sea level to seafloor	366	28	No
From 0 to ~30 m below the seafloor	30[1]	3	No
From ~30 to 90 ± 1 m below the seafloor	60	5-7	Yes[2]
Clean up & Completion	NA	NA	No

[1]Estimated range of gravity-based penetration; [2]See Figure 1-4.

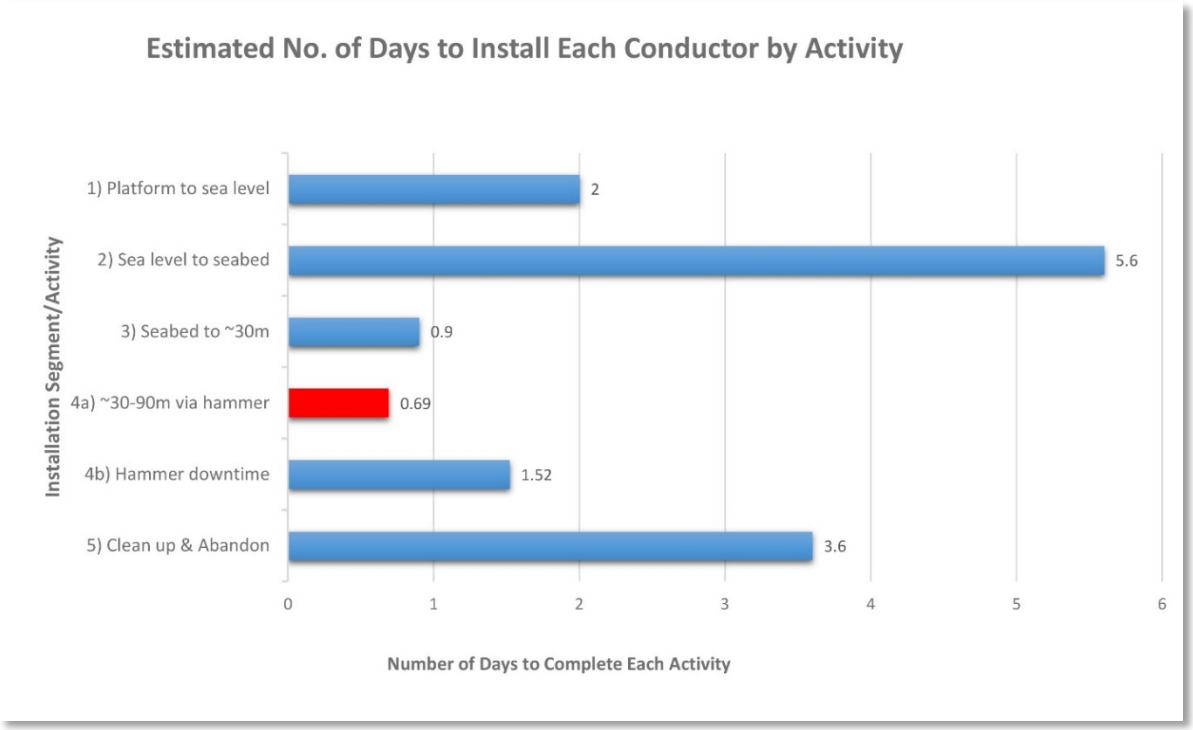

Figure 1-3. Number of days estimated to complete each activity required to install one conductor pipe. Note: **red** denotes total duration of active hammer driving estimated per conductor based on 3.3 hours for each of 5 joints.

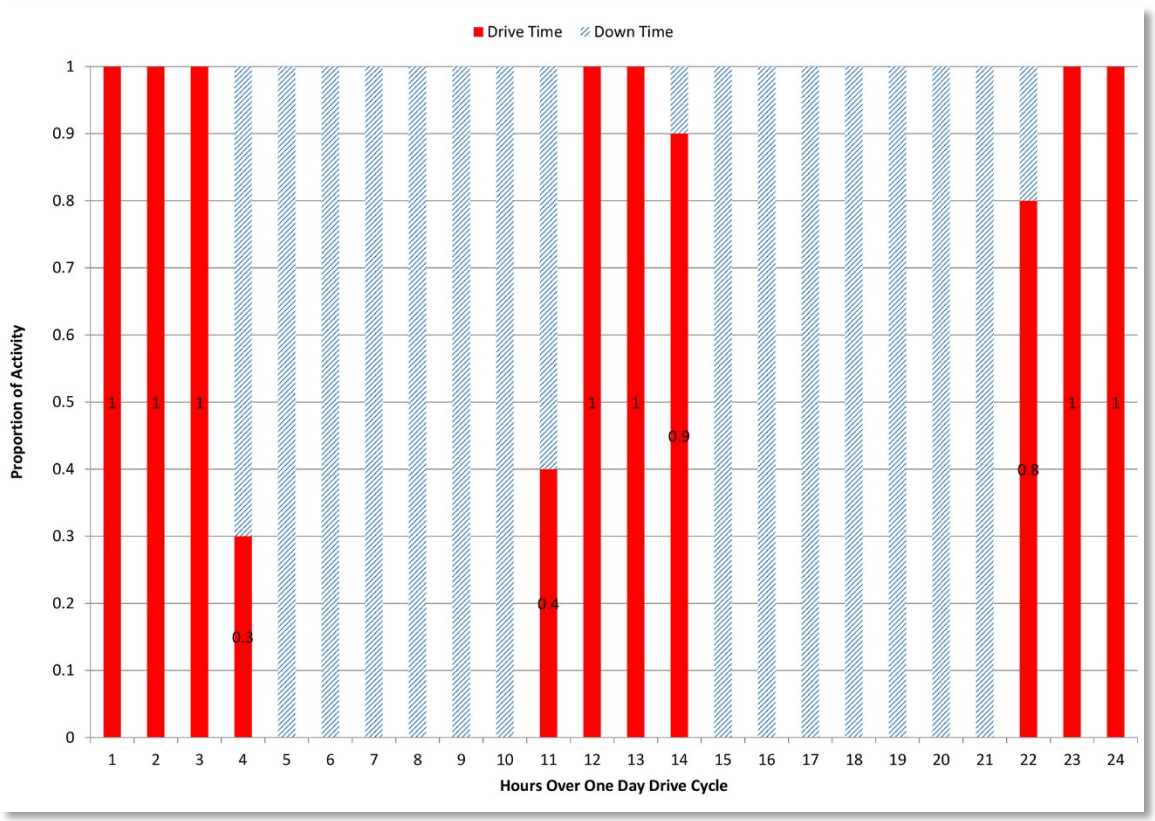

Figure 1-4. Maximum number of hours of hammer driving (9.4 hours) shown in **red** that could occur in one 24-hour period assuming 3.3 hour drive/7.3 hour downtime cycle.

2 DATES, DURATION, AND LOCATION OF ACTIVITIES

The dates and duration of such activities, and the specific geographical region where they will occur.

- Estimated project dates: optimal is mid-July to mid-October 2014, but could occur anytime within a 12-month period from the effective date of the IHA
- Estimated project duration: 84 to 91 days
- Geographical region: 10 km offshore southern California in the Santa Barbara Channel

This section presents the anticipated dates and duration of the project, and a description of the project location and setting. In particular, information on geological and oceanographic setting, as it relates to underwater sound propagation, is presented.

2.1 Dates and Duration

Assuming timely completion of the regulatory process, the project is targeted to begin as early as mid-July 2014 and proceed to completion in mid-October 2014, but precise scheduling is not presently possible due to logistical and regulatory permitting uncertainties. Once the project is started, the expected duration is 91 days, under normal working conditions with approximately 84 days of installation activity on Harmony platform bounded by seven days of project mobilization/demobilization activities. As described in Section 1, it will take approximately 14 days to install each conductor (6 conductors x 14 days = 84 days). An additional 30 days may be required to complete the regulatory process, shifting the project start date to mid-August, and ending in mid-November. ExxonMobil respectively requests that the IHA permit is issued in July–August 2014 timeframe to allow for flexibility in scheduling operations, equipment, and personnel, as well as to ensure sufficient time to arrange for monitoring field services (see Section 13).

A timeline of activities over the approximate three month duration is depicted in **Figure 2-1**. Of the estimated 84 days, hammer driving will occur over 30 intermittent intervals of 3.3-hours each for a combined total of 4.125 days, or 5% of the entire project (3.3 hours x 5 joints x 6 conductors = 99 hours or 4.125 days). As described in Section 1, each drive interval is followed by an estimated 7.3 hours of downtime, before the next 3.3 hours of driving begins. This process is repeated for each of the five joints and for each of the six conductors.

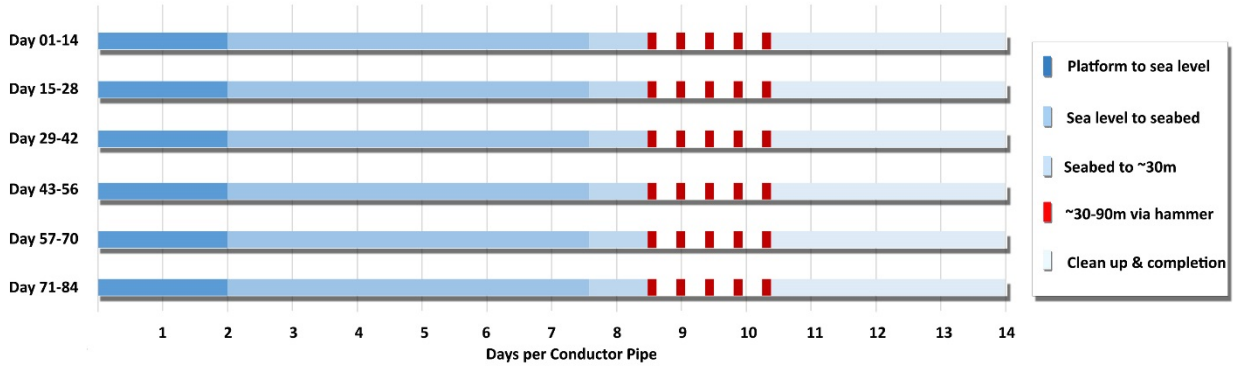

Figure 2-1. Representative project timeline showing installation activity period for each of the six conductor pipes (14 days x 6 pipes = 84 days). Active hammer driving at 3.3-hour intervals is shown in **red** (3.3 hrs x 5 joints = 16.5 hrs/pipe or 4.125 days total for 6 pipes). Actual drive time may vary from 2.5-3.3 hours. There is no hammer driving during any other (non-red) period.

2.2 Geographical Region and Setting

Harmony platform is located in the Santa Barbara Channel (the Channel), which is approximately 100-km long and 40-km wide, situated between the Channel Islands and the east-west trending coastline. The Channel is the site of several other producing oil fields, including Ellwood, Summerland, Carpinteria offshore and Dos Cuadras. The Santa Barbara basin is the prominent feature of the Channel, with sill depths of approximately 250 m and 450 m at eastern and western entrances, respectively, with shallow (ca. 60 m) inter-island passages to the south.

Harmony's geographical position is 34° 22′ 35.906′′ N, 120° 10′ 04.486′′ W, at a water depth of 366 m on the continental slope below a relatively steep (7.5%) descent, and at 4.7 km from the shelf break, typically defined at the 100-m isobath (contour) (USGS 2009) (see **Figure 1-1**, Section 1). It is 3.3 km from the nearest buffered 200-m contour, which has been noted for its association with higher recorded densities of selected cetacean species (Redfern et al. 2013). It also is located 10-15 km north of a common traffic route used by vessels to access the ports of Long Beach and Los Angeles (see **Figure 1-1**).

Descriptions of general physical and environmental features of the project area relevant to underwater sound propagation follow. Additional background material is provided in a report prepared by JASCO, which presents methods and results of in-air and in-water acoustic modeling specific to this project. The report is included in an addendum to this IHA application.

2.2.1 Site Bathymetry and Sediment Physical Characteristics

Harmony platform is located below a relatively steep (7.5%) descent from the shelf margin, which is defined by the 100-m contour in this area (USGS 2009). It sits at a water depth of 366 m, just above the northern rim of the Santa Barbara Basin which is roughly confined by the 400-m contour, descending to depths exceeding 600 m. Depths below the platform are defined by a gentle slope (ca. 1%), which extends to the 600-m contour at the basin maximum. To the west of the platform, the slope attenuates to about 3% grade between 100-m and 400-m contours, near the western sill of the basin. To the east, the slope becomes steeper, approaching 15% grade between 100-m and 400-m contours, at 20 km east of the platform.

Harmony platform is located on unconsolidated fine-grained silty-clay and clayey-silt sediments (**Table 2-1**). These sediments are typical of slope depths proceeding into the basin where sediments may be 2000 m thick. Stein (1995) reported similar sediment grain characteristics from core segments penetrating 196 below the sediment surface at a basin depth of 565 m. Sediments were primarily of terrigeneous origin, dominated by quartz and clay minerals montmorillonite and illite. These sediments are similar in quartz content and clay-mineral composition to suspended sediment introduced by the Santa Clara River, which has an average annual sediment load of about 600,000 m^3 (Brownlee and Taylor 1981). These turbid sediment plumes, arising primarily from the Santa Clara River to the east and from Santa Maria and Santa Inez Rivers north of Point Conception, may extend more than 5 Km from shore and inshore from Harmony platform during periods of heavy runoff.

Sediments at Harmony and throughout the Channel slopes and basin reflect terrigeneous origins from coastal watersheds (mainly the Santa Clara River), with relatively minor inclusions of marine biogenic origin (e.g., calcareous and diatomaceous fractions). Shell fragment debris dislodged from the jacket structure during peak storm wave surges and from periodic maintenance has been observed around the periphery of the jacket in ROV surveys, but significant debris was not observed at the conductor pipe locations designated for this project.

No known hard substrates have been identified by Minerals Management Service and National Marine Fisheries Service surveys within 5 km of the Platform (see Keller et al. 2005). Extending from shore to the 100-m shelf break, hard substrate is common, supporting extensive kelp beds at depths less than 20 m,

on cobbles and boulders. Further offshore, at depths of about 65 m to the shelf break, regions of folded ridges and pinnacles up to 3 m in relief have been recorded (USGS 2009).

Sediment physical and geophysical acoustic data are required to model underwater sound resulting from conductor hammer driving. To accomplish this, JASCO used sediment physical properties to produce a geoacoustical profile, ranging from the sediment-water interface to depths >500 m in the sediment profile. Geoacoustical results and corresponding sediment data are summarized in **Table 2-1**. In summary, an increase in sediment density of 1.75 g cm^{-3} at the sediment surface to 2.4 g cm^{-3} at profile depths >500 m, results in a concomitant increase of 58% in compressional sound speed.

Table 2-1. Sediment characteristics and modeled geoacoustical profile in the vicinity of Harmony platform. Results representative of Harmony location are shown in bold (provided by JASCO).

Depth below seafloor (m)	Sediment Physical Properties		Geoacoustical Profile			
	Particle Size Class	Density (g cm^{-3})	Compressional sound speed (m s^{-1})	Compressional attenuation (dB λ^{-1})	Shear sound speed (m s^{-1})	Shear attenuation (dB λ^{-1})
0–200[1]	**Silty clay and clayey silt[1]**	**1.75**	**1500**	**0.5**	**100**	**1.5**
200–500	Silty clay and clayey silt	1.75–1.97	1850–2374	0.4–0.095		
> 500	Semi-consolidated sediment	2.4	2374	0.095		

[1]representative conditions for target depth of ~90 m for installed conductor pipes at Harmony platform

2.2.2 Hydrodynamics and Water Column Physical Properties

Hydrodynamic and seawater properties at Harmony are complex as a result of shifting wind and current patterns that occur in the Channel in response to changing coastline orientation at Point Conception (Beckenbach 2004). The Channel is a cross-roads for large scale water masses moving along the California coast. Waters from north of Point Conception are cooled by coastal upwelling as they move southward. Most of these waters pass outside the Channel Islands but some enter the Channel at its west end. Warmer waters from the south are driven poleward by the Southern California Counter-current. Mean nearshore circulation in the entire Southern California Bight is dominated by this current (Hickey 1993), which enters the Channel from the east. Water mass properties are determined by relative inputs to the Channel from eastern and western entrances.

Hydrodynamics. Auad et al. (1999) determined that transport from the east accounted for 60% of the water entering the Channel with 33% originating from the southern portion of the western entrance and the remaining 7% from southern inter-island passages. These contrasting source waters mix in the Channel, often forming complex patterns visible in satellite images of sea surface temperature. They represent the more persistent large scale movement of water masses, which are driven by dynamic processes on scales much larger than the Channel. Current speed fluctuations exhibit significant variation, typically ranging from 10 to 40 cm s^{-1} (Hickey 1992), extending to a depth of 200 m, and tending to follow longshore isobaths. Seasonal mean currents over the continental slope are 20 to 30 cm s^{-1}. However, surface circulation may be driven by winds that create rapidly developing high energy surface flows that vary in direction over scales of several kilometers. In the Channel, wind stress from the northwest creates surface flows characterized by cyclonic, and occasionally anticyclonic, flow vortices

which propagate westward. These occur intermittently throughout the year, and may last for months (Beckenbach 2004; Oey 2001). Vertical upwelling along the coast is also a feature of the water mass, occurring primarily from spring through fall (Harms and Winant 1998).

In conclusion, lnet water mass movement in the vicinity of Harmony platform is from west to east, extending to basin sill depth, with highly variable patterns of flow at the surface under the periodic influence of gyre vortices lasting from days to months, meandering from east to west, typically from spring to fall.

Water Column Physical Properties. Water column profiles of salinity and temperature were obtained by JASCO and used to generate underwater sound speed profiles, which are needed to model sound pressure levels (see Section 6). Average monthly profiles of temperature and salinity were obtained from the U.S. Naval Oceanographic Office's Generalized Digital Environmental Model (GDEM) for the Channel region. The latest release of the GDEM database (version 3.0) provides average monthly profiles of temperature and salinity for the world's oceans on a latitude/longitude grid with 0.25° resolution. Resulting water column profiles of salinity, temperature, and calculated sound speed are illustrated in **Figure 2-2**.

Seasonal changes in water column stability (density structure) result from changes in temperature and salinity that occur seasonally from air-sea surface interactions, and from periodic fluctuations in relative contributions of different source waters (e.g., eastern and western flows). The water column is density stratified as temperatures decline and salinity increases with depth. Seasonal effects are evident with the strongest density gradient occurring during summer months, primarily within the upper 25 m.

Temperatures shown in **Figure 2-2** ranged from about 13 to 16.5 ^{o}C at the surface, become nearly isothermal (9-9.5 ^{o}C) at 150 m depth, likely varying little to the platform depth of 366 m. Seasonal salinities varied little, ranging from about 33.3 to 33.7 ‰ at the surface to 34.0 to 34.1 ‰ to 150 m depth.

As shown in **Figure 2-2**, the profile for sound speed correlates strongly with temperature, which is the main determinant of water density structure. Changes in sound propagation in the water column are minor, seasonally well-contained within a narrow envelope of speeds between 1498 to 1508 m s^{-1}. These results show that water column density structure has only a minor influence on the speed of sound propagation in the water column, varying by less than 1% from typical seasonal changes in temperature and salinity.

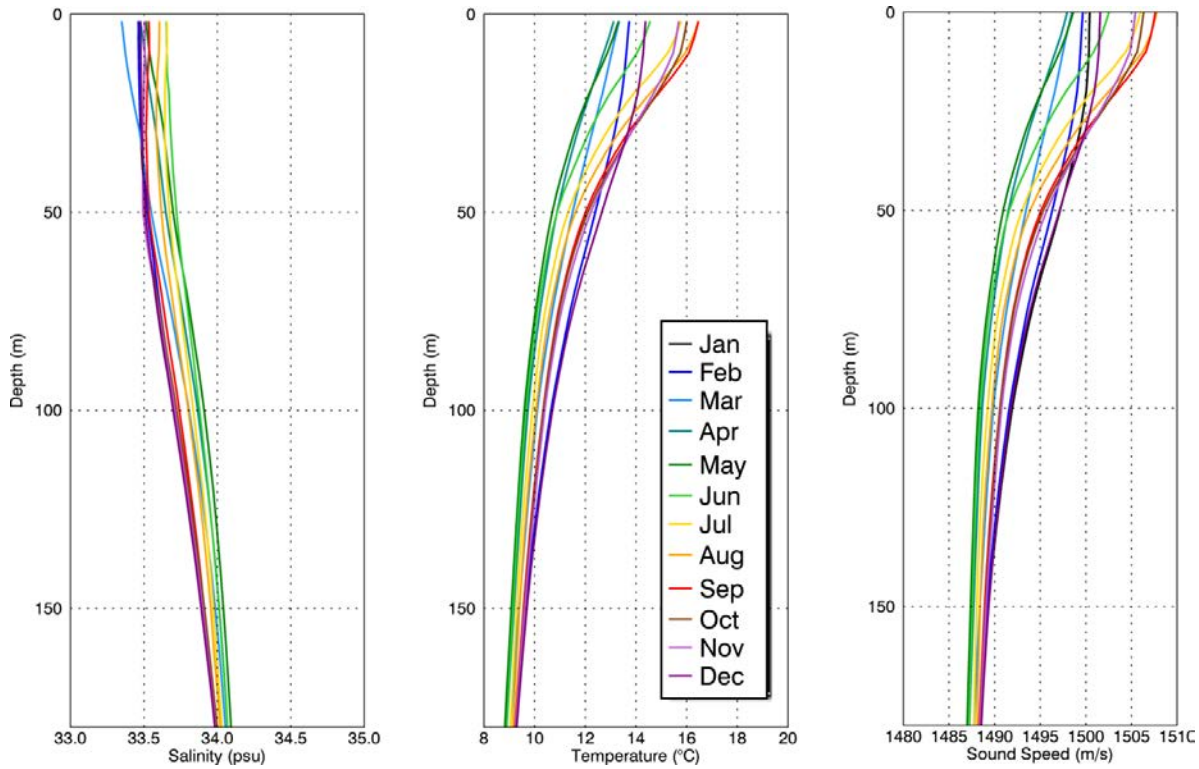

Figure 2-2. Salinity, temperature, and sound speed profiles in the vicinity of Harmony platform derived from GDEM database.

