APPENDIX I
METHODOLOGY FOR ESTIMATION OF MARINE MAMMAL TAKE AND PROJECT-SPECIFIC WEIGHTING OR CORRECTION FACTORS

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I.1 Overview

A basic model was developed to utilize radial distances to sound pressure levels (SPL) of regulatory concern for impulsive sound – 190 dB re 1 μPa rms for pinnipeds in water (injury), 180 dB re 1 μPa rms for cetaceans (injury), and 160 dB re 1 μPa rms for marine mammals (behavioral modification). The basic model employed densities for California marine mammals and total area ensonified by five different equipment types to 190, 180, and 160 dB re 1 μPa rms levels to estimate incidental take resulting from a representative low energy geophysical survey in California State waters. The analysis produced incidental take estimates (i.e., Level A and Level B) individually for each equipment type.

The following appendix summarizes marine mammal densities, marine mammal hearing groups and thresholds, sound source modeling parameters and radial distances to regulatory thresholds of concern, results of ensonified area calculations, and incidental take estimates, the latter of which includes raw take estimates and a series of biological and equipment-specific correction and weighting factors applied to estimate take with mitigation.

I.2 Marine Mammal Density Estimates

The area of consideration includes over 1,200 km of coast line and there is limited information available to fully assess the probability of occurrence for many of the species due to varied temporal and spatial potential in distribution and the operations of concern. Therefore, the marine mammal summary has focused on the probability of encountering species during an undefined OGPP survey anywhere in State waters.

A precautionary approach was adopted in the synthesis of marine mammal density estimates. For example, when species-specific density estimates were available for winter and summer seasons, the higher value was employed. This approach is most appropriate for wide-ranging species like mysticete whales, as local density estimates are not easily predicted due to