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3 MARINE MAMMAL SPECIES AND NUMBERS

Species and numbers of marine mammals likely to be found within the activity area:

- 22 cetacean species likely to be found in the Santa Barbara Channel region
  - Including five ESA/MMPA listed whales: blue, fin, humpback, sei, and sperm
- 4 pinniped species likely to be found in the Santa Barbara Channel region

This section identifies marine mammals likely to be found within the Santa Barbara Channel, including the activity area surrounding Harmony platform. Identified species consist of marine mammals found off the southern California coast, ranging from Point Conception and south, including the entire Southern California Bight and Santa Barbara Channel Islands that are listed in the NMFS 2012 Pacific Stock Assessment Report (Caretta et al. 2013). Corresponding abundances for each species were used to estimate densities, assuming the entire stock occurred in a 12,593 km^2 area (herein referred to as the study area), encompassing the Santa Barbara Channel (see Figure 1-1, Section 1). Resulting densities were then used to produce a conservative estimate of the number of each species that could occur in the "activity area" or zone of influence, as presented in Section 6.

3.1 Species of Marine Mammals

All marine mammals in the United States are protected under the MMPA, some receiving additional protection under the ESA. Four main types of marine mammals are generally recognized: cetaceans (whales, dolphins, and porpoises), pinnipeds (seals, sea lions, and walruses); sirenians (manatees, dugongs, and sea cows); and several species of marine carnivores (marine otters and polar bears). Only cetaceans, pinnipeds (excluding walruses), and marine otters occur in the Santa Barbara Channel (Rice 1998; Jefferson et al. 2008); and only cetaceans and pinnipeds fall under NMFS jurisdiction.

A total of 28 species known to occur in this area were identified primarily from the NMFS 2012 Pacific Stock Assessment Report (Carretta et al. 2013) and are listed in **Table 3-1**. Identified species consist of 23 cetaceans and five pinnipeds. Of these 28 species, 26 were retained for further evaluation, consisting of 22 cetaceans and four pinnipeds, and are indicated as "Yes" in the **Table 3-1** column "Evaluated for Sound Effects".

Taxonomic name, common name, stock, abundance, seasonality, and status for each species are presented in **Table 3-1**. The MMPA defines a marine mammal stock as "a group of marine mammals of the same species or smaller taxon in a common spatial arrangement that interbreed when mature." For MMPA management purposes, a stock is considered an isolated population or group of individuals within a whole species that is found in the same area. However, generally due to a lack of sufficient information, management stocks recognized by NMFS may include groups of multiple species, such as the Mesoplodon beaked whale group.

Geographical references for wide-ranging stocks, as well as location-specific stocks are made to various regions of the Pacific Ocean delineated by NMFS. For mammals that occur in the Santa Barbara Channel, the main cetacean stocks are the: 1) Eastern North Pacific; 2) California-Oregon-Washington; and 3) California / California Coastal. The largest of these areas is the Eastern North Pacific, defined as east of 140 degrees (°) west (W) longitude and north (N) of the equator. Pinniped stocks that occur in the Santa Barbara Channel area are the: 1) California (harbor seal, northern elephant seal), 2) U.S. – West Coast (California sea lion), and San Miguel Island (regional northern fur seals).

3.1.1 Exclusion of species

Two of the 28 species listed in **Table 3-1** are unlikely to be found in the activity area, and were therefore excluded from the list of potentially affected species. These species are identified as "No" under "Evaluated for Sound Effects" in **Table 3-1**, and consist of one cetacean: Bryde's whale (*Balaenoptera edeni*); and one pinniped: the ESA endangered/MMPA depleted Guadalupe fur seal (*Arctocephalus townsendi*).

Balaenoptera edeni is extremely rare in the Southern California Bight, with fewer than ten confirmed sightings from August 2006 to September 2010 (Smultea et al. 2012).

Guadalupe fur seals are most common at Guadalupe Island, Mexico, their primary breeding ground (Melin and Delong 1999). Although adult and juvenile males have been observed at San Miguel Island, California, since the mid-1960s, and in the late 1990s a pup was born on the island (Melin and Delong 1999), more recent sightings are extremely rare. A 1993 population estimate of all age classes in Mexico was 7,408 (Carretta et al. 2013). There is no population estimate for Guadalupe fur seals occurring in United States waters.

3.2 Numbers (Abundance) of Marine Mammals

Because stock abundance and distribution data are generally not specific to the Santa Barbara Channel or even Southern California, abundances for each species shown in **Table 3-1** were used as conservative estimates of the total number of individuals that could occur in the Santa Barbara Channel region during the project period. Stock variability, shown as coefficients of variation (CV), also are presented when available from corresponding reference sources (also shown in **Table 3-1**). Abundance data rely primarily on the most recent published data (2012) from the NMFS Pacific Stock Report (Carretta et al. 2013); however, other published and non-published sources also were used as appropriate to improve site-specific estimates or data not included in the 2012 stock report.

Systematic surveys (1991-1993, 1996, 2001, 2005) in the southern California region have been carried out via aircraft (Carretta and Forney 1993) and vessel (Ferguson and Barlow, 2001; Barlow, 2003) by NMFS. In addition, a vessel survey in the US Exclusive Economic Zone (EEZ), and out to 556 km offshore California, Oregon and Washington, was conducted in the summer and fall of 2005 by NMFS (Forney 2007). Many other regional surveys also have been conducted (Carretta 2003). Becker (2007) analyzed data from vessel surveys conducted since 1986, and compiled marine mammal densities. Data derived from these studies are presented in **Table 3-1**, listing stock abundance estimates, periods of occurrence, and ESA/MMPA status for 28 marine mammal species (and one subspecies) that may occur in the Santa Barbara Channel study area as depicted in **Figure 1-1** (Section 1).

As previously noted, two of the 28 species (Bryde's whale and the Guadalupe fur seal) were excluded from further consideration because they are either extremely rare or are primarily found south of the Santa Barbara Channel. Additionally, for the purpose of stock calculations, the common bottlenose dolphin *coastal* and the common bottlenose dolphin *offshore* listed in **Table 3-1** have been combined.

Table 3-1. Marine mammal species likely to occur in the Santa Barbara Channel (Excluded: *Yes*=evaluated for possible effects; *No*=not evaluated).

Common Name / Species / Stock	Stock Abundance (CV)	Occurrence in Southern California	ESA/MMPA Status	References	Evaluated for Sound Effects
Low-Frequency (LF) Cetaceans*					
Blue whale *Balaenoptera musculus musculus* Eastern North Pacific	2497 (0.24); 1,647 (0.07)[A]	Seasonal; Arrive Apr-May; more common late summer to fall in SOCAL[B]	Endangered/ Depleted	1	Yes
Bryde's whale *Balaenoptera edeni* Eastern Tropical Pacific	None Available	Rare, Infrequent summer occurrence off California	-	1	No
Fin whale *Balaenoptera physalus physalus* California, Oregon, & Washington	3044 (0.18)	Year-round presence	Endangered/ Depleted	3,4,5,6,7, 1	Yes
Gray whale *Eschrichtius robustus* Eastern North Pacific	20,990 (0.05)	Transient during seasonal migrations	-	11,20	Yes
Humpback whale *Megaptera novaeangliae* California, Oregon, & Washington	2043 (0.10)	Seasonal; more sightings around the northern Channel Islands	Endangered/ Depleted	12,1	Yes
Minke Whale *Balaenoptera acutorostrata scammoni* California, Oregon, & Washington	478 (1.36)	Less common in summer; small numbers around northern Channel Islands	-	1,3,4,5,6,7,13	Yes
Sei whale *Balaenoptera borealis borealis* Eastern North Pacific	126 (0.53)	Rare; Infrequently summer occurrence off California.	Endangered/ Depleted	3,4,5,6,7,13,17	Yes

Common Name / Species / Stock	Stock Abundance (CV)	Occurrence in Southern California	ESA/MMPA Status	References	Evaluated for Sound Effects
Mid-Frequency (MF) Cetaceans*					
Baird's beaked whale *Berardius bairdii* California, Oregon, & Washington	907 (0.49)	Primarily along continental slope from late spring to early fall	-	1	Yes
Common bottlenose dolphin coastal *Tursiops truncatus* California Coastal	323 (0.13); 450-500	Limited, small population within 1 km of shore	-	1,14	Yes
Common bottlenose dolphin offshore *Tursiops truncatus* California, Oregon, & Washington Offshore	1006 (0.48)	Year-round presence	-	1	Yes
Cuvier's beaked whale *Ziphius cavirostris* California, Oregon, & Washington	2143 (0.65)	Possible year-round occurrence but difficult to detect due to diving behavior	-	1	Yes
Killer whale *Orcinus orca* Eastern North Pacific Offshore/Transient[C]	240 (no CV available)	Occurrence varies on an inter-annual basis but more likely in winter (Jan-Feb)	-	1	Yes
Long-beaked common dolphin *Delphinus capensis capensis* California	107016 (0.42)	Common; more inshore distribution (within 50 nm of coast). Year-round presence	-	1	Yes
Mesoplodont beaked whales *Mesoplodon spp.* California, Oregon, & Washington	1024 (0.77)	Distributed throughout deep waters and continental slope regions; difficult to detect given diving behavior. Limited sightings; generally seaward of 500-1000 m depth	-	1	Yes

Common Name / Species / Stock	Stock Abundance (CV)	Occurrence in Southern California	ESA/MMPA Status	References	Evaluated for Sound Effects
Northern right whale dolphin *Lissodelphis borealis* California, Oregon, & Washington	8334 (0.40)	Common; cool water species; more abundant Nov-Apr	-	1	Yes
Pacific white-sided dolphin *Lagenorhynchus obliquidens* California, Oregon, & Washington	26930 (0.28)	Common; year round cool water species; more abundant Nov-Apr	-	15, 16, 1	Yes
Risso's dolphin *Grampus griseus* California, Oregon, & Washington	6272 (0.30)	Common; present in summer, but higher densities Nov-Apr	-	15, 1	Yes
Short-beaked common dolphin *Delphinus delphis delphis* California, Oregon, & Washington	411211 (0.21)	Common; one of the most abundant SOCAL dolphins; higher summer densities	-	1	Yes
Short-finned pilot whale[D] *Globicephala macrorhynchus* California, Oregon, & Washington	760 (0.64)	Uncommon; more common before 1982	-	1	Yes
Sperm Whale *Physeter macrocephalus* California, Oregon, & Washington	2142 (0.58)	Common year-round; More likely in waters > 1,000 m depth, most often > 2,000 m	Endangered/ Depleted	1,3,5,18,20	Yes
Striped dolphin[C] *Stenella coeruleoalba* California, Oregon, & Washington	10908 (0.34)	Occasional visitor; warm water oceanic species	-	1	Yes

Common Name / Species / Stock	Stock Abundance (CV)	Occurrence in Southern California	ESA/MMPA Status	References	Evaluated for Sound Effects
High-Frequency (HF) Cetaceans*					
Dall's porpoise *Phocoenoides dalli dalli* California, Oregon, & Washington	42000 (0.33)	Common in cold water periods; more abundant Nov-Apr	-	1,6,7	Yes
Pygmy sperm whale *Kogia breviceps* California, Oregon, & Washington	579 (1.02)	Seaward of 500-1000 m depth; limited sightings over entire Southern California Bight (SCB)	-	1,7	Yes
Phocid Pinnipeds*					
Harbor seal *Phoca vitulina richardii* California	30196 (0.157)	Common; Channel Island haul-outs and rookeries; bulk of stock found north of Pt. Conception	-	1	Yes
Northern elephant seal *Mirounga angustirostris* California	124,000	Common; Channel Island haul-outs of different age classes; Dec-Mar and Apr-Aug; spend 8-10 months at sea	-	19	Yes
Otariid Pinnipeds*					
California sea lion *Zalophus californianus californianus* U.S. Stock	296,750	Most common pinniped, Channel Islands breeding sites in summer	-	1	Yes
Northern fur seal *Callorhinus ursinus* San Miguel Island	9,968	Common; small population breeds on San Miguel Island May-Oct	-	1	Yes

Common Name / Species / Stock	Stock Abundance (CV)	Occurrence in Southern California	ESA/MMPA Status	References	Evaluated for Sound Effects
Guadalupe fur seal *Arctocephalus townsendi* Mexico Stock	7,408 (no CV available)	Rare, have been observed in the Channel Islands	Endangered/ Depleted	1	No

*Hearing thresholds defined in NOAA's Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals (2013) for informational purposes only
[A]Lower estimate based on 2013 Stock Assessment Report, currently still in DRAFT
[B]Blue whale sighted in the Santa Barbara Channel on 6 February 2013 (http://condorexpress.com/blue-whale-watching/)
[C]Stocks were combined to estimate abundance offshore California, Oregon, and Washington per Carretta et al. 2013
[D]Typically a pelagic species

References

1. Carretta et al. 2013
2. Smultea et al. 2012
3. Dohl et al. 1983
4. Barlow 1997
5. Forney et al. 1995
6. Forney 2007
7. Barlow 2010
8. Rugh et al. 2001
8. Schwartz et al. 2006
10. Laake et al. 2009
11. Calambokidis et al. 2010
12. Calambokidis et al. 2009
13. Barlow and Forney 2007
14. Dudzik et al. 2006
15. Green et al. 1992
16. Forney 1994
17. Mangeis and Gerrodette 1994
18. Barlow 1995
19. Stewart and Huber 1993
20. NOAA 2014, Draft

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4 MARINE MAMMAL STATUS, DISTRIBUTION, AND SEASONALITY

A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities.

- 22 cetacean species likely to occur in the Santa Barbara Channel study area
- 4 pinniped species likely to occur in the Santa Barbara Channel study area

This section presents the status, population distribution, and seasonal distribution (as available) for the 22 cetacean and four pinniped species identified in **Table 3-1** (Section 3) that occur in the Santa Barbara Channel study area, and could be affected by project activities. Information is presented for each species, grouped by hearing frequency: low-, mid-, and high-frequency cetaceans; and phocid and otariid pinnipeds. As previously noted, Beaked whales (genera *Mesoplodon and Berardius)* are grouped into a single stock for management purposes and described as a group.

The order Cetacea is divided into two suborders. The toothed whales of the suborder Odontoceti (e.g., sperm whale, killer whale, dolphins, porpoises, beaked whales) range in size from slightly longer than 1 m to more than 18 m. The baleen whales of the suborder Mysticeti (e.g., minke, humpback, gray, fin, and blue whales) are large and may exceed 30 m as adults. Mysticeti are referred to as baleen whales because, instead of teeth, they have a fibrous structure (baleen) made of keratin in their mouths which they use to engulf, suck, or skim large numbers of small prey from the water column or bottom sediment (Heithaus and Dill 2008). The different feeding strategies between mysticetes and odontocetes affect patterns in their distribution and occurrence. Cetaceans occur throughout the Santa Barbara Channel study area, including nearby the Harmony Platform, from the surf zone to open ocean environments beyond the Channel Islands. Distribution is influenced by a number of factors, but primary among these are patterns of major ocean currents, bottom relief, and sea surface temperature. More importantly, these physical oceanographic conditions affect prey abundance, which may attract marine mammals during periods of high productivity, and visa versa. Water movement is near continuous, varying seasonally, and is generally greatest from late spring to early fall in response to varying wind stress. This phenomenon is much greater in the western Santa Barbara Channel, in the vicinity of Harmony Platform, compared to the eastern portion of the Santa Barbara Channel. This near continuous movement of water from the ocean bottom to the surface creates a nutrient-rich, highly productive environment for marine mammal prey (Jefferson et al. 2008). For most cetaceans, prey distribution, abundance, and quality largely determine where and when they occur (Heithaus and Dill 2008). Most of the large cetaceans are migratory, but many small cetaceans do not undergo extensive migrations. Instead, they undergo local or regional dispersal, on a seasonal basis or in response to food availability. Population centers may shift on spatial scales exceeding 100 km over small time scales (days or weeks) Dailey and Bonnell 1993)

Pinnipeds occurring in California include two families, phocidae (true seals) and otariids (fur seals and sea lions). Phocids lack ear flaps, their fore flippers are short and have hair, and their hind flippers are oriented towards the back of their bodies and cannot be rotated forward. Otariids have external ear flaps, long hairless or partially haired fore flippers, and hind flippers that can be rotated beneath their bodies. These pinnipeds sometimes use low platform structures (e.g., boat landings, jacket infrastructure, and shell encrustations) as temporary haul-out sites for resting after foraging, and regulating their body temperature. Four species of pinnipeds (California sea lion, pacific harbor seal, northern fur seal, and northern elephant seal) occur in the Channel study area as common inhabitants.

Common prey for cetaceans and pinnipeds includes a wide variety of nekton species spanning the water column pelagic, epipelagic, benthopelagic, and demersal zones. The most common prey groups found in

the area are hagfish, lampreys, cartilaginous and bony fish (including anchovies), and large free swimming invertebrates (e.g., squids). Pinnipeds can also be considered prey for large cetaceans (e.g., killer whales). Prey for the baleen cetaceans (e.g., blue whale) include local large zooplankton (e.g, krill), opportunistically consumed during migration/transit through the Channel. Infaunal benthic amphipods exist in the area and are common prey items for baleen bottom feeding Gray whales, but the Channel is not known as a feeding ground for this species.

4.1 Low Frequency Cetaceans

4.1.1 Blue whale (*Balaenoptera musculus musculus*) – Eastern North Pacific

Population Status: The eastern North Pacific stock of blue whales is listed as endangered under the ESA and as depleted under the MMPA.

Blue whales are the largest species of baleen whale found worldwide in all oceans of the world from the ice edge in the Antarctic to tropical waters of equatorial regions. Four subspecies have been proposed: the northern hemisphere, Antarctic, sub-Antarctic Indian Ocean and northern Indian Ocean. In the North Atlantic and North Pacific, they can reach up to about 27 m in length and weigh more than 150,000 kg (330,000 pounds). Females tend to be slightly larger than males with regional size differences within the North Pacific. Blue whales have a broad, flat rostrum and proportionately small dorsal fin, compared to other baleen whales, with a mottled gray color pattern, all of which are distinctive of this species.

Distribution. Blue whale migratory behavior is variable considering that some populations are thought to be resident (e.g., northern Indian Ocean), while others undergo seasonal migrations. Blue whales from southern California migrate south into eastern tropical pacific waters (Mate et al. 1999) as evidenced by photo identification studies documenting, movement from southern California to the Costa Rica Dome during the winter (Calambokidis, pers. Comm. in Carretta et al. 2012). The Gulf of California was also identified as a wintering ground for the southern California population, where the California population seasonally mingles with a population that remains permanently in the Gulf. Tagging studies also showed that there is a lot of variation in the distribution of blue whales from Oregon to California, with some occurring 2000 km offshore, while others are more coastally distributed.

In the past, North Pacific blue whales were thought to belong to as many as five separate populations (Reeves et al. 1998). Current acoustic evidence suggests only two populations, in the eastern and western north Pacific, respectively (Stafford et al. 2001; Stafford 2003). Each of these two populations produces distinct, stereotypic calls (referred to as the northwestern and northeastern call types) that allow for acoustic differentiation of these populations (Stafford et al. 2001; Stafford 2003). The northeastern call predominates in the Gulf of Alaska, the U.S. West Coast, and the eastern tropical Pacific, and the northwestern call predominates from south of the Aleutian Islands to the Kamchatka Peninsula in Russia, though both call types have been recorded concurrently in the Gulf of Alaska (Stafford et al. 2001; Stafford 2003; Rankin et al. 2006). Some individuals from the Eastern North Pacific Stock may range as far west as Wake Island and as far south as the equator, based on locations where the northeastern call type has been recorded (Stafford et al. 1999, 2001).

In the California Channel Islands, most blue whales are found in cold, well-mixed and productive water that upwells along the coast north of Point Conception and then advects south. They aggregate in this water near San Miguel and Santa Rosa Islands, where they feed on dense, subsurface layers of euphausiids, both on the shelf and extending off the shelf edge (Fiedler et al. 1998). Analysis of two opportunistic sighting databases indicates that blue whale concentrations are highest (i.e., 'hot spots'), north of Santa Rosa and west of Santa Cruz Islands. These areas of highest concentration agree with density distributions identified around the Channel Islands by Redfern et al. (2013).

Seasonal Distribution. Both line transect and mark-recapture techniques were used to determine the size and distribution of U.S. West Coast blue whale stock. Because of the extensive research effort in the waters off California, several line-transect studies have surveyed the southern California region, though mostly during only two seasons: summer and fall. Data collected between 2001 and 2008 from visual line transect abundance summer/fall research cruises provided estimates ranging from 400 to 800 animals. Previous vessel-based line transect estimates based on data collected between 1991 and 1996 had derived higher estimates of approximately 1900 whales. This decrease in the more recent abundance estimate for the southern California region is not thought to be an actual population decrease, but due to a movement of some whales northward, some as far as the Gulf of Alaska. Mark-capture methods also have been used to provide an estimate of the population size of the eastern North Pacific blue whale stock (Calambokidis et al. 2009). New photographic mark-recapture estimates of abundance for the period 2005 to 2011 presented by Calambokidis (2013) range from approximately 1000 to 2300 animals, with the most consistent estimates represented by a 4-yr sampling period Chao model that incorporates individual capture heterogeneity over time. The Chao model consistently yielded estimates of approximately 1500 whales. Additional estimates of blue whale abundance from 2008 to 2011 using Chao model results of Calambokidis (2013) are 1647 (CV=0.07) whales. Redfern et al. (2013) calculated densities of blue whales in the Santa Barbara Channel in an assessment of potential ship strikes. The range of densities in the Harmony Platform area from this study is 0.003-0.004 individuals km^{-2}. As this density information is specific to the activity area, the density of 0.004 blue whales km^{-2} is used in Section 6 calculations.

4.1.2 Fin Whale (*Balaenoptera physalus*) – California, Oregon, & Washington

Population Status: The fin whale is listed as endangered under the ESA and as depleted under the MMPA.

Pacific fin whale population structure is not well known. In the North Pacific, there is a California, Oregon, and Washington stock; a Hawaii stock; and an Alaska stock (Carretta et al. 2010). The range of the fin whale is known to include the California Current and Insular Pacific-Hawaiian Large Marine Ecosystems, and the open ocean. The abundance estimate of fin whales in California, Oregon, and Washington waters is 3,044 (CV 0.18) (Carretta et al. 2013). Abundance estimates may be low because of difficult survey conditions (e.g., weather, bad sighting conditions), resulting in “unidentified rorqual” or “unidentified large whale” in recorded data (Carretta et al. 2010). A recent study indicates that the abundance of fin whales in waters off the U.S. west coast has increased during the 1991–2008 survey period, most likely from in situ population growth combined with distribution shifts (Moore and Barlow 2011).

Distribution. The fin whale is found in all the world’s oceans and is the second largest species of whale (Jefferson et al. 2008). Fin whales prefer temperate and polar waters and are rarely observed in warm, tropical waters (Reeves et al. 2002). Fin whales typically congregate in areas of high productivity. They mostly occupy coastal and shelf waters, but can also be found in deeper locations (>2,000 m) (Aissi et al. 2008, Reeves et al. 2002). Fin whales are often seen close to shore in areas of upwelling where krill density is high (Azzellino et al. 2008). This species of whale is not known to have a singular habitat and is highly adaptable, following prey, typically off the continental shelf (Azzellino et al. 2008, Panigada et al. 2008).

Fin whales have been documented from 60° to 23° N, and have been recorded in offshore waters within the study area (Carretta et al. 2010; Mizroch et al. 2009). Aggregations of fin whales are present year-round in southern and central California (Forney et al. 1995). Aerial surveys conducted in October and November 2008 by the Marine Mammal Research Consultants offshore Southern California resulted in the sighting of 22 fin whales (Oleson and Hill 2009; Acevedo-Gutiérrez et al. 2002). Navy-sponsored monitoring in the SOCAL Range Complex for the 2009–2010 period also recorded the presence of fin whales (U.S. Department of the Navy 2010). Moore and Barlow (2011) indicate that, since 1991, there is

strong evidence of increasing fin whale abundance in the California Current area; they predict continued increases in fin whale numbers over the next decade, and that perhaps fin whale densities are reaching "current ecosystem limits." Redfern et al. (2013) calculated densities of fin whales in the Santa Barbara Channel. The range of densities in the Harmony Platform area from this study is 0.00045-0.00065 individuals km^{-2}. As this density information is specific to the activity area, the density of 0.00065 fin whales km^{-2} is used in Section 6 calculations.

Breeding and calving ground locations are unknown, but many whales migrate seasonally to higher latitudes to feed, and migrate to lower latitudes to breed (Kjeld et al. 2006; MacLeod et al. 2006). The fin whale's ability to exploit areas of high productivity is reported as the main driver of migratory patterns (Canese et al. 2006; Reeves et al. 2002).

4.1.3 Gray whale (*Eschrichtius robustus*) – Eastern North Pacific

Population status. There are two geographic distributions of gray whales known to occur offshore California: the dominant Eastern North Pacific population, and the rare occurrence of individual animals from the smallerWestern North Pacific population, or "Korean" stock, found primarily along the coast of eastern Asia (see http://swfsc.noaa.gov/srg.aspx; U.S. West Coast Cetacean and Pinniped SARS, DRAFT 2014; Document No. PSRG-2014-03). The Eastern North Pacific gray whale is not listed under the ESA and is not considered depleted under the MMPA. The Western North Pacific gray whale is listed as endangered under the ESA is considered depleted under the MMPA.

Only the Eastern North Pacific population is considered likely to be found in the activity area during the project. Fairly recent abundance estimates for the Eastern North Pacific (eastern) gray whale population have ranged between 17,000 and 20,000 (Swartz et al. 2006; Rugh et al. 2008). For stock assessment purposes, NMFS currently uses an abundance of 19,126 animals (CV 0.071; Carretta et al. 2013). The eastern population appears to be generally increasing, despite the 1999 event in which an unusually large number of gray whales stranded along the coast, from Mexico to Alaska (Gulland et al. 2005).

Distribution. Gray whales primarily occur in shallow water over the continental shelf and are considered to be one of the most coastal of the great whales (Jefferson et al. 2008; Jones and Swartz 2009). Feeding grounds are relatively shallow when compared to other baleen whales (average 68.6 m deep, see Jones and Swartz 2009). Three major breeding lagoons of Eastern North Pacific gray whales are in Baja California, Mexico (Alter et al. 2009, Urban-R. et al. 2003).

Gray whales are known to migrate along the California coast in the California Current Large Marine Ecosystem on their north and south migrations (Sumich and Show 2011), and are frequently observed in the Southern California Bight (Carretta et al. 2000; Forney et al. 1995; Henkel and Harvey 2008; Hobbs et al. 2004). During aerial surveys off San Clemente Island, gray whales were the most abundant marine mammal from January through April, a period that covers both the northward and southward migrations (Carretta et al. 2000; Forney et al. 1995).

This species makes the longest annual migration of any mammal with a roundtrip of 15,000 to 20,000 km (Jefferson et al. 2008, Jones and Swartz 2009). The migration connects arctic feeding grounds with southern mating and calving regions, calving in temperate and in subtropical coastal waters in winter. Winter grounds extend from central California south along Baja California, the Gulf of California, and the mainland coast of Mexico. In the fall, whales start the southward migration from November to late December, and mainly follow the coast to Mexico and travel time averages 2 months. The northward migration to the feeding grounds occurs in two phases. The first phase in late January through March consists of newly-pregnant females, who go first to maximize feeding time, followed by adult females and males, then juveniles. The second phase, in April through May, consists primarily of mothers and

calves that have remained in the breeding area longer, allowing calves to strengthen and rapidly increase in size before the northward migration (Jones and Swartz 2009).

The migration routes of the Western North Pacific stock of gray whale are poorly known (Weller et al. 2002). Previous sighting data suggested that the remaining population of western gray whale had a limited range extent between the Okhotsk Sea off the coast of Sakhalin Island and the South China Sea (Weller et al. 2002). Photo-catalog comparisons of eastern and western North Pacific gray whale populations, as well as genetic and telemetry studies, suggest that there is more exchange between the populations than previously thought, since "Sakhalin" whales were found off Santa Barbara, California; British Columbia, Canada; and Baja California, Mexico (Weller et al. 2013). The occurrence of eastern gray whales in the Santa Barbara Channel is rare (total population estimated at less than 100 individuals, see http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/graywhale.htm#distribution) in comparison with the western stock; and therefore, no eastern gray whales are likely to be found in the project activity area during hammer driving activities.

4.1.4 Humpback Whale (*Megaptera novaeangliae*) – California, Oregon, & Washington

Population Status. Humpback whales are listed as endangered under the ESA and as depleted under the MMPA.

The overall abundance of humpback whales in the north Pacific was recently estimated at 21,808 individuals (CV 0.04), confirming that this population of humpback whales has continued to increase and is now greater than some pre-whaling abundance estimates (Barlow et al. 2011). The current best estimate for the California, Oregon, and Washington stock is 2,043 (CV 0.10) (Carretta et al. 2010). Based on ship surveys conducted in the summer and fall from 1991 to 2005, it is estimated that 36 humpback whales (CV 0.51) occur off Southern California in the waters south of Point Conception (Barlow and Forney 2007).

Distribution. Humpback whales are distributed worldwide in all major oceans and most seas. They are found in high-latitude feeding grounds during the summer and during the winter in the tropics and subtropics around islands, over shallow banks, and along continental coasts, where calving occurs.

The California, Oregon, and Washington stock uses the waters in Southern California as a feeding ground, with peak occurrence from December through June (Calambokidis et al. 2001). During late summer, more humpback whales are sighted north of the Channel Islands, and limited occurrence is expected south of the northern Channel Islands (San Miguel, Santa Rosa, Santa Cruz) (Carretta et al. 2010). Most humpback whale sightings are in nearshore and continental shelf waters; however, humpback whales frequently travel through deep oceanic waters during migration (Calambokidis et al. 2001, Clapham and Mattila 1990, Clapham 2000). Redfern et al. (2013) calculated densities of humpback whales in the Santa Barbara Channel. The range of densities in the Harmony Platform area from this study is 0.00035-0.00055 individuals km^{-2}. As this density information is specific to the activity area, the density of 0.00055 humpback whales km^{-2} is used in Section 6 calculations.

Humpback migrations are complex and cover long distances (Calambokidis 2009, Barlow et al. 2011). Each year, most humpback whales migrate from high-latitude summer feeding grounds to low latitude winter breeding grounds, one of the longest migrations known for any mammal; individuals can travel nearly 8,000 km from feeding to breeding areas (Clapham and Mead 1999). While there are exceptions, the vast majority of humpback whales that feed off Washington, Oregon, and California breed in waters off mainland Mexico and Central America (Barlow et al. 2011).

4.1.5 Minke whale (*Balaenoptera acutorostrata scammoni*) – California, Oregon, & Washington

Population status. The minke whale is not listed under the ESA and is not considered depleted under the MMPA. Minke whales from California to Washington appear behaviorally distinct from migratory whales further north and those in Hawaii. Minke whales in coastal waters of California, Oregon, and Washington are considered a separate stock from the Alaskan stock (Carretta et al. 2010).

The abundance estimate for minke whales from 2005 and 2008 summer/fall ship surveys in California, Oregon, and Washington waters is approximately 478 individuals (CV 1.36) (Carretta et al. 2010). There are three recognized subspecies of the minke whale, however, only *Balaenoptera acutorostrata scammoni* is present in the north Pacific and the study area (Jefferson et al. 2008). The minke whale range includes the California Current and Insular Pacific-Hawaiian Large Marine Ecosystems, North Pacific Gyre and the North Pacific Transition Zone (Okamura et al. 2001, Yamada 1997). The northern boundary of their range is within subarctic and arctic waters (Kuker et al. 2005).

In the open ocean, minke whales participate in annual migrations between low-latitude breeding grounds in the winter and high-latitude feeding grounds in the summer (Kuker et al. 2005). Minke whales generally occupy waters over the continental shelf, including inshore bays, and even occasionally enter estuaries. Records from whaling catches and research surveys worldwide indicate an open ocean component to the minke whale's habitat. The migration paths of the minke whale include travel between breeding to feeding grounds, and have been shown to follow patterns of prey availability (Jefferson et al. 2008).

The minke is present in summer and fall in the study area (Carretta et al. 2009). They often use both nearshore and offshore waters as habitats for feeding and migration to wintering areas.

4.1.6 Sei whale (*Balaenoptera borealis*) – Eastern North Pacific

Population Status. The sei whale is listed as endangered under the ESA and as depleted under the MMPA.

The sei whale is a medium-sized rorqual whale and is between the fin whale and Bryde's whale with respect to size. As a result of similarities in size and general appearance, field identifications of three species are difficult and causing some sightings to be recorded as unidentified rorqual. Although the probably for occurrence of the sei whale in the vicinity of Harmony Platform is extremely low (see Section 5), it is endangered and depleted, and therefore, retained for further analysis. Abundance for the Eastern North Pacific stock of sei whales that occur off California, Oregon, and Washington waters out to 556 km is 126 animals (CV 0.53) (Carretta et al. 2010).

Distribution. Sei whales have a worldwide distribution and are found primarily in cold temperate to subpolar latitudes. During the winter, sei whales are found from 20° N to 23° N and during the summer from 35° N to 50° N (Horwood 2009; Masaki 1976, 1977; Smultea et al. 2010). However, a recent survey of the Northern Mariana Islands recorded sei whales south of 20° N in the winter (Fulling et al. 2011). They are considered absent or at very low densities in most equatorial areas.

Sei whales are most often found in deep oceanic waters of the cool temperate zone. They appear to prefer regions of steep bathymetric relief, such as the continental shelf break, canyons, or basins between banks and ledges (Best and Lockyer 2002; Gregr and Trites 2001; Kenney and Winn 1987; Schilling et al. 1992). On feeding grounds, the distribution is largely associated with oceanic frontal systems (Horwood 1987). Characteristics of preferred breeding grounds are unknown. These whales spend the summer feeding in high subpolar latitudes and return to lower latitudes to calve in winter. Whaling data provide some evidence of differential migration patterns by reproductive class, with females arriving at and departing from feeding areas earlier than males (Horwood 1987; Perry et al. 1999).

Sei whales have been found in offshore waters of southern California (Carretta et al. 2010) and feeding along the California Current (Perry et al. 1999). There are records of sightings in California waters as early as May and June, but primarily are encountered during July to September, and leave California waters by mid-October. Aerial surveys conducted in October and November 2008 off the Southern California coast resulted in the sighting of one sei (or possibly fin) whale (Oleson and Hill 2009)4.2 Mid-Frequency Cetacean Species and Distribution

4.2.1 Baird's beaked whale (*Berardius bairdii*) – California, Oregon, and Washington

Population status. Baird's beaked whale is not listed under the ESA and is not considered depleted under the MMPA. Baird's beaked whale stocks are defined for the two separate areas within Pacific U.S. waters; Alaska and, California, Oregon, and Washington (Carretta et al. 2010).

The population estimate for the California, Oregon, and Washington stock of Baird's beaked whale is 907 (CV 0.49) (Carretta et al. 2013). This species is rarely sighted during surveys along the West Coast of North America, and does not appear to occur in high densities anywhere in U.S. waters (Barlow et al. 2004; Forney 2007).

Distribution. Baird's beaked whale range is known to include the California Current Large Marine Ecosystem and the North Pacific Transition Zone. Distribution of Baird's beaked whales in the mid-Pacific, as well as their winter habitats, are not well known, but this species is generally found through the colder waters of the north Pacific, ranging from off Baja California, Mexico, to the Aleutian Islands of Alaska (Jefferson et al. 2008; MacLeod and D'Amico 2006).

The continental shelf margins from the California coast to 125° W longitude were recently identified as key areas for beaked whales (MacLeod and D'Amico 2006). Along the West Coast, Baird's beaked whales are seen primarily along the continental slope, from late spring to early fall (Carretta et al. 2010; Green et al. 1992). Baird's beaked whales are sighted less frequently in the colder water months of November through April and are presumed to be farther offshore during this period (Carretta et al. 2010).

4.2.2 Common bottlenose dolphin (*Tursiops truncatus*) – California Coastal and California, Oregon, & Washington

Population status. The common bottlenose dolphin is not listed under the ESA and is not considered depleted under the MMPA. For the MMPA stock assessment reports, bottlenose dolphins within the Pacific U.S. Exclusive Economic Zone are divided into seven stocks. Only the California coastal stock and the California, Oregon and Washington offshore stock are likely to occur in the Channel study area. Respective abundance for each stock is 323 (CV 0.13) and 1,006 (CV 0.48) (Carretta et al. 2013).

Distribution. Common bottlenose dolphins are found most in coastal and continental shelf waters of tropical and temperate regions of the world. They occur in most enclosed or semi-enclosed seas. They can inhabit shallow, murky, estuarine waters and also deep, clear offshore waters in oceanic regions (Jefferson et al. 2008; Wells et al. 2009). Common bottlenose dolphins are often found in bays, lagoons, channels, and river mouths and are known to occur in very deep waters of some ocean regions.

Sighting records off California and Baja California suggest continuous distribution of offshore bottlenose dolphins in these regions. Aerial surveys during winter/spring 1991–1992 and shipboard surveys in summer/fall 1991 indicated no seasonality in distribution (Barlow 1995; Carretta et al. 2010; Forney et al. 1995).

The majority of California coastal bottlenose dolphins are found within approximately 1 km of shore, generally from Point Conception to as far south as San Quintin, Mexico (Carretta et al. 1998; Defran and

Weller 1999). During El Niño conditions coastal common bottlenose dolphins have been consistently sighted off central California and as far north as San Francisco. Common bottlenose dolphins are known to occur year round in both coastal and offshore waters of Monterey Bay, Santa Monica Bay, San Diego Bay, and San Clemente Island, California (Maldini Feinholz 1996; Carretta et al. 2000; Bearzi 2005a, b; Henkel and Harvey 2008; Bearzi et al. 2009). The California, Oregon, and Washington stock also is sited close to shore. In 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 and Defran 1993).

Although in most areas bottlenose dolphins do not migrate (especially where they occur in bays, sounds, and estuaries), seasonal shifts in abundance do occur in many areas (Griffin and Griffin 2004).

4.2.3 Cuvier's beaked whale (*Ziphius cavirostris*) – California, Oregon, and Washington

Population Status. Cuvier's beaked whale is not listed under the ESA and is not considered depleted under the MMPA.

There are seven recognized stocks of Cuvier's beaked whale, including the California/Oregon/Washington stock, with an estimated abundance of 2,143 (CV 0.65) (Carretta et al. 2010).

Distribution. Cuvier's beaked whales have an extensive range that includes all oceans, from the tropics to the polar waters of both hemispheres. Worldwide, beaked whales normally inhabit continental slope and deep oceanic waters. Cuvier's beaked whales are generally sighted in waters with a bottom depth greater than 200 m and are frequently recorded in waters with bottom depths greater than 1000 m (Falcone et al. 2009; Jefferson et al. 2008). Cuvier's beaked whale range is known to include all waters of the California Current and Insular Pacific-Hawaiian Large Marine Ecosystems, the North Pacific Gyre, and the North Pacific Transition Zone (Jefferson et al. 2008; MacLeod and D'Amico 2006).

Cuvier's beaked whales are widely distributed in offshore waters of all oceans occurring in temperate and tropical waters of the Pacific (Barlow et al. 2006; Ferguson 2005; Jefferson et al. 2008; Pitman et al. 1988). Typically, most are found offshore in deeper waters off California and Hawaii (MacLeod and Mitchell 2006; Mead 1989; Ohizumi and Kishiro 2003; Wang et al. 2001). A single population likely exists in offshore waters of the eastern north Pacific, ranging from Alaska south to Mexico (Carretta et al. 2010). Little is known about potential migration.

There are no apparent seasonal changes in distribution for this species for the U.S. west coast, ranging from Alaska to Baja California, Mexico (Carretta et al. 2010; Mead 1989; Pitman et al. 1988). Repeated sightings of the same individuals have been reported off San Clemente Island in southern California, which indicates some level of site fidelity (Falcone et al. 2009).

4.2.4 Killer whale (*Orcinus orca*) – Eastern North Pacific Offshore/Transient (combined)

Population status. Neither the eastern north Pacific offshore stock nor the eastern north Pacific transient stock of the killer whale is listed under the ESA, or considered depleted under the MMPA.

A single species of killer whale is currently recognized, but there is the possibility of several different species of killer whales worldwide, many of which are called "ecotypes" (Ford 2008). The different geographic forms of killer whale are distinguished by distinct social and foraging behaviors and other ecological traits. In the north Pacific, these recognizable geographic forms are variously known as ''residents'', ''transients" and "offshore" ecotypes (Hoelzel et al. 2007). For stock assessment purposes, an estimated abundance of 240 individuals (CV 0.49) from the combined eastern north Pacific offshore

and transient stocks was used for killer whales occurring offshore California, Oregon, and Washington (see Carretta et al. 2013).

Distribution. Killer whales are found in all marine habitats from the coastal zone (including most bays and inshore channels) to deep oceanic basins and from equatorial regions to the polar pack ice zones of both hemispheres. Although killer whales are also found in tropical waters and the open ocean, they are most numerous in coastal waters and at higher latitudes (Dahlheim and Heyning 1999). Their range includes the California Current and Insular Pacific-Hawaiian Large Marine Ecosystems, the North Pacific Gyre, and North Pacific Transition Zone. Only the eastern north Pacific transient stock and the eastern north Pacific offshore stock are expected to occur in the Channel study area.

Along the west coast of North America, all three ecotypes of killer whales are known to occur (Calambokidis and Barlow 2004; Dahlheim et al. 2008; Ford and Ellis 1999; Forney et al. 1995). Although they are not commonly observed in Southern California coastal areas, killer whales are found year round off the coast of Baja California. In the eastern tropical Pacific, killer whales are known to occur from offshore waters of San Diego to Hawaii and south to Peru (Barlow 2006; Ferguson 2005). Offshore killer whales are known to inhabit both the western and eastern temperate Pacific and likely have a continuous distribution across the north Pacific (Steiger et al. 2008). In most areas of their range, killer whales do not show movement patterns that would be classified as traditional migrations. However, there are often seasonal shifts in density, both onshore/offshore and north/south.

The killer whale is protected under the MMPA, and the overall species is not listed on the ESA. Five killer whale stocks are recognized within the Pacific U.S. Exclusive Economic Zone, with only the eastern north Pacific transient stock (Alaska through California) and the eastern north Pacific offshore stock (Southeast Alaska through California) stock occurring in the study area (Carretta et al. 2010).

4.2.5 Long-beaked common dolphin (*Delphinus capensis*) – California stock

Population Status. For management purposes, there is a single California stock of long-beaked common dolphins (Carretta et al. 2013). This stock is not listed under the ESA and is not considered depleted under the MMPA.

Common dolphins are made up of two different species, the short-beaked common dolphin (*Delphinus delphis*) and the more recently described long-beaked common dolphin (*D. capensis*) (Heyning and Perrin 1994). Long-beaked common dolphins are less abundant than short-beaked common dolphins. Off the west coast of the U.S. the distribution of these two species overlap (Rosel et al. 1994; Carretta et al. 2013). Historically, many studies did not discriminate between the two species, so little long-term information is available on this species in many areas.

Long-beaked common dolphins are relatively small dolphins with a sleek but robust body shape, rounded melon and pointy, slightly falcate, two-toned dorsal fin. Occasionally the dorsal fin can be sub-triangular in shape. The beak is moderately long. A post-anal 'keel' is apparent on some individuals. A prominent hourglass pattern marks the side of the animal, with a brownish cape joining with a tannish/yellowish thoracic patch on the flank and pale wash on peduncle. But individual coloration patterns can vary widely, with some dolphins having muted or dark thoracic patches. The face is 'muddy', with the eye blending into the flipper to gape stripe, and not clearly distinctive as seen in short-beaked common dolphins. Adults range in size from 1.9 to 2.5 m long, with males being slightly larger than females. Long-beaked common dolphins range in weight from 72 to 226 kg (160-500 lbs) (Jefferson et al. 2008). The two species of common dolphin can be difficult to distinguish at sea in some areas (Perrin 2002). Both external morphological traits as well as skeletal characteristics (length of rostrum, tooth and vertebral counts) are used to distinguish between the two species of common dolphin off California (Heyning and Perrin 1994)

though high variability in these morphological traits in other areas can make for difficult species classification (Perrin 2002).

Only a few localized studies have been undertaken which provide abundance estimates for long-beaked common dolphins. Carretta et al. (2011) provide a population estimate for long-beaked common dolphins along the California and west Baja California coasts. Using data collected from a ship-based survey, they estimated 183,396 (CV=0.41) long-beaked common dolphins within California waters, with 95,786 (CV=0.47) animals found in the waters from the US/Mexico border to the tip of Baja California. These estimates are the highest abundance estimates for long-beaked common dolphins for California and may be due to improved study design and/or increased numbers of animals off California. Using results from two years of ship-based visual surveys conducted in 2008 and 2009, the mean abundance estimate for California, Oregon and Washington waters is 107, 016 (CV=0.42) (Carretta et al. 2013).

Distribution. Along the west coast of the United States, long-beaked common dolphins are found off California, though there are reports of extra-limital sightings in Canadian waters (Ford 2005). Along the west coast of Baja California, Mexico, most sightings of long-beaked common dolphins have been made within the 250-m isobath, with fewer sightings made in deeper water (>500 m) in depth (Gerrodette and Eguchi 2011).

4.2.6. Mesoplodont beaked whales (*Mesoplodon* spp.) – California, Oregon, & Washington

Status. Due to difficulty in distinguishing the different *Mesoplodon* species from one another, the United States management unit is usually defined to include all *Mesoplodon* species that occur in the area. The five species in the Mesoplodont beaked whale group are not listed under the ESA and are not considered depleted under the MMPA.

Due to difficulty in distinguishing the different Mesoplodont species from one another, six species that have been sighted in Southern California are being considered as a single group the group includes; *Mesoplodon carlhubbsi, M. ginkgodens, M. perrini, M. peruvianus, M. stejnegeri and M. densirostris* and are considered to be the Pacific Stock (Carretta et al. 2010).

As a consequence of the combining six species into a single stock, one of the most widely distributed and distinctive of the genus, Blainville's beaked whales *(Mesoplodon densirostris*), is described as a surrogate for all six of the Mesoplodont beaked whales.

Distribution. Blainville's beaked whales are one of the most widely distributed of the distinctive toothed whales within the *Mesoplodon* genus (Jefferson et al. 2008; MacLeod and Mitchell 2006). Blainville's beaked whale range is known to include the California Current and Insular Pacific-Hawaiian Large Marine Ecosystems, North Pacific Gyre, and the North Pacific Transition Zone (Jefferson et al. 2008; Pitman 2008a). There are a handful of known records of the Blainville's beaked whale from the coast of California and Baja California, Mexico, but the species does not appear to be common in the study area (Carretta et al. 2010; Mead 1989; Pitman et al. 1988). Blainville's beaked whales are found mostly offshore in deeper waters along the California coast, Hawaii, Fiji, Japan, and Taiwan, as well as throughout the eastern tropical Pacific (Leslie et al. 2005; MacLeod and Mitchell 2006; Mead 1989).

It is unknown whether this species makes specific migrations, and none have so far been documented.

4.2.7. Northern right whale dolphin (*Lissodelphis borealis*) – California, Oregon, & Washington

Population Status. This species is not listed under the ESA and is not considered depleted under the MMPA. The management stock in U.S. waters consists of a single California, Oregon, and Washington stock (Caretta et al. 2010).

The northern right whale dolphin occurs in cool-temperate to subarctic waters of the north Pacific Ocean, from the west coast of North America to Japan and Russia. It can be found in oceanic waters and along the outer continental shelf and slope, normally in waters colder than 20°C (Jefferson and Lynn 1994; Leatherwood and Walker 1979). Northern right whale dolphins generally move nearshore only in areas where the continental shelf is narrow or where productivity on the shelf is high (Smith et al. 1986).

Distribution. Northern right whale dolphins occur year round off California, but are more abundant in relatively nearshore waters in winter and spring, and off central and northern California (Dohl et al. 1983; Bonnell & Dailey 1993)). Distribution shifts northward into Oregon and Washington occur as water temperatures increase during late spring and summer (Barlow 1995; Forney et al. 1995; Forney and Barlow 1998; Leatherwood and Walker 1979). Northern right whale dolphins do not migrate, although seasonal shifts do occur. Occasional movements south of 30° N are associated with unusually cold water temperatures (Jefferson and Lynn 1994; Leatherwood and Walker 1979). Surveys suggest that seasonal inshore-offshore and north-south movements are related to prey availability, with peak abundance in the Southern California Bight during winter (Forney and Barlow 1998). These periods of peak abundance in southern California, including the Santa Barbara Channel, correspond very closely with known periods of peak abundance of market squid, a major prey species (Jefferson and Lynn 1994; Leatherwood and Walker 1979). In the Santa Barbara Channel, northern right whale dolphins inhabit the island shelves. This species is rarely seen in pelagic waters offshore.

4.2.8 Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) – California, Oregon, & Washington

Population status. This species is not listed under the ESA and is not considered depleted under the MMPA. Morphological studies indicate that two different populations of Pacific white-sided dolphins exist off California (Lux et al. 1997). However, the population boundaries are dynamic, and there is no reliable way to distinguish animals from the two populations in the field. Thus, these two populations are managed by NMFS as a single stock, the California, Oregon, and Washington stock (Carretta 2010). Genetic analysis has shown some variation between Pacific white-sided dolphins known to occur off Baja California, and those found off the coast of Point Conception, California (Caretta et al. 2010; Lux et al. 1997). Acoustic studies have also supported a distinction between these two populations off California (Soldevilla et al. 2008).

Genetic analysis suggests the existence of several populations of Pacific white-sided dolphins throughout their range and may be differentiated geographically between offshore and nearshore areas. Hayano et al. (2004) have suggested the existence of four unique offshore populations located in of Baja California, California to Oregon, British Columbia and Alaska, and in the offshore waters west of 160° W, respectively.

Several abundance estimates for Pacific white-sided dolphins have been based on visual and acoustic surveys in different parts of their range (Black 2009; Reeves et al. 2002). The most accurate, up to date surveys have estimated the abundance of the California, Oregon, and Washington stock at 26,930 individuals (CV = 0.28) (Carretta et al. 2013). No long-term trends have been proposed based on historical and recent visual surveys of this species (Carretta et al. 2013).

Distribution. The Pacific white-sided dolphin is found in cold temperate waters across the northern rim of the Pacific Ocean (Carretta et al. 2013; Ferguson 2005; Jefferson et al. 2008; Reeves et al. 2002). It is typically found in deep waters along the continental margins and outer shelf and slope waters. It is also known to inhabit inshore regions of southeast Alaska, British Columbia, and Washington, and occurs seasonally off Southern California (Brownell et al. 1999; Forney and Barlow 1998). In the open ocean, the Pacific white-sided dolphin is most common in temperate waters over the outer continental shelf and

slope. Sighting records and captures in open sea driftnets indicate that this species also occurs in oceanic waters well beyond the shelf and slope (Ferrero and Walker 1996; Leatherwood et al. 1984).

Primary habitat includes the cold temperate waters of the north Pacific Ocean and deep ocean regions. They range as far south as the mouth of the Gulf of California, northward to the southern Bering Sea and coastal areas of southern Alaska (Leatherwood et al. 1984; Jefferson et al. 2008). Off California, Forney and Barlow (1998) found significant north/south shifts in the seasonal distribution of Pacific white-sided dolphin, with the animals moving north into Oregon and Washington waters during the summer, and showing increased abundance in the Southern California Bight in the winter. Off California, the species is found mostly at the outer edge of the continental shelf and slope and does not frequently move into shallow coastal waters. Although Pacific white-sided dolphins do not migrate, seasonal shifts have been documented as noted above. From November to April, Pacific white-sided dolphins can be found in shelf waters off the coast of Southern California, and thus may be present in the study area at the end of Harmony Platform activities. These dolphins appear to northward to the Oregon and Washington coasts and can be found in shelf waters in late spring (Reeves et al. 2002; Tsutsui et al. 2001). They also occur in the waters of southeast Alaska in the cooler water months.

4.2.9 Risso's dolphin (*Grampus griseus*) – California, Oregon, & Washington

Population Status. The California, Oregon, and Washington stock of Risso's dolphins is not listed under the ESA and is not considered depleted under the MMPA.

Risso's dolphins are medium sized delphinids with grayish, robust bodies, reaching lengths of approximately 2.4 to 4 m (8-13 ft) and weighing approximately 260 to 500 kg. No significant differences in length, due to sexual dimorphism, have been observed (Kruse et al. 1999). Characteristic species traits include a rounded, bulbous head with no obvious rostrum and creased melon, tall, sickle-shaped falcate dorsal fin and grayish body color, with very visible and apparent scars and scratches in mature animals. With age, body color lightens, with very young animals being black or dark gray with few to no scratches and older animals losing color, with many rake marks caused by interactions with other dolphins and prey species. Old animals can appear almost white in color.

In U.S. waters, two stocks are currently recognized: the California/Oregon/Washington stock and the Hawaiian stock (Carretta et al. 2013). The current estimate for the California/Oregon/Washington stock of Risso's dolphins was based on data collected during two, shipboard, abundance cruises in 2005 and 2008 (Carretta et al. 2013). Data were collected during summer and fall. Seasonal and annual variations in distribution were noted for animals found off California/Oregon/Washington. Because of this variation, the results from two studies were combined to come up with a population estimate for this stock of 6272 animals (Carretta et al. 2013).

Risso's dolphins are usually found in groups of less than 50 animals (Leatherwood et al. 1980; Kruse et al. 1999; Bearzi et al. 2011) though group size can vary from a few animals to loose aggregations of thousands. They also have been seen in mixed species aggregations with many other species of cetacean including bottlenose dolphins, gray whales (Shelden et al. 1995), northern right whale dolphins, Pacific white-sided dolphins (Kruse et al. 1999) and striped and short-beaked common dolphins (Frantzis and Herzing 2002).

Distribution. Risso's dolphins are a cosmopolitan species found in all oceans throughout deep tropical to warm-temperate waters (Perrin et al. 2009), though they are most commonly found in tropical and warm temperate areas with water temperatures between 10 to 20°C (50-68°F). Numerous studies have documented a preference by Risso's dolphin for continental shelf and slope areas (e.g. Baumgartner 1997; Bearzi et al. 2011). An analysis of both shipboard and aerial survey data from the northern Gulf of Mexico found greater numbers of Risso's dolphin in a narrow region along steep areas of the continental

slope in waters between the 350-m and 975-m isobaths, perhaps due to concentration of prey in these areas (Baumgartner 1997). Off the west coast of the United States, Risso's dolphin can be found off California and as far north as Washington (Kruse et al. 1999). The distribution of Risso's dolphin along the U.S. West Coast appears to be discontinuous with animals found off California, Oregon and Washington being distinct from the animals found off the eastern tropical Pacific and the Gulf of California (Carretta et al. 2013). Off the Southern California Bight, they can be found on shelf waters (Carretta et al. 2013). They have been sighted in southern California during all seasons, but as water temperatures increase during the spring and summer months, animals shift their distribution into Oregon and Washington (Leatherwood et al. 1980; Forney and Barlow 1998). Long-term local distribution and abundance shifts have been observed in the Southern California Bight. In the 1950's and 1960's, Risso's dolphins were only rarely observed in the area (Kruse et al. 1999), but during an El Niño event of 1982/1983, the dolphins moved into the area, especially around Santa Catalina Island, where they are now commonly observed. Shane (1985) hypothesized that Risso's dolphins moved into the area after oceanographic conditions caused changes in movements of spawning squid.

4.2.10 Short-beaked common dolphin (*Delphinus delphis delphis*) – California, Oregon, & Washington

Population Status. Short-beaked common dolphins are not listed under the ESA and are not considered depleted under the MMPA.

The short-beaked common dolphin is moderately robust, handsomely marked oceanic dolphin that ranges throughout tropical and warm temperate regions of the Atlantic and Pacific Oceans. They have a moderately long beak and tall, slightly falcate dorsal fins and moderately large, tapered flippers (Reeves et al. 2002). These dolphins are strikingly patterned with dark brownish-gray to black dorsal surface, white bellies and an 'hourglass' or crisscross pattern on the sides (thoracic patch). The anterior segment of the 'thoracic patch' is light grey to yellow and contrasts sharply with the dark dorsal color. Short-beaked common dolphins are small dolphins; less than 2.7 m (9 ft) long and weigh about 200 kg (440 lbs).

The short-beaked common dolphin is, by far, the most abundant species of cetacean found in the Southern California Bight., seasonally accounting for 57% to 84% of the total cetacean population for this area (Dohl 1981). The California/Oregon/Washington stock is considered as one management unit with a population estimate of 411,211 (CV=0.21) (Carretta et al. 2013). Distribution varies with season and there may be a northward shift of the population into California with subsequent increase in abundance (Heyning and Perrin 1994; Barlow et al. 1997; Forney 1997). Since the 1970's, abundance of short-beaked common dolphins off California has grown dramatically. At the same time, there has been a decrease in numbers in the eastern tropical Pacific Ocean, suggesting a migration northward into California (Forney et al. 1995; Forney and Barlow 1998). Breeding usually takes place during the warmer months of June to September and calving peaks in late spring or early summer (Reeves et al. 2002).

This species of dolphin is gregarious and energetic and usually found in large social groups of hundreds of individuals, but are occasionally found in 'mega-pods' of thousands of animals. These mega-pods are thought to consist of sub-groups that are separated by age and/or sex, and may be related. These are highly acrobatic dolphins and will often approach vessels to bowride for long periods of time (Reeves et al. 2002).

Distribution. The short-beaked common dolphin is one of the most widely distributed cetacean species, found in subtropical, tropical and temperate waters worldwide. Along the west coast of the U.S., the distribution of short-beaked common dolphins ranges from just off the coast to at least 556 km (300 nm) offshore (Carretta et al. 2013). Their distribution overlaps in many areas with that of the long-beaked common dolphin (*Delphinus capensis*). Seasonal and annual shifts in distribution and abundance have been reported based on changing oceanographic conditions (Dohl et al. 1986; Barlow 1995; Forney and

Barlow 1998). Preliminary data suggest multiple stocks, based on differing color patterns of dorsal fins including at least two possible stocks off California (Farley 1995). For the MMPA stock assessment reports, animals found within the U.S. EEZ West Coast (California, Oregon and Washington) are considered a single management stock (Carretta et al. 2013).

4.2.11 Short-finned pilot whale (*Globicephala macrohynchus*) – California, Oregon, & Washington

Population Status: Short-finned pilot whales are not listed under the ESA and are not considered depleted under the MMPA. For MMPA stock assessment reports, short-finned pilot whales within the Pacific U.S. Exclusive Economic Zone are divided into two discrete areas: 1) waters off California, Oregon and Washington, and 2) Hawaiian waters (Carretta et al. 2010). The short-finned pilot whale is widely distributed throughout most tropical and warm temperate waters of the world.

The 2005–2008 average abundance estimate for short-finned pilot whales in California, Oregon, and Washington waters, derived from two ship-based surveys, was 760 individuals (CV 0.64) (Carretta et al. 2013).

Distribution: A number of studies in different regions suggest that the distribution and seasonal inshore/offshore movements of pilot whales coincide closely with the abundance of squid, their preferred prey (Bernard and Reilly 1999; Hui 1985; Payne and Heinemann 1993). Short-finned pilot whale distribution off Southern California changed dramatically after El Niño in 1982–1983, when squid did not spawn as usual in the area, and pilot whales virtually disappeared from the area for nine years (Shane 1995).

Along the U.S. Pacific coast, short-finned pilot whales are most abundant south of Point Conception (Carretta et al. 2013; Reilly and Shane 1986). A few hundred pilot whales are believed to group each winter at Santa Catalina Island (Carretta et al. 2010; Reilly and Shane 1986), although these animals are not seen as regularly as in previous years. In the open ocean, short-finned pilot whales occur mainly in offshore areas; occupying waters over the continental shelf break and slope, and in areas of high topographic relief (Olson 2009).

Short-finned pilot whales are not considered a migratory species, although seasonal shifts in abundance have been noted in some portions of the species' range.

4.2.12 Sperm Whale (*Physeter macrocephalus*) – California, Oregon, & Washington

Population status. The sperm whale is listed as endangered under the ESA and is considered depleted under the MMPA.

The best estimate of sperm whale abundance offshore the west coast of the U.S. and Canada is a trend-based estimate corresponding to the most recent NOAA survey (2008), or 2,142 animals (CV=0.58) (see SARS Draft 2014). This estimate is corrected for diving animals not seen during surveys.

Sperm whales are divided into three stocks in the Pacific. Based on genetic analyses, Mesnick et al. (2011) found that sperm whales in the California Current are demographically independent from animals in Hawaii and the eastern tropical Pacific. The sperm whale is the largest of the odontocete (toothed) whales. Occurrence of the sperm whale in the vicinity of Harmony Platform is considered unlikely, since it typically inhabits waters with depths greater than 1000 m; however, this species is endangered and depleted, and is therefore evaluated.

Distribution. The sperm whale occurs throughout the entire Southern California Bight. Typically this species is found in the temperate and tropical waters of the Pacific (Rice 1989). This species appears to have a preference for deep waters (Jefferson et al. 2008). Sperm whale concentrations correlate with

areas of high productivity. These areas are generally near drop offs and areas with strong currents and steep topography (Gannier and Praca 2007, Jefferson et al. 2008). Sperm whales are found year round in California waters (Barlow 1995; Forney and Barlow 1993) and reach peak abundance from April through mid-June and from the end of August through mid-November (Carretta et al. 2013).

Sperm whales are somewhat migratory. General shifts occur during summer months for feeding and breeding. In some tropical areas, sperm whales appear to be largely resident (Rice 1989, Whitehead 2003, Whitehead et al. 2008). Pods of females with calves remain on breeding grounds throughout the year, between 40° N and 45° N (Rice 1989, Whitehead 2003), while males migrate between low-latitude breeding areas and higher-latitude feeding grounds (Pierce et al. 2007). In the northern hemisphere, "bachelor" groups (males typically 15 to 21 years old and bulls not taking part in reproduction) may leave warm waters at the beginning of summer and migrate to feeding grounds that can extend as far north as the perimeter of the arctic zone. In fall and winter, most return south, although some may remain in the colder northern waters during most of the year (Pierce et al. 2007).

4.2.13 Striped dolphin (*Stenella coeruleoalba*) – California, Oregon, & Washington

Population Status: This species is not listed under the ESA and is not considered depleted under the MMPA.

Abundance estimates of the California, Oregon, and Washington stock is 10,908 (CV 0.34) (Carretta et al. 2013).

Distribution: Striped dolphin are primarily a warm-water species; however, the range of this species extends higher into temperate regions than those of any other species in the genus *Stenella*. Striped dolphins also are generally restricted to oceanic regions and are seen close to shore only where deep water approaches the coast. They are associated with convergence zones and regions of upwelling (Au and Perryman 1985; Reilly 1990). In the eastern tropical Pacific, striped dolphins inhabit areas with large seasonal changes in surface temperature and thermocline depth, as well as seasonal upwelling (Au and Perryman 1985; Reilly 1990). In some areas, this species appears to avoid waters with sea temperatures less than 20°C (Van Waerebeek et al. 1998).

Seasonal Distribution. In and near the California Current Large Marine Ecosystem, striped dolphins are found mostly offshore and are much more common in the warm-water summer/fall period, although they are found there throughout the year. During summer/fall surveys, striped dolphins were sighted primarily from 180 to 555 km offshore of the California coast. Based on sighting records, striped dolphins appear to have a continuous distribution in offshore waters from California to Mexico (Carretta et al. 2010). The striped dolphin also occurs far offshore, in waters affected by the warm Davidson Current as it flows northward (Archer 2009; Jefferson et al. 2008). This species is non-migratory in Southern California.

4.3 High Frequency Cetaceans

4.3.1 Northern Dall's Porpoise (*Phocoenoides dalli dalli*) – California, Oregon, & Washington

Population Status. Dall's porpoises are not listed under the ESA and are not considered depleted under the MMPA.

Dall's porpoise are uniquely identifiable by their relatively small, triangular head with little or no beak, and a thick, robust, black-and-white colored body, with white markings on their forward-angled, triangular dorsal fin (Reeves et al. 2002; Shirihai and Jarrett 2006). They can reach a maximum length of

just less than 2.4 m (8 ft) and weigh up to 220 kg (480 lbs) (Reeves et al. 2002; Shirihai and Jarrett 2006). This species of porpoise is endemic to temperate waters of the North Pacific Ocean where they are usually seen in shelf, slope and offshore waters of the U.S. west coast (Morejohn 1979).

These porpoises are usually found in groups averaging of 2 to 20 individuals, but occasionally form larger, loosely associated groups in the hundreds or even thousands of animals. As fast swimming swimmers, they are attracted to fast moving vessels and commonly bowride (Reeves et al. 2002). Considering the north-south movement of this stock along the U.S. west coast, and the fact that this movement appears to be significantly affected by oceanographic conditions (Forney 1997; Forney and Barlow, 1998), distribution in the southern California region is highly variable. The most recent estimate of Dall's porpoise abundance is the geometric mean of 42,000 animals (CV=0.33) estimated from 2005 (Forney 2007) and 2008 (Barlow, 2010) summer/autumn vessel-based line transect surveys of California, Oregon, and Washington waters.

Distribution. The stock structure of eastern North Pacific Dall's porpoises is not known, but based on patterns of stock differentiation in the western North Pacific, where they have been more intensively studied, it is expected that separate stocks will emerge when data become available (Perrin and Brownell 1994).

Data collected from aerial and shipboard surveys at different times of the year (Green et al. 1992, 1993; Mangels and Gerrodette 1994; Barlow 1995; Forney et al. 1995) indicate that Dall's porpoise move between the states of California, Washington and Oregon as oceanographic conditions change, both on seasonal and inter-annual time scales. Although the southern end of this population's range is not clearly defined, they are commonly seen off Southern California in winter, and probably range into Mexican waters off northern Baja California during cold-water periods. Bonnell & Dailey (1993) reported that, while common, the population of the Southern California Bight was less than 1000.

4.3.2 Pygmy sperm whale (*Kogia breviceps*) – California, Oregon, & Washington

Population Status. The pygmy sperm whale is not listed under the ESA and is not considered depleted under the MMPA.

Population Status: There are two species of *Kogia*: the pygmy sperm whale (*Kogia breviceps*) and the dwarf sperm whale (*Kogia sima*). Before morphological distinction was shown (Handley 1966), they were considered to be the same species. Dwarf and pygmy sperm whales are difficult to distinguish from one another at sea, and many misidentifications have been made. Sightings of either species are sometimes categorized as the genus *Kogia* (Jefferson et al. 2008). The pygmy sperm whale is not listed under the ESA. Pygmy sperm whales are divided into two discrete stocks: 1) California, Oregon, and Washington waters; and 2) Hawaiian waters (Carretta et al. 2013).

Few abundance estimates have been made for this species, and only minimal information is available to obtain reliable population estimates for U.S. west coast waters (Carretta et al. 2010). The abundance estimate for pygmy sperm whales found along the West Coast is based on the average of two ship surveys of California, Oregon, and Washington waters in 2005 and 2008, 579 (CV 1.02) (Carretta et al. 2010).

Distribution: Pygmy sperm whales can occur close to shore, sometimes over the outer continental shelf. Several studies; however, have suggested that this species generally occurs beyond the continental shelf edge (Bloodworth and Odell 2008; MacLeod et al. 2004). The pygmy sperm whale frequents more temperate habitats than the other *Kogia* species. Only two sightings of this species have been made in offshore waters along the California coast during surveys sited by Carretta et al. (2010).

Deep oceanic waters are the primary habitat of pygmy sperm whales and historically very few oceanic sightings offshore have been recorded offshore Southern California. However, this may be a consequence

of the difficulty of detecting and identifying this species at sea (Caldwell and Caldwell 1989, Maldini et al. 2005). Records of this species from both the western (Japan) and eastern Pacific (California) suggest that the range of this species includes the North Pacific Central Gyre, and North Pacific Transition Zone (Carretta et al. 2010, Jefferson et al. 2008, Katsumata et al. 2004, Marten 2000, Norman et al. 2004).

Little is known about possible migrations of this species. No specific information regarding routes, seasons, or resighting rates in specific areas is available.

4.4 Phocid Pinnipeds

4.4.1 Harbor Seal (*Phoca vitulina richardii*) – California

Population Status. The California Stock of harbor seal is not listed under the ESA and is not considered depleted under the MMPA.

Harbor seals are members of the 'true seal' family, known as the Phocidae or 'earless seals' (lacking external ear flaps). They are found in coastal habitats of the North Pacific and North Atlantic Oceans. Currently there are five recognized subspecies, distinguished principally by their geographical location. Harbor seals are medium-sized, with a short, spindle-shaped body, robust head and broad, long snout. The pattern of their pelage varies substantially with latitude and some seals are light tan or silver with scattered dark spots, while others are black with scattered, light, incomplete rings. Both morphs are present in the Pacific, the dark morph occurring more commonly in southern areas, while the light and intermediate morphs are generally found in the northern areas. Males are slightly larger than females, reaching maximum lengths of just over 1.9 m (6 ft) while females measure just less than 1.7 m (6 ft), and weigh 170 kg and 130 kg, respectively (Reeves et al. 2002).

Because abundance estimates are based on counts of harbor seals at haul-out sites, and presence at the haul-out sites varies, a complete count of all harbor seals is impossible. Also, since pups enter the water soon after birth, a complete pup count is also not possible. Thus, population size is a calculated estimation of 30,196 seals (CV=0.157) (Carretta et al. 2013).

Harbor seals are not migratory, being littoral in distribution; this species breeds and feeds in the same general area (usually within 46 km [25 nm]) throughout the year (Bigg 1981). Females give birth in spring and summer and mating takes place at sea, three to four weeks later, after the pups are weaned (Reeves et al. 2002).

In late fall and winter, harbor seals may be at sea for several weeks, presumably to feed to recover the body mass lost during the breeding and molting season (Reeves et al. 2002). Being non-specialist feeders, harbor seals eat a highly varied diet of demersal fish, pelagic schooling fish, octopus, and squid. These pinnipeds can spend up to 85% of the day diving to depths of about 10 to 150 m (30-500 ft). Harbor seals in southern California sometimes dive to approximately 450 m (1500 ft) (Reeves et al. 2002). Grigg et al. (2009), reported seasonal shifts in harbor seal movements based on prey availability.

Distribution. Harbor seals are one of the most widely distributed of all the pinnipeds. They are generally non-migratory and occur on both the U.S. east and west coasts. On the west coast, they are considered abundant across their range from Baja California to the eastern Aleutian Islands. During late May to early June peak numbers of harbor seals haul-out on land in order to molt. Multiple haul-out sites (400-600) have been identified along the California mainland and Channel Islands, including intertidal sandbars, rocky shores and beaches (Hanan 1996; Lowry et al. 2008), where harbor seals prefer sandy, cobble, and gravel beaches (Stewart and Yochem 1994).

4.4.2 Northern elephant seal (*Mirounga angustirostris*) – California breeding

Population status. The northern elephant seal is not listed under the ESA and is not considered depleted under the MMPA. Movement and some genetic interchange occur among rookeries, but most elephant seals return to the rookeries where they were born to breed and thus may have limited genetic differentiation (Caretta et al. 2013). There are two distinct populations of northern elephant seals; Baja California, Mexico, and a population that breeds on islands off California.

The population estimate for the California stock is 124,000 (Carretta et al. 2013). The population in California appears to be increasing and the Mexican stock appears to be stable or slowly decreasing (Carretta et al. 2013; Stewart and DeLong 1994).

Distribution. Northern elephant seals are found in both coastal and deep waters of the eastern Pacific. Breeding and pupping take place on offshore islands and mainland rookeries (Caretta et al. 2013; Jefferson et al. 2008). Most of their prey are found in open oceans and thus northern elephant seals are often found in deepwater zones (Jefferson et al. 2008; Stewart and DeLong 1995). Northern elephant seals spend little time nearshore, and migrate through offshore waters four times a year as they travel to and from breeding/pupping and molting areas on various islands and mainland sites along the coasts of Mexico and California. Small colonies of northern elephant seals breed and haul-out on Santa Barbara Island with large colonies on San Nicolas and San Miguel Islands (U.S Navy 2008).

Northern elephant seals are found in coastal areas and deeper waters of the California Current Large Marine Ecosystem (Caretta et al. 2013; Jefferson et al. 2008). The foraging range of northern elephant seals extends thousands of kilometers offshore from the breeding range into the central North Pacific Transition Zone; however, their range is not considered to be continuous across the Pacific (Stewart and Huber 1993; Simmons et al. 2010). Adult males and females segregate while foraging and migrating (Stewart 1997; Stewart and DeLong 1995; Simmons et al. 2010). Adult females mostly range west to about 173° W, between the latitudes of 40° N and 45° N, whereas adult males range farther north into the Gulf of Alaska and along the Aleutian Islands to between 47° N and 58° N (Le Boeuf et al. 2000; Robinson et al. 2012; Stewart and DeLong 1995; Stewart and Huber 1993). Adults stay offshore during migration, while juveniles and subadults are often seen along the coasts of Oregon, Washington, and British Columbia (Stewart et al. 1993).

The northern elephant seal is found only in the north Pacific Ocean and occurs almost exclusively in the eastern and central north Pacific. This species is observed as far north as the Gulf of Alaska and is one of the most common pinnipeds observed in waters off Washington (Calambokidis et al. 2004; Jefferson et al. 2008).

In California, elephant seals breed in the southern Channel Islands (Stewart and DeLong 1994). There are large rookeries on San Miguel and San Nicolas Islands and smaller rookeries on Santa Barbara and San Clemente Islands (Stewart and DeLong 1994; Stewart et al. 1993). Elephant seals use these islands as rookeries from late December to February, and to molt from April to July. Some evidence indicates that elephant seals may be expanding their pupping range northward, possibly in response to continued population growth (Hodder et al. 1998). Other northern mainland breeding rookeries include Ano Nuevo, Point Reyes and Cape San Martin (Stewart et al. 1994).

Elephant seals spend more than 80 percent of their annual cycle at sea, making long migrations to offshore foraging areas and feeding intensively to build up the blubber stores required to support them during breeding and molting haulouts (Hindell and Perrin 2009). This migration takes place twice a year, the first for periods of up to 8 months. They range widely offshore in the northern Pacific Ocean. These migrations occur after the end of the breeding season from island rookeries in California waters to offshore foraging areas of the north Pacific and Gulf of Alaska. Typically this species returns to land to

molt (2 to 4 months in duration) and then returns to sea before the following breeding season (Stewart and DeLong 1994).

4.5 Otariid Pinnipeds

4.5.1 California Sea Lion (*Zalophus californianus californianus*) – U.S. Stock (west coast)

Population Status. The California sea lion, including the species *Zalophus californianus californianus*, is not listed under the ESA and is not considered depleted under the MMPA.

The California sea lion is the most abundant pinniped along the California coast. The estimated population size of the U.S. stock of the California sea lion is 296,750 (Carretta et al. 2013). Overall, its population is abundant and generally increasing (Jefferson et al. 2008; Carretta et al. 2010). Typically during the summer, California sea lions congregate near rookery islands and specific open-water areas. The primary rookeries off the U.S. west coast are on San Nicolas, San Miguel, Santa Barbara, and San Clemente Islands (Carretta et al. 2000; Le Boeuf and Bonnell 1980; Lowry et al. 1992; Lowry and Forney 2005). Haulout sites are also found on Santa Catalina Island in the Southern California Bight (Le Boeuf 2002). 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.

Distribution. The California sea lion ranges from 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).

California sea lions can be found in the California Current Large Marine Ecosystem, often using deeper waters as habitat (Barlow et al. 2008; Jefferson et al. 2008; Lander et al. 2010). They 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; Zavala-Gonzalez and 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 (175 mi) from shore during longer foraging bouts; however, females and subadults normally stay mostly within 65 km (25 mi) of the coast (Thomas et al. 2010). Most individuals stay within 50 km (20 mi) of the rookery islands during the breeding season (Melin and DeLong 2000). Individuals breeding on the Channel Islands typically feed over the continental shelf and remain within 150 km (60 mi) of the islands. Tagging results showed that lactating females foraging along the coast would travel as far north as Monterey Bay and offshore to the 1000 m (3280 ft) depth (Melin and DeLong 2000; Henkel and Harvey 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 and DeLong 2000).

In the nonbreeding season, adult and subadult males migrate northward along the coast of California to Washington and return south the following spring (Lowry and Forney 2005). Females and juveniles also disperse somewhat, but tend to stay in the southern California area (Lowry and Forney 2005; Melin and DeLong 2000; 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 and Forney 2005). 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 are susceptible to entanglement and other interactions with fishery operations, with a total human-caused mortality of at least 431 animals per year for this stock of which 337 are commercial

fishery related. The total fishery mortality and serious injury rate (337 animals/year) for this stock is less than 10% of the calculated PBR and, therefore, is considered to be insignificant and approaching a zero mortality and serious injury rate.

In January 2013, an elevated number of strandings of California sea lion pups were observed along the coasts of five Southern California counties, including the Channel coast of Santa Barbara County. These strandings were the sixth Unusual Mortality Event involving California sea lions that has occurred in California since 1991. The 2013 Unusual Mortality Event has been confined to California sea lion pups born in the summer of 2012. The stranded pups were found to be emaciated, dehydrated, and underweight for their age. Investigation of the 2013 stranding is ongoing with hypotheses ranging from prey-related causes, as well as infectious diseases, parasites, and water pollution. (see http://www.nmfs.noaa.gov/pr/health/mmume/, accessed 18 Jan 2014).

4.4.4 Northern fur seal (*Callorhinus ursinus*) – San Miguel Island

Population Status: Two stocks of northern fur seals (*Callorhinus ursinus*) are recognized in United States waters: an eastern Pacific stock and a San Miguel Island stock (Carretta et al. 2010). The eastern Pacific stock is listed as depleted under the MMPA, while the San Miguel Island stock is not considered depleted (Carretta et al. 2010). The northern fur seal is not listed under the ESA.

The San Miguel Island stock abundance is considered in this analysis due to its proximity to the Channel study area. Abundance at San Miguel Island has increased steadily over the past 4 decades, except for two severe declines associated with El Niño-Southern Oscillation events in 1993 and 1998 (Carretta et al. 2010). The population estimate for the San Miguel Island stock is 9,968 (Carretta et al. 2010).

Distribution. The range of the northern fur seal includes the North Pacific Transition Zone and California Current Large Marine Ecosystem (Jefferson et al. 2008; Gentry 2009). Northern fur seals range throughout the north Pacific along the West Coast, from northern Baha California to the Bering Sea (Baird and Hanson 1997; Carretta et al. 2013).

In California waters, the northern fur seal can be found on San Miguel Island, nearby Castle Rock, the Farallon Islands, and occasionally San Nicolas Island during summer (Baird and Hanson 1997; Pyle et al. 2001). Northern fur seal colonies are present at Adams Cove on San Miguel Island and on Castle Rock, an offshore island approximately 1 km northwest of San Miguel Island (Stewart et al. 1993). Although both stocks are found off California during the fall and winter, animals from the San Miguel Island stock remain in or near the area throughout the year (Koski et al. 1998).

Seasonal Distribution. Northern fur seals are found throughout their offshore range throughout the year, although seasonal peaks are known to occur. Females and sub-adult males are often observed off Canada's west coast during winter (Baird and Hanson 1997).

5 TYPE OF INCIDENTAL TAKE REQUEST AND ESTIMATION METHOD

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

- Authorization requested for Level B behavioral disturbance takes only
- Method of take is incidental exposure to sound from impulsive hammer driving

This section describes the type and method of incidental takes by harassment of marine mammals requested by ExxonMobil for the project. ExxonMobil is requesting only incidental takes that have the potential to cause behavioral disturbance as defined by the MMPA (as amended) associated with project-related noise in the environment.

5.1 Take Authorization Request

ExxonMobil requests an IHA pursuant to Section 101(a)(5)(D) of the MMPA for potential takes of marine mammals by Level B harassment only, incidental to conductor pipe installation at Harmony platform. Authorization is requested for 12 months beginning as early as mid-July 2014. The project duration is approximately 91 days; however, activities associated with potential takes are estimated at a total of 4.125 days comprised of discrete intervals of active hammer driving, ranging from 2.5 to 3.3 hours. Inactive periods are used mainly to assemble and guide the conductor pipes through the water column and top sections of the seabed, which do not require hammer driving, and therefore, have no potential to harass marine mammals.

5.2 Method of Incidental Taking

Harmony platform conductor pipe installation activities described in Section 1 have the potential to "take" marine mammals by harassment. Takes by harassment may occur if a marine mammal is exposed to sound levels from impulsive hammer driving that are in excess of current NOAA thresholds that may result in either injury (Level A) or behavioral disturbance (Level B). Current sound threshold guidance posted on the NOAA West Coast Region website can be found at http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html, accessed 24 Jan 2014). Exposures to sound may occur when a marine mammal comes within a defined distance of an actively driven conductor pipe as described in Section 6.

Incidental takes from the project are estimated (see Section 6), and consist of the following possible range of temporary, non-injurious physical and/or behavioral responses only (see Richardson et al. 1995):

1. Behavioral reactions
2. Prevention of marine animals from hearing important sounds (masking)
3. Temporary reduction of hearing sensitivity or temporary threshold shift
4. Temporary non-auditory physiological effects

Sound effects will depend on species, the behavior of the animal at the time of reception of the stimulus, as well as the distance and received sound level. Behavioral disturbance reactions by some marine mammals in the vicinity of Harmony platform may likely occur. However, no animals will be exposed to sound levels that could cause injury from project activities due to the platform configuration (which

excludes large cetaceans), short period of active hammering, and the relatively small zone of influence (i.e., ≤10 m for Level A).

Type and number of takes requested for likely affected species over the project duration are presented in Section 6, which also presents methods, data, and assumptions used to estimate takes for each species evaluated. Proposed mitigations to negate or reduce the number of estimated takes are presented in Section 11 (proposed mitigation). Additional mitigations are achieved through monitoring during project activities, as described in Section 13.

6 NUMBER AND TYPE OF TAKES AND ESTIMATION METHOD

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in paragraph (a)(5) of this section, and the number of times such takings by each type of taking are likely to occur;

- 309 cetaceans and 53 pinnipeds estimated Level B takes from in-water noise
  - Including five ESA/MMPA listed species: one each of blue, fin, humpback, sei whales, and two sperm whales
- All takes based on anticipated 4.125 days of cumulated hammer driving for project

This section presents results, along with data and methods used to estimate the number of marine mammal behavioral disturbance and potential injury "takes" that may occur from project-related noise. Conservative (protective) assumptions were used throughout the estimation process, so actual takes are expected to be lower than predicted, or non-existent for most species. Estimated takes were calculated using information on source sound levels, sound propagation, maximum distances from the sound source to Level A and Level B exposure thresholds, and estimated density of marine mammals in the activity area for each potentially affected species. Take estimates were calculated for in-water (cetaceans and pinnipeds) and are summarized in **Table 6-1**. There are no take requests for in-air exposure to pinnipeds.

Table 6-1. Requested number of Level B "takes" for each in-water species.

Species	Level B	Species	Level B
Cetaceans			
Blue whale[1]	1	Pacific white-sided dolphin	30
Fin whale[1]	1	Risso's dolphin	10
Gray whale	10	Short-beaked common dolphin	45
Humpback whale[1]	1	Short-finned pilot whale	1
Minke whale	1	Sperm whale[1]	2
Sei whale[1]	1	Striped dolphin	20
Baird's beaked whale	1	Dall's porpoise	50
Common bottlenose dolphin	10	Pygmy sperm whale	1
Cuvier's beaked whale	1	***Pinnipeds***	
Killer whale	1	California sea lion	33
Long-beaked common dolphin	120	Harbor seal	4
Mesoplodont beaked whales	1	Northern elephant seal	14
Northern right-whale dolphin	1	Northern fur seal	2
Total Number of Cetaceans			*309*
Total Number of Pinnipeds			*53*

[1] ESA/MMPA-listed species.

6.1 Method of Take Calculations for In-water Exposures

The following information was used to estimate the number of marine mammal takes from noise exposure that could potentially occur without mitigation for 21 in-water cetacean species and four in-water/in-air pinniped species.

1. In-air and in-water noise sensitivity thresholds for marine mammals potentially exposed
2. Sound levels at the conductor pipe from hammer strike
3. Sound propagation (transmission/spreading loss) through the environment (i.e., air, water)
4. Maximum distances from sound source for Level A and B exposures for each mammal group
    a. Noise threshold Zone of Influence (ZOI) based on maximum distances
5. Density (*d*) estimate for each marine mammal species
    a. Calculated as stock abundance ÷ 12,592 km^2 area[1], except where noted
6. Number of takes for each species ($Take_{species}$) within a group. Note: only pinnipeds evaluated for in-air exposure:
    a. $Take_{species} = d \times ZOI \times$ days of activity

Sound levels for impulsive (impact) hammer driving and propagation through water and air at Harmony platform were modeled by JASCO Applied Sciences (Victoria, B.C., Canada). Model results are presented in an addendum report to this IHA application. Summarized information from the JASCO report pertaining to above Items 2–4 is presented in Sections 6.1.2 through 6.1.4.

Methods used to estimate marine mammal densities and takes for the Channel study area (Items 5–6) are presented in Sections 6.1.5 and 6.1.6 for likely exposed species selected for evaluation in Section 3.

6.1.1 Item 1 – Noise sensitivity thresholds

Current NOAA threshold criteria regarding exposure of marine mammals to underwater high level impulsive sounds are expressed in decibels (dB) relative to a fixed reference pressure of 1 µPa, and applied against root-mean-square sound pressure levels (SPL_{rms}) corresponding to the sound source (defined in Section 6.1.2). The corresponding NOAA in-water thresholds, expressed as dB_{rms} (re 1 µPa) are shown in **Table 6-2** for cetaceans and pinnipeds considered to have been taken by Level B (behavioral disturbance), which may or may not result in a stress response. The presence and magnitude of a stress response in an animal depends on its life history stage, environmental conditions, reproductive state, and experience with the stressor.

Table 6-2 also shows current NOAA in-air sound level behavioral thresholds, which apply to pinnipeds grouped by harbor seals and non-harbor seal pinnipeds (e.g., sea lions, fur seals, elephant seals).

In-water and in-air noise sensitivity thresholds for the taking of marine mammals by harassment are at http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html (accessed 03 Feb 14).

[1] Study area shown in Figure 1-1 (Section 1), used to calculate densities throughout the Santa Barbara Channel, including activity area

Table 6-2. In-water and in-air thresholds for impulsive noise (impact hammering).

Marine Mammal Group	In-air Behavioral Threshold Level B (re 20 µPa)	In-water Injury Threshold Level A (re 1 µPa)	In-water Behavioral Threshold Level B (re 1 µPa)
Cetaceans	not applicable	180 dB_{rms}	160 dB_{rms}
Harbor seals	90 dB_{rms}	190 dB_{rms}	160 dB_{rms}
Non-harbor seal pinnipeds	100 dB_{rms}	190 dB_{rms}	160 dB_{rms}

Note: All thresholds expressed as SPL_{rms}; In-air values are NMFS West Coast Region interim thresholds

6.1.2 Item 2 – Sound source levels

The predicted in-water sound field during conductor pipe hammer driving at Harmony platform was modeled by JASCO. Sound levels emitted from the conductor pipe were estimated using underwater recordings (Illingworth and Rodkin 2007) for impact driving of 24- to 30-inch steel piles (pipes) back-calculated to 1 m from the sound source, assuming a combination of cylindrical and spherical spreading. Sound level at the source was then scaled to the anticipated energy range of 9 and 90 kJ for the impact hammer and coupled to an acoustic model of a representative steel pipe (Claerbout 1976; Reinhall and Dahl 2011). Only modeled results associated with the maximum hammer energy of 90 kJ were used to estimate takes.

As described in Section 1, each 505-m long conductor pipe is assembled from 12-m long sections welded end to end, and then lowered from a top deck of the platform through 366 m of water until the pipe encounters the seafloor and penetrates approximately 60 m of the seabed under its own weight. Because of the extremely long length of the conductor pipe compared to those represented in the literature, the pipe was modeled as a line array of 12 sources at 30-m intervals (i.e., over 360 m pipe length). This procedure produced a more realistic estimate of the maximum sound SPL_{rms} from impact hammer driving of Harmony's conductor pipe, compared with a single sound source representation (e.g., mid-pipe) that is generally used for shorter pipes (piles). At the maximum hammer energy of 90 kJ, the corresponding maximum sound pressure throughout the water column was estimated at 202 dB_{rms} (re 1 uPa) at 1 m from the conductor, depicted as the y-intercept (SPL_{rms}) (red triangles) in **Figure 6-1**.

6.1.3 Items 3 & 4 – Sound propagation and calculated maximum exposure distances

In-water. Modeled maximum distances to Level A and Level B received sound levels (SPL_{rms}) are presented in **Table 6-3**. Sound propagation and corresponding maximum distances were modeled using Jasco's model Full Waveform Range-dependent Acoustic Model (FWRAM), which is based on a modified version of the U.S. Navy's parabolic Range-dependent Acoustic Model (RAM) to account for an elastic seabed. FWRAM enhances RAM by accounting for seabed dissipation of acoustic energy and incorporates local bathymetry, seafloor geoacoustics, and underwater sound speed profiles. Physical data specific to the platform location were used by JASCO to model sound propagation and are shown in **Table 2-1** and **Figure 2-2** (Section 2). Representative data include sediment grain size and density, and water column salinity/temperature, as these properties affect seafloor geoacoustic properties and in-water sound speed, respectively.

Routines in FWRAM were used to model sound as SPL_{rms} over water column depth and distance from the conductor pipe based on maximum hammer energy (90 kJ). **Figure 6-2** shows water depth versus

distance from the conductor pipe (sound source), where the "160" isopleth represents the maximum distance of Level B exposure (i.e., 160 dB_{rms}) for cetaceans and pinnipeds. As seen in **Figure 6-2**, maximum Level B distances are generally higher in the top 100 m of the water column.

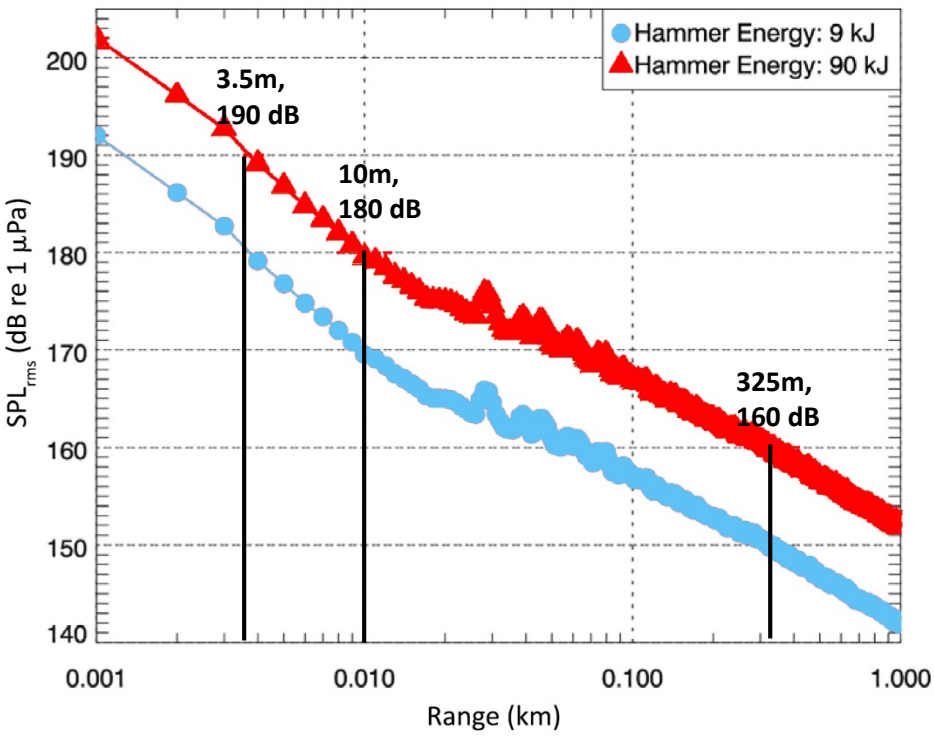

Figure 6-1. Root-mean-square sound pressure levels (SPL_{rms}) with distance from the conductor pipe for minimum (9kJ) and maximum (90 kJ) hammer energies. Maximum distances (m) corresponding to 190, 180, and 160 dB_{rms} noise thresholds also are shown (adapted from JASCO).

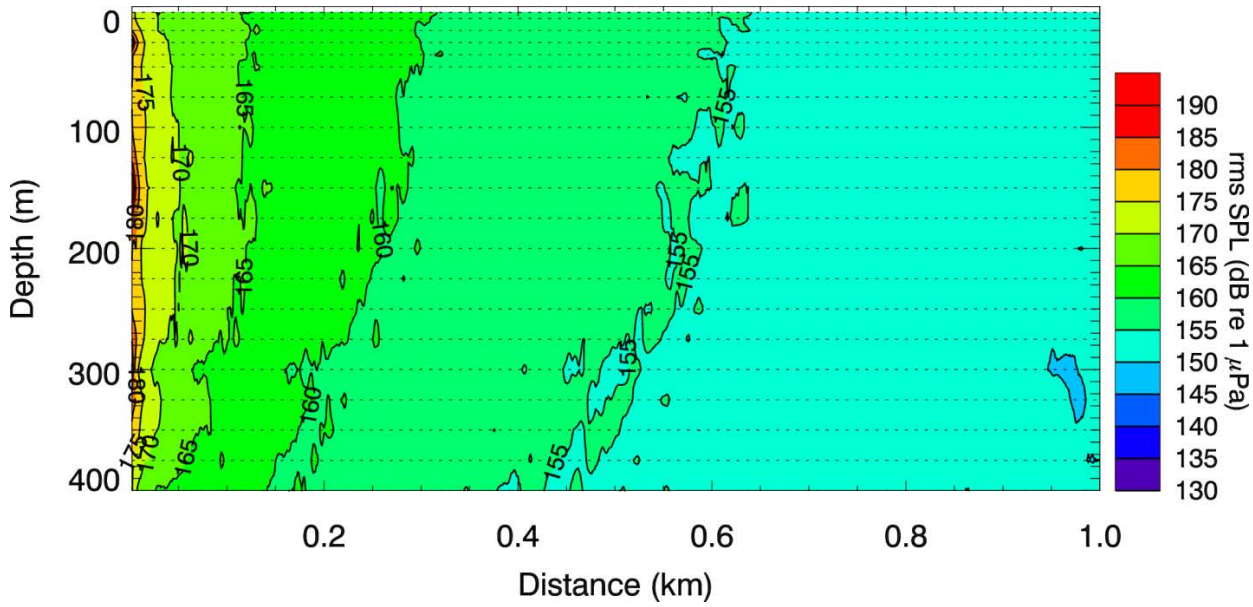

Figure 6-2. Maximum distances from the conductor sound source to Level B threshold (depicted as the 160 [dB_{rms}] isopleth) modeled over water depth for 90kJ hammer energy (from JASCO).

Table 6-3. Maximum distances (m) from the conductor pipe for Level A and Level B exposures to marine mammals (expressed as SPL_{rms}) based on maximum hammer energy (90kJ).

Marine Mammal Group	In-air Maximum Distance for Level B Exposure[1]	In-water Maximum Distance for Level A Exposure[2]	In-water Maximum Distance for Level B Exposure[2]
Cetaceans	not applicable	**10 m** (180 dB_{rms})	**325 m** (160 dB_{rms})
Harbor seals	**123 m** (90 dB_{rms})	**3.5 m** (190 dB_{rms})	**325 m** (160 dB_{rms})
Non-harbor seal pinnipeds	**41 m** (100 dB_{rms})	**3.5 m** (190 dB_{rms})	**325 m** (160 dB_{rms})

[1]in-air decibels (dB_{rms}) based on re 20 µPa; [2]in-water decibels (dB_{rms}) based on 1 µPa

To evaluate potential seasonal effects on sound propagation in the water column, year-round conditions using selected monthly averages (Jan, Apr, Aug, Nov) of water column salinity and temperature were modeled along one azimuth, south of the platform. Results showed no significant seasonal variations (<1 dB_{rms}) up to 1 km from the platform.

Potential differences in sound propagation with direction from the platform also were investigated by JASCO. There were no significant differences in the sound field modeled for four equally spaced transects out to 1 km from the platform.

In-air. JASCO used in-air sound levels calculated from recordings of pipe driving tests performed by ExxonMobil using a 90 kJ energy hammer that is planned for use on this project. The tests used the S-90 hammer at 90 percent of its maximum energy with a steel pipe of unknown size. The estimated sound levels represent A-weighted received levels, calculated at six distances between 0 and 12 m, and indicated a source level of 132.4 dB_{rms} (re 20 µPa, A-weighted). Calculated distances from the sound source to Level B behavioral disturbance thresholds from sound levels (SPL_{rms}) using spherical spreading loss are shown in **Table 6-3**.

6.1.4 Item 5 – Densities of marine mammals in the activity area

Table 6-4 presents densities of marine mammal species likely to occur in the Santa Barbara Channel were: 1) taken directly from the literature; or 2) calculated using corresponding stock abundances.

Table 6-4. Information used to estimate densities of marine mammal species.

Species	Density or Number of Animals on Platform	Comments
In-water		
Blue, fin, and humpback whale	Density taken from Redfern et al. (2013)	Upper density range at platform location
All other species	Density = Abundance ÷ 12,593 km^2	Abundance see Table 3-1 (Section 3); Channel study area = 12,593 km^2 (see Figure 1-1, Section 1)
In-air		
All pinnipeds	Number on platform = Channel density x 0.00113 km^2	Channel density = Abundance ÷ 12,593 km^2 (see Table 3-1, Section 3 for Abundance)

Density estimates for the blue, fin, and humpback whale were taken directly from Redfern et al. (2013), using the upper limit reported for the density contour that includes Harmony platform. Redfern et al. (2013) estimated densities for these three species using NMFS whale sightings collected from primarily August through November over a period from 1991–2009 throughout the Santa Barbara Channel. Results are depicted in **Figures 6-3** through **6-5** for the three species, and presented in **Table 6-6**. These densities are considered more accurate than those based on reported stock abundances because even though they are for the same monthly period and geographical location, they include a correction factor to correct for non-observational periods.

For calculated densities of likely affected species, stock abundances, which range from Washington State to northern Baha California, were assumed to be concentrated within the 12,593 km^2 Channel study area (see **Figure 1-1**, Section 1). The area includes Harmony platform, and extends 18 km to the north, 60 km to the west, and 70 km to the south of Point Conception. The eastern boundary is 35 km east of Anacapa Island. Use of this area produces a conservative density estimate because the geographical range of each species evaluated is much greater than the 70 km of the coastline selected to represent the study area, including season-specific ranges for species that migrate (e.g., gray whale). Calculated densities are presented in **Table 6-6**.

For species potentially exposed to in-air noise, pinniped densities were calculated by dividing the stock abundance for each species by the 1130 m^2 (0.00113 km^2) area of the platform near sea level (see Figure 1-2, Section 1), where the animals could potentially haul out.

6.1.5 Item 6 – Estimated number of takes for each species

In-water. Estimated takes were calculated for each species by multiplying animal density by the Zone of Influence (ZOI) area by the total number of days of active hammer driving: $Take_{species} = d \times ZOI \times$ days of activity for each species and take level. The ZOI area was calculated from the maximum exposure distances presented in **Table 6-3**, where ZOI = π x (maximum distance)^2, assuming omnidirectional spreading of sound from the conductor pipe. **Table 6-5** presents ZOI areas for Level A and Level B.

An example Level B take calculation for Cuvier's beaked whale follows:

$$\text{Level B Take}_{species} = 0.17 \text{ animals km}^{-2} \times 0.3318 \text{ km}^2 \times 4.125 \text{ days} = 0.23 \text{ animal} \cdot \text{days}$$

Complete results for all likely impacted species are shown in **Table 6-6**. Similar to the above example, take estimates for most species were <1 for Level B, except for five "dolphin" species, and all four pinnipeds. Take results were ≤0.01 for all ESA listed species, except for the sperm whale at 0.1.

Takes are requested for whole not partial animals, and as such, Level B takes ≥0.05 were rounded to the smallest integer that is greater than or equal to the fractional take value, except for the five ESA/MMPA listed cetaceans. For these species, if the Level B fraction was ≥0.005, a Level B take of one is requested for the rare event that an endangered species may transit within 325 m of the platform and through the Level B ZOI. Take requests also were increased by a factor of 10 of the corresponding estimate for those species that display large group behavior, and are identified in **Table 6-6**.

There are no Level A take requests. In the event that any marine mammal species enters a Level A ZOI, a provision to shut-down operations is included (see Section 11).

Table 6-5. Calculated Level A and Level B ZOI areas based on maximum hammer energy (90kJ).

Marine Mammal Group	In-water ZOI for Level A Exposure	In-water ZOI for Level B Exposure
Cetaceans	**0.000314 km²** (180 dB_{rms})	**0.33 km²** (160 dB_{rms})
Pinnipeds	**0.000038 km²** (190 dB_{rms})	**0.33 km²** (160 dB_{rms})

In-air. As previously discussed, there are no estimated Level B takes of any pinniped species. Relevant data supporting these results are presented in **Table 6-7**.

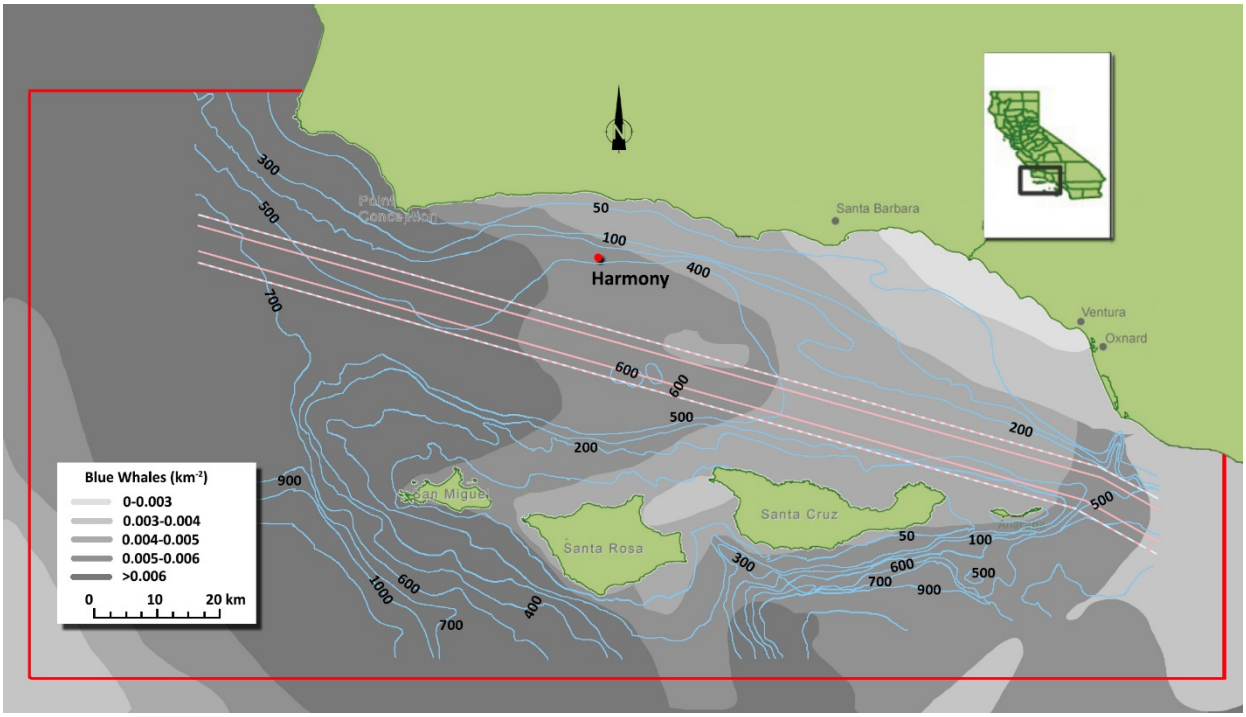

Figure 6-3. Density estimates for the blue whale in the Channel study area and vicinity of Harmony platform (adapted from Redfern et al. [2013]).

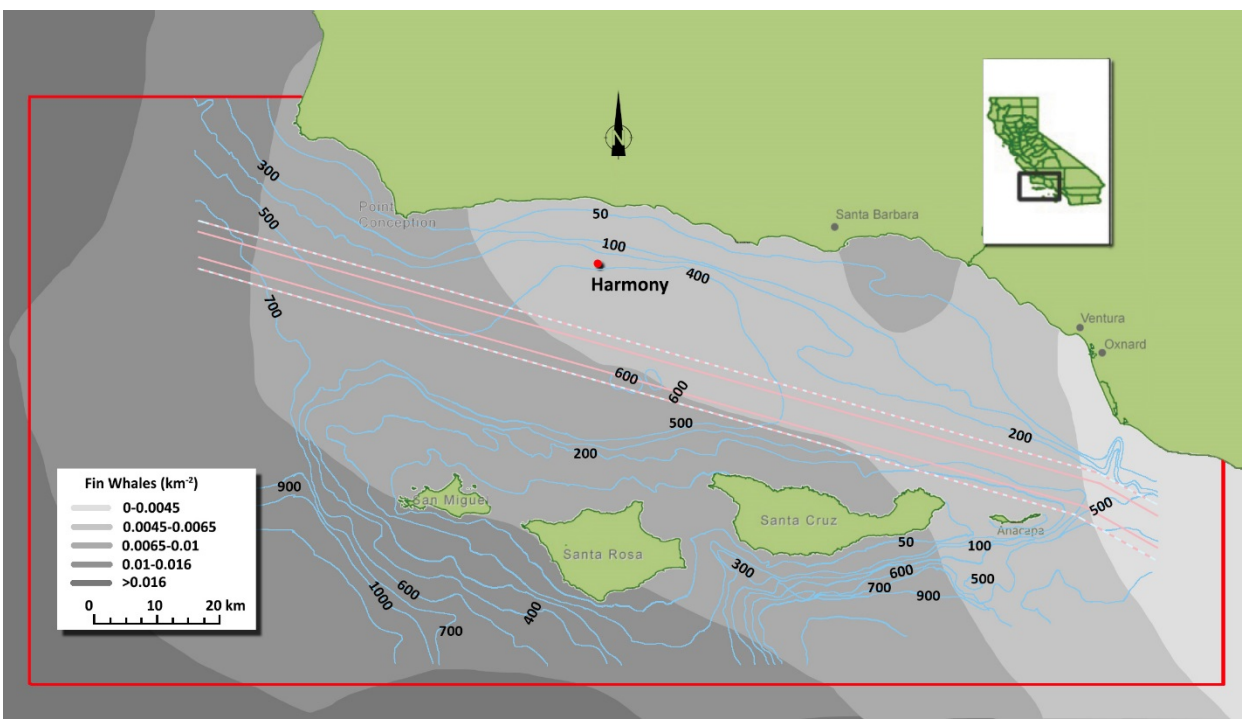

Figure 6-4. Density estimates for the fin whale in the Channel study area and vicinity of Harmony platform (adapted from Redfern et al. [2013]).

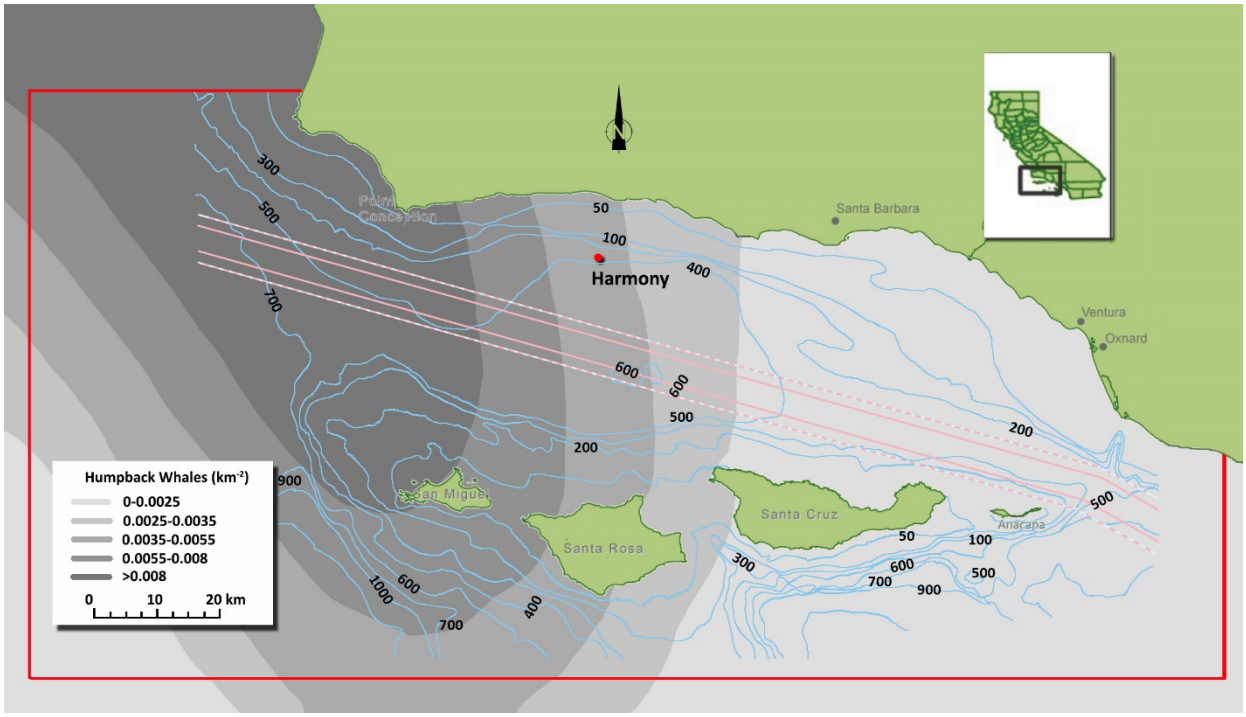

Figure 6-5. Density estimates for the humpback whale in the Channel study area and vicinity of Harmony platform (adapted from Redfern et al. [2013]).

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Table 6-6. In-water Level A and Level B take calculations and requests.

Species	Stock Abundance [2]	Density (*d*) in Study Area[3] (km^{-2})	Mammals in Level B ZOI[4]	Estimated Level B Takes[5] (number · days)	Level B Take Requests	Mammals in Level A ZOI[5]	Estimated Level A Takes (number · days)	Level A Take Requests
Blue whale[1]	2497	*0.008	0.0027	0.011	1	<0.001	<0.01	0
Fin whale[1]	3044	*0.004	0.0013	0.005	1	<0.001	<0.01	0
Gray whale[6]	20,990	*0.5067	0.1681	0.693	10	<0.001	<0.01	0
Humpback whale[1]	2043	*0.0055	0.0018	0.007	1	<0.001	<0.01	0
Minke Whale	478	0.04	0.0133	0.055	1	<0.001	<0.01	0
Sei whale[1]	126	0.01	0.0033	0.014	1	<0.001	<0.01	0
Baird's beaked whale	907	0.07	0.0232	0.096	1	<0.001	<0.01	0
Common bottlenose dolphin[6]	1329	0.11	0.0365	0.151	10	<0.001	<0.01	0
Cuvier's beaked whale	2143	0.17	0.0564	0.233	1	<0.001	<0.01	0
Killer whale	691	0.05	0.0166	0.068	1	<0.001	<0.01	0
Long-beaked common dolphin[6]	107016	8.5	2.8206	11.635	120	0.0027	0.01	0
Mesoplodont beaked whales	1024	0.08	0.0265	0.109	1	<0.001	<0.01	0
Northern right-whale dolphin	8334	0.66	0.2190	0.903	1	<0.001	<0.01	0
Pacific white-sided dolphin[6]	26930	2.14	0.7101	2.929	30	0.0007	<0.01	0
Risso's dolphin[6]	6272	0.5	0.1659	0.684	10	<0.001	<0.01	0
Short-beaked common dolphin[6]	411211	32.65	10.83	44.691	450	0.0103	0.04	0
Short-finned pilot whale	760	0.06	0.0199	0.082	1	<0.001	<0.01	0
Sperm whale[1]	2142	0.17	0.05646	0.231	2	<0.001	<0.01	0
Striped dolphin[6]	10908	0.87	0.2887	1.191	20	<0.001	<0.01	0
Dall's porpoise[6]	42000	3.34	1.1083	4.572	50	<0.001	<0.01	0
Pygmy sperm whale	579	0.05	0.0166	0.068	1	<0.001	<0.01	0
California sea lion	296750	23.6	7.8179	32.249	33	<0.001	<0.01	0
Harbor seal	30196	2.40	0.7964	3.285	4	<0.001	<0.01	0
Northern elephant seal	124000	9.85	3.2685	13.483	14	<0.001	<0.01	0
Northern Fur seal	9968	0.79	0.2621	1.081	2	<0.001	<0.01	0

[1]ESA listed species; [2]See Table 3-1, Section 3 for source; [3]Channel study area=12,593 km^2; [4]=325 m from source; [5]=3.5m from source for pinnipeds, 10m for cetaceans; [6]=take request increased 10x to account for group behavior.

Table 6-7. In-air pinniped Level B take calculations, resulting in no take requests.

Species	Stock Abundance[1]	Density (*d*) in Study Area (km^{-2})	Estimated No. of Mammals at Platform[2]	Level B maximum distance from source (m)	Distance from Sound Source to Haul-out	Estimated Level B Takes (number · days)	Level B Take Requests
California sea lion	296750	23.6	0.0267	41	47	0	0
Harbor seal	30196	2.40	0.0027	123	47	0.011	0
Northern elephant seal	124000	9.85	0.0111	41	47	0	0
Northern Fur seal	9968	0.79	0.0089	41	47	0	0

[1]See Table 3-1 (Section 3) for source; [2]Platform area at sea level potentially accessible for haul-out = 1130 m^2 (mammals = density in study area x area of platform).

7 IMPACT OF ACTIVITY ON THE SPECIES OR STOCK

The anticipated impact of the activity upon the species or stock:

- Only temporary behavioral disturbances to marine mammal species are anticipated from project activities
- No impact on marine mammal stocks from project activities

7.1 Impact on Species

Federal Register Notice (Vol. 70, No. 7, pp. 1871-1875) establishes thresholds for acoustic impacts to marine mammals. These regulations set standards for behavioral harassment ("Level B" criteria) of marine mammals at 160 dB_{rms} (re 1 µPa) for impact sound sources, including hydraulic hammer driving. The regulations also set the criteria for physical injury ("Level A" criteria) from an impact source at 180 dB_{rms} (re 1 µPa) cetaceans and 190 dB_{rms} (re 1 µPa) for pinnipeds.

Project activities may have temporary behavioral impacts to marine mammal species as a result of conductor pipe hammer driving, but no long term impacts to the species or stock are expected to occur as a result of the project. Potential Level B behavioral impacts include temporary threshold shift, masking, short term changes in the animal's typical behavior, and/or avoidance of the affected area. Other potential behavioral changes could include increased swimming speed, increased surfacing time, increased haul-out time (pinnipeds only), and decreased foraging in the affected area. There are no anticipated Level A harassment/injury effects (or take requests), including permanent threshold shifts, stranding, mortality, or vessel impacts associated with the project.

Preventative measures, including a gradual increase in sound levels generated by the hydraulic hammer also will help deter mammals from the activity zone (see in Section 11). Thus, the primary anticipated impact to exposed cetaceans and pinnipeds can be characterized as a temporary behavioral change to avoid a 0.33 km^2 ensonification area that exceeds the 160 dB_{rms} non-injurious threshold limit.

7.1 Impact on Stocks

Any exposed cetacean stocks would be transient, including migrating gray whales and their calves, as no breeding, calving, or nursery areas occur in the vicinity of Harmony platform.

San Miguel Island provides habitat for the northern elephant seal, northern fur seal, and the California sea lion. However, it is located approximately 40 km southeast of Harmony platform, so potentially exposed pinnipeds also would be transient.

The estimated number of behavioral disturbance "takes" to the cetacean long-beaked common dolphins (California stock) and short-beaked common dolphins (California, Oregon, and Washington stock), and the pinniped California sea lions (U.S. stock), and Northern elephant seals (California stock) each represent ≤0.01% of their respective populations (shown in **Table 3-1**, Section 3). These species have the four highest stock abundances reported for the Santa Barbara Channel study area. Hence, no measurable impact to these or other marine mammal species with respect to their stock would be expected over the short 4.125 days of cumulated hammer driving for the Harmony platform conductor pipe installation project.

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8 IMPACT ON MARINE MAMMALS FOR SUBSISTENCE USES

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

- NOT APPLICABLE

There are no subsistence uses of any of the 22 cetacean (of which 21 were considered likely to occur in the activity area) or four pinniped species potentially occurring in the Santa Barbara Channel during the project period; thus, no impact on the availability of these species for subsistence uses will occur.

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9 IMPACT OF ACTIVITY ON HABITAT OF MARINE MAMMALS

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

- There is no measurable impact on marine mammal habitat from this project

The primary impact of the activity on the local environment is from sound, above and below the water surface to a depth of 366 m. The transitory nature of sound will not impact the habitat of the marine mammal populations. A secondary impact from the activity will be the temporary suspension of bottom sediment, resulting from the installation via hammer driving of six 26-inch diameter steel conductor pipes within the platform jacket structure. The small amount of suspended sediment will quickly disperse and resettle to the seafloor.

No permanent impacts are expected to marine mammals. The impacts are temporary in nature and are associated with pile driving and construction noise disturbance and would not require restoration. Site conditions are anticipated to be unchanged from existing conditions for marine mammals following project implementation.

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10 MARINE MAMMAL HABITAT LOSS OR MODIFICATION

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

- There is no measureable loss or modification of marine mammal habitat resulting from the project

There is no measureable loss of existing marine mammal water column or benthic habitat resulting from the installation of six conductor pipes at Harmony Platform. The impacts associated with the proposed project are temporary and are not expected to have long term effects on marine mammals or marine mammal habitat.

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11 PROPOSED MITIGATIONS

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.

- Visual monitoring, soft-starts, and shut-down protocol are proposed to negate Level A harassment of sea lions and reduce potential Level B behavioral disturbance of marine mammals
- Other NOAA-recommended methods are considered for the deterrence of sea lions at the platform

The project is not anticipated to result in Level A impacts to marine mammals, but may result in Level B harassment. Level B harassment would be temporary in duration, and is not expected to result in any long term effects to marine mammal stocks or habitat in the region. The short intervals and cumulated periods of hammer driving, estimated at 2.5-3.3 hours and 4.125 days, respectively, will also minimize potential affects to marine mammals.

The following mitigation measures are proposed for the project.

11.1 Shut-Down of Hammer Driving Activities

All visual monitoring will be conducted by qualified marine mammal observers (MMO), as described in Section 13. Visual monitoring will be conducted continuously during active hammering activities. MMOs will not have any tasks other than visual monitoring and will conduct monitoring from the best vantage point(s) practicable (e.g., on the platform or other suitable location) that provides 360° visibility of the Level A and Level B ZOIs (aka “shut-down” and “buffer” zones), as far as possible. The MMO will be in radio communication with the hammer operator during activities, and will call for a shut-down in the event that a pinniped or cetacean appears to be headed toward its respective Level A ZOI (i.e., 3.5-m for pinnipeds; 10-m for cetaceans). Additional information on monitoring and reporting is presented in Section 13.

11.2 Hours of Operation

Project operations are conducted on a continual 24-hour basis, so some of the 2.5- to 3.3-hour active driving periods are expected to occur during non-daylight hours. To facilitate monitoring during non-daylight hours, the Level A ZOI will be illuminated to permit easy viewing by the MMO. Lighting is not expected to attract marine mammals. The Level A ZOI areas fall within the jacket structure, and therefore can be easily lit and monitored in non-daylight hours.

For the Level B ZOI, which extends out to 325 m from the conductor pipe, MMOs will be stationed on an upper deck of the platform to monitor marine mammals during hammer driving. During non-daylight hours, MMOs will utilize night-vision binoculars and other appropriate equipment to monitor marine mammals. If nighttime visual aids are insufficient, we propose to use daytime visual counts of marine mammals as an estimate of the number of marine mammals present during non-daylight hours (within a 24-hour period), noting that diurnal activities for most marine mammals are expected to vary somewhat.

11.3 Soft-Start Procedure

As recommended by NOAA, this project will make use of soft-start techniques appropriate for impact pipe driving. A soft-start consists of an initial set of three strikes from the impact hammer, at 40% energy, followed by a 30-second waiting period, then two subsequent 3-strike sets. The soft-start is used in order to provide additional protection to marine mammals in the area by providing them with a warning and/or giving marine mammals a chance to vacate the area, prior to hammer driving.

The Level B ZOI will be monitored by dedicated MMOs beginning 30 minutes before hammer driving (to ensure the ZOI is clear of all cetaceans), during driving, and for 30 minutes after driving stops (see Section 13). The Level A ZOIs for pinnipeds and cetaceans will be monitored together by a dedicated MMO following the Level B ZOI procedure. However, if any marine mammals are observed in the Level A ZOI, operations will be delayed until the zone is clear of animals for at least 30 minutes and NMFS will be notified within 24 hours. If a marine mammal enters the Level B ZOI "buffer" zone during operations, observed behavior and approximate distance from the sound source will be recorded by the MMO.

11.3.1 Establishment of shutdown zones

A Level A ZOI "shutdown" zone will be established for cetaceans and pinnipeds, at 3.5 m and 10 m from the conductor sound source, respectively. The shutdown zones will be monitored by a dedicated MMO as described in Section 13. If specified marine mammals are present within the shutdown zone before operations begin, start of operations will be delayed until the zones are clear for at least 30 minutes. If specified marine mammals appear in the shutdown zone during operations, the MMO will instruct the hammer operator to halt all operations in a safe, but immediate manner. Operations will only resume once the shutdown zone has been cleared for at least 30 minutes. In the unlikely event that marine mammals enter the shutdown zone during operations, the exposure and behaviors will be documented and reported by the MMO and NFMS will be contacted within 24 hours.

A non-MMO safety spotter will also be assigned to the lower deck observation area. All personnel operating at the lower observations levels will be required to wear appropriate personal protective equipment (PPE).

11.4 NOAA-Recommended Deterrence Methods

California sea lions have been observed to haul out and rest on low portions of the Harmony platform jacket structure, which could place them well within the Level B buffer zone and very close to the Level A shutdown zone. ExxonMobil has procedures to legally deter sea lions from the platform that are consistent with NOAA-recommended deterrence methods. The MMPA does not allow private citizens to deter marine mammals from undeveloped property; however, pinnipeds, including California sea lions that are exhibiting problem behavior (e.g., hauling out, impeding access) can be deterred from man-made structures, such as Harmony platform that was constructed for the sole purpose of crude and condensate production (see NOAA 2008). Formal guidelines and regulations for deterring marine mammals are under development by NOAA. Until they are available the agency provides interim advice for deterring California sea lions on its NOAA Fisheries West Coast Region website (NOAA 2008). The previously described noise introduced through the soft-start procedure represents an effective deterrent for errant California sea lions visiting the platform. Other NOAA-recommended methods already in place as part of ExxonMobil's normal operations are expected to prevent nuisance sea lions from entering the Level A ZOI.

12 EFFECTS ON ARTIC MARINE MAMMALS FOR SUBSISTENCE USES

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a "plan of cooperation" or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses.

- NOT APPLICABLE

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13 MONITORING

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.

- In-situ acoustic monitoring to validate model predictions of sound at 10 m from the source (Level A for cetaceans), and at 325 m from the source (Level B for all mammals)
- Visual marine mammal monitoring during activity of Level A and Level B ZOIs for cetaceans and pinnipeds

Objectives, methods summary, and reporting requirements for the monitoring of sound and marine mammals during project activities are described in this section. In addition, marine mammal observer (MMO) qualifications are presented. Acoustic and marine mammal monitoring plans will be provided to NMFS for consideration in support of this IHA application.

Two main types of monitoring will be performed for this project: 1) in-situ measurement of sound pressure levels; and 2) visual observations of the number and type of marine mammals that enter sound exposure zones (aka zones of influence [ZOI], see Section 6). In-situ acoustic data will be used to validate model predictions of sound pressure levels (SPL_{rms}) near and with distance from the conductor pipe sound source, including the predicted maximum distances of Level A and Level B ZOIs. If measured results differ from modeled results, measured data will be used to revise ZOI boundaries to reflect actual conditions during project activities (with NMFS approval). Data from visual monitoring of marine mammals will be used to validate exposure (take) predictions, ensuring that the actual number of takes is less than or equal to the number requested (see Section 6) and authorized under the project IHA. The relationship between information used to estimate the number of marine mammal "takes", and data collected in the field is shown in **Figure 13-1.**

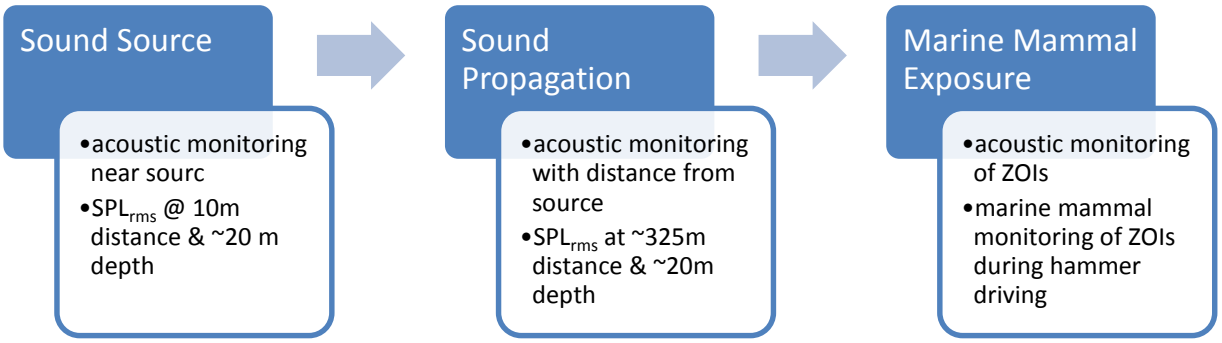

Figure 13-1. Relationship between predicted/modeled data (blue) and monitoring data used to validate predictions (white).

It should be noted that critical distances from the sound source used to assess injury and behavioral disturbances have various names, depending on their use. They are often referred to as "isopleths" in acoustic monitoring, as "shut-down" and "buffer" zones in marine mammal monitoring, and as Level A and Level B ZOI boundaries by risk assessors. For consistency and to avoid confusion, they are designated as the maximum ZOI distance from the sound source as follows:

- Level A ZOI (3.5m): refers to Level A 3.5-m isopleth and shut-down zone for pinnipeds
- Level A ZOI (10m): refers to Level A 10-m isopleth and shut-down zone for cetaceans
- Level B ZOI: refers to Level B 325-m isopleth and buffer zone for cetaceans and pinnipeds

13.1 Acoustic Monitoring

Acoustic monitoring is conducted to obtain both in-air and in-water sound levels during project activities as discussed below. Each hydrophone (in-water) and microphone (in-air) is calibrated following manufacturer's recommendations prior to the start of the project and checked for accuracy and precision at the end of data collection for each conductor pipe or as practical during conductor pipe installation activity.

Environmental data will be collected to supplement the acoustic monitoring and include: wind speed and direction, air temperature, humidity, near-surface water temperature, weather conditions, and other appropriate factors that could contribute to influencing either in-air or in-water sound transmission levels. Prior to deploying monitoring equipment, the acoustics specialist will be provided with the hammer model and size, hammer energy settings, and projected blows per minute for the conductor pipe segments requiring hammer driving.

Background in-air and in-water sound levels will be measured at Harmony platform in the absence of hammer driving activities to obtain an ambient noise level, and recorded over a frequency range of 10 Hz to 20 kHz. Sound pressure levels associated with soft-start techniques (see Section 11) also will be measured.

13.1.1 In-water

Acoustic monitoring will be performed at a minimum of two fixed stations located at 10 m and approximately 325 m from the conductor sound source. These distances represent the 180 dB_{rms} and 160 dB_{rms} modeled sound level thresholds for cetaceans and cetaceans/pinnipeds, respectively. The Level A ZOI (10m) results will be used to validate predicted sound pressure levels nearer to the conductor pipe source.

The following general approach will be used to measure in-water sound levels:

1. Acoustic monitoring will be conducted over the entire hammer driving period for each conductor, starting approximately 1 hour prior to driving through 1 hour after hammering has stopped. Pre- and post-hammer driving data will be used to determine ambient/background noise levels.
2. A stationary hydrophone system with the ability to measure and record sound pressure levels (SPLs) will be deployed at a minimum of two monitoring locations (stations). SPLs will be recorded in voltage, converted to micro Pascals (µPa), and post-processed to decibels (dB [re 1 µPa]), as described below.
    a. For the first conductor pipe installation, hydrophones are placed at 10 ± 1 m and at 325 ± 33 m from the conductor pipe at depths ranging from 10 to 30 m (e.g., 20 m) below the water surface to avoid potential inferences from surface water energy, and to target the depth range of maximum occurrence of marine mammals most likely in the area during the project. The equipment will obtain data for the most likely depth range of marine

mammal occurrence. Horizontal displacement of ±10 percent may be expected for instrument movement due to the water depth and forces from tides, currents and storms.

b. Additional hydrophone mooring systems may be deployed at additional distances and/or depths.

3. Following each successive conductor pipe installation, the water depth and geographical orientation of the hydrophone may be changed to validate modeled sound pressure levels at varying water depths and direction.

At a minimum, the following sound data will be analyzed (post-processed) from recorded sound levels:

1. Absolute peak overpressure and under pressure levels for each conductor pipe.
2. Average, minimum, and maximum root-mean-square (rms) sound pressure levels (SPL_{rms}), integrated from 3 Hz to 20 kHz.
3. Average duration of each hammer strike (blow), and total number of strikes per continuous hammer driving period for each conductor.

In the event that field measurements indicate different SPL_{rms} values than those predicted by modeling for either the Level A or Level B maximum distances/ZOIs from the conductor sound source, corresponding boundaries will be increased/decreased accordingly, following NMFS notification and authorization.

13.1.2 In-air

Reference measurements will be made at approximately 10 to 20 m from the initial hammer strike position using a stationary microphone. The microphone will be placed as far away from other large sound sources as practical.

The in-air Level B behavioral disturbance predicted for "non-harbor seal pinnipeds", including California sea lions of 100 dB_{rms} (re 20 µPa) was estimated at 41 m from the hammer impact point on the conductor pipe. In-air sound levels will be recorded at several points around the base of the platform at sea level to validate modeled sound. Distances closer to the sound source may be monitored for model validation purposes, but only if safety issues are not introduced. Recorded data will be reported as dB_{rms} (re 20 µPa, A-weighted and unweighted) to compare with Level B in-air noise thresholds of 100 dB_{rms} for non-harbor seal pinnipeds, as defined by current NOAA Fisheries West Coast Region in-air acoustic thresholds.

13.2 Marine Mammal Monitoring

Marine mammal monitoring will be performed at a minimum during periods of active hammer driving throughout the project following general procedures in Baker et al. (2013). Monitoring will begin 0.5 hours before the start of hammer driving, continue through an estimated 2.5 to 3.3 hours of driving, and conclude 0.5 hours after driving stops (up to 4.3 hours of monitoring per driving period). As described in Section 1, five to seven hammer driving periods are required for each conductor pipe. In addition, to "during hammer driving" monitoring, baseline monitoring of marine mammals will be performed up to one week before and one week after conductor pipe installation, as well as selected periods in between hammer driving activities.

Modeling results predict that in-water Level A sound levels (SPL_{rms}) from hammer driving will not exceed the 3.5-m or 10-m ZOI from the conductor pipe for pinniped and cetacean species, respectively. However, a safety zone will be monitored to preclude physical harm to these species. A comprehensive

monitoring plan will be developed to ensure compliance with the issued IHA for this project. A brief description of the monitoring plan supporting hammer driving activities follows.

13.2.1 Methods

There will be a team of three marine mammal observers (MMOs) conducting monitoring during active hammering periods. Observations will take place during active hammering periods which includes both daylight and nighttime operations. The monitoring will occur for approximately 4.3 hours (3.3 hour monitoring plus 0.5 hour pre- and post-hammering) during a single hammering phase followed by approximately 6.3 hours of off-duty rest. A total of five to seven observation periods corresponding to the driving of the pipe segments (see Section 1) is anticipated for each of the six conductors. It is possible that a hammer driving session will take less than 3.3 hours and that the "rest interval" for the monitors separating driving segments will be less than 6.3 hours. If driving and rest intervals are reduced and additional segments are added (e.g., seven instead of five), two alternating teams of three MMOs may be required. At the conclusion of hammer driving activities for a single conductor pipe, observers may be transferred to shore to await the next active driving phase.

MMOs will be placed at the best practicable vantage point(s) (e.g., lower platform level, upper platform level) to monitor the 3.5-m/10-m and the 325-m ZOIs for marine mammals. The MMOs will have authority to implement shutdown/delay start procedures, if applicable, by calling the hammer operator for a shutdown via radio communication.

For the 325-m ZOI, two MMOs will be stationed on an upper platform deck where they have a clear view of the monitoring area. They will be approximately 180 degrees apart and each will monitor approximately one-half of the corresponding ZOI with binoculars and other appropriate equipment covering a radius of approximately 350 m from the conductor pipe. For the Level A ZOIs, one MMO will concurrently monitor radii of 3.5 m and 10 m for pinnipeds and cetaceans, respectively, from a lower level observation post that provides a clear view of the sea surface around the actively driven conductor pipe. These respective distances establish shut-down zones around the conductor to preclude Level A harassment of pinnipeds and cetaceans. The lower observation area will be illuminated during night-time observations. Visual aids may be used but are not required, providing the observer has a clear view of the sea surface without aids. A non-MMO safety spotter will also be assigned to the lower deck observation area. The safety spotter will be available to deter errant California sea lions using NMFS-recommended methods (NMFS 2008). All personnel operating on the platform will be required to receive required training and wear appropriate personal protective equipment (PPE).

Equipment for monitoring is expected to include hearing protection when observations are made from high noise areas of the platform, marine radios with headsets, time keeping device (e.g., watch or cell phone), day and night range-finding binoculars (7X50 or greater), notebooks with standardized recording forms, identification guides, project-specific monitoring plan approved by NMFS (to be submitted separately).

13.2.2 Observation Records and Reporting

MMOs will use NMFS-approved Marine Mammal Sighting Forms. These forms will be finalized at the conclusion of each observational shift. Each MMO will record all observations of marine mammals following standard marine mammal data collection protocols. The list of data to be collected includes:

1. Date, time, location description, latitude and longitude, observer name, affiliations;
2. Weather (including Beaufort Sea State, wind direction);

3. Species description, number of animals, distance from sound source and direction of travel with respect to the platform, behavior of the marine mammals, whether or not a shutdown was required.

Level B. Sightings of marine mammals within the 325-m ZOI will be reported in a manner and frequency designated by the NMFS Long Beach, California office, which may include up to one report per 24-hour period or multiple reports throughout the project duration.

Level A. Sightings of marine mammals within corresponding 3.5-m and 10-m ZOIs for pinnipeds and cetaceans, respectively, will be reported to the NMFS Long Beach, California office as soon as possible during normal business hours. For any Level A sighting, the MMO will instruct the hammer operator by radio to halt operations in a safe, but immediate manner.

Injured or Dead Protected Species. Any sightings of injured or dead protected species throughout the project duration will be reported to the NMFS West Coast Regional Stranding Hotline (1-866-767-6114) within 24 hours of the sighting and a reporting form will be completed.

13.2.3 MMO qualifications

Monitoring will be conducted by qualified marine mammal observers, defined in Baker et al. (2013), and approved by NMFS. An MMO is a biologist with prior training and experience in conducting marine mammal monitoring or surveys, and who has the ability to identify marine mammal species and describe relevant behaviors that may occur in proximity to the activity. MMOs dedicated to this project will have no other activity-related task.

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14 RESEARCH & PROJECT SPECIFIC MEANS TO REDUCE POTENTIAL EFFECTS

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

- ExxonMobil has an established history of actively engaging in scientific research on anthropogenic sound effects on marine mammals
- All marine mammal data gathered during installation will be made available to NMFS, researchers, and other interested parties

Activities at Harmony platform, consisting of installation of six conductor pipes by impulsive hammer driving, will be conducted in accordance with federal regulations and include minimization measures approved by NMFS to protect potentially exposed marine mammals from project-related noise. Project activities and data, including sound measurements and marine mammal observations, will be communicated regularly through the regional NMFS office in Long Beach, California in accordance with IHA authorization. This information can be made available upon request by interested parties to potentially further understanding of anthropogenic sound in the marine environment and its potential effect on marine mammals.

ExxonMobil supports research on marine mammals and sound in the environment through academic, industry, and private sector collaborations. ExxonMobil is a founding member and largest contributor to the Sound and Marine Life Joint Industry Program (JIP) through the International Oil and Gas Producers (OGP), and The International Association of Geophysical Contractors (IAGC). Through JIP and other venues, ExxonMobil provides annual funding and support for fundamental and applied scientific research to better understand the effects of anthropogenic sound on marine life. ExxonMobil also conducts internal research and monitoring programs specific to sound effects from exploration and production activities. These efforts have helped produce effective mitigation strategies and techniques to reduce potential sound effects on marine mammals from our operations and those from the oil and gas industry as a whole.

ExxonMobil conducts its coastal and offshore operations to comply with federal, state, and local environmental regulations, and to minimize potential effects on marine mammals, including threshold shifts in hearing, and associated effects on behavior and/or physiology. In addition, ExxonMobil and our contractors conduct environmental studies and risk assessments prior to operations. Mitigation measures are carefully designed and implemented to address site-specific environmental conditions of each operation to ensure that sound exposure levels and vessel traffic do not harm marine mammals or other protected species.

Selected examples of ExxonMobil's significant involvement and contributions to scientific research on marine mammals and sound in the marine environment follow.

1. *Bioenergetics research on elephant seals and gray whales to understand energy requirements for different life stages (breeding, feeding, migration, lactation)*. In addition to breaking new ground in this area of marine mammal science, the research results also helps ExxonMobil conduct offshore activities to avoid or minimize impact to marine life. The research results have been assembled into a computer model capable of predicting bio-energy (calories) consumption under a range of scenarios. The research is conducted primarily by Prof. Dan Costa and his team at the University of California, Santa Cruz.

2. *Acoustic studies of spotted and ringed seals*. The research concerns the auditory capabilities of spotted and ringed seals as measured in the laboratory. These sorts of studies on species-typical auditory biology are increasingly relevant to the protection of marine mammals that likely depend on auditory cues for orientation and communication. Results pertain to both underwater and aerial audiometry. The research is carried out by Dr. Colleen Reichmuth and Jillian Sills at the University of California at Santa Cruz. Research partner include National Marine Mammal Lab, Native Village of Kotsebue (Alaska), Navy Marine Mammal Program, SeaWorld San Diego, Alaska SeaLife Center, NMFS Office of Protected Resources. ExxonMobil has funded this directly and through the Oil and Gas Producers International Sound and Marine Life Joint Industry Program.

3. *Sound mitigation for marine mammals*. Research to date has demonstrated that some odontocetes quickly learn to lower their own hearing sensitivity to protect themselves when a short warning sound is given before the delivery of a 170 dB (re 1 µPa) 20 kHz tone. When a warning tone was emitted randomly between 0 and 9 seconds before the louder sound, the whale reduced its hearing by 13 dB but when the sound was presented 20 to 40 seconds before the loud sound no hearing reduction occurred. It was as if the animal reduced its hearing ability when it could anticipate the arrival of the loud sound. We continue to support this research to find out whether this self-mitigation technique will also occur with other species, such as the bottlenose dolphin and the harbor porpoise. If this hearing change process is found in widely diverse species, it is very likely that it occurs in all echo-locating whales and dolphins. The research is conducted by Prof. Paul Nachtigall at the University of Hawaii.

4. *The Patagonian Right Whale Program* is a collaborative effort of Ocean Alliance, a U.S. nonprofit founded by Roger Payne and based in Gloucester, Massachusetts, and Instituto de Conservación de Ballenas, an Argentine nonprofit founded by Roxana Schteinbarg and Diego Taboada, based in Buenos Aires (see http://www.oceanalliance.org). The research is aimed at understanding the Southern Right Whale habitat and life stages. Of specific concern, is the attempt to understand elevated calf mortality. Results to date point to malnutrition, biotoxins (red tide algal blooms), infectious disease, and/or seagull harassment.

5. *2013 Satellite-monitored tagging of sperm whales in the Gulf of Mexico*. With this 2013 work, ExxonMobil is continuing the time series of tagged sperm whale data to determine the extent of "home-ranges" and habitat characteristics, and how whale foraging attempts (from Dive Behavior tags) can identify the distribution of squid. The 2013 field season data are now near final analysis and ready for publication. The work was led by Prof. Bruce Mate, Oregon State University.

6. *Use of novel environmental DNA techniques* to detect rare and endangered native species in various marine habitats. This information helps ExxonMobil plan the timing, location and extent of activities in order to minimize environmental impacts. Modern molecular methods, including DNA extraction procedures, polymerase chain reaction, and next-generation genomic sequencing methods are employed to assess the genetic material contained in samples. This so-called environmental-DNA method is useful to detect organisms of all sizes, from unicellular organisms to whales. A new direction of this research is to use full-service autonomous underwater vehicles for sample acquisition. The research is carried out by Battelle, ExxonMobil, and the North Slope Borough (Dept. of Wildlife Management, Barrow, Alaska).

7. *Understanding the migration patterns of Western Gray Whales*. Results from tagged western gray whales off Sakhalin Island showed that these marine mammals travel from Sakhalin, Russia, across the northern Pacific Ocean to the USA and Mexico pacific coasts. This research documented the longest migration of any mammal, and was conducted by A.N. Severtsov

Institute of Ecology and Evolution of the Russian Academy of Sciences and Oregon State University Marine Mammal Institute in collaboration with the U.S. National Marine Fisheries Service, Kronotsky State Nature Biosphere Reserve, the Kamchatka Branch of the Pacific Institute of Geography, and ExxonMobil (see http://mmi.oregonstate.edu/Sakhalin2011). The research was contracted through the International Whaling Commission and International Union for Conservation of Nature (IUCN) with funding from Exxon Neftegas Ltd. and Sakhalin Energy Investment Company Ltd.

8. *Assisted an international group of Arctic marine biologists and oceanographers* – led by Dr. Arne Bjørge at the Norwegian Marine research Institute in Bergen – to improve our understanding of habitats and foraging traits for five seal species throughout Western Greenland, Svalbard, and Novaya Zemlya. Such understanding of food webs for seals helps ExxonMobil map ecosystem parameters through space and time, and mitigate human impacts.

9. *ExxonMobil's internal research on environmental aspect analysis and the interplay of ecosystems and socioeconomics* has provided us with an industry leadership position in the area of ecosystem services (i.e. the broad set of values and benefits that humans derive from the environment). Preserving the ability of the environment to provide valued Ecosystem Services is one of the overall objectives of environmental management. Publication (*In Press*): Werner et al. (2014), Rapid Prioritization of Marine Ecosystem Services and Ecosystem Indicators.

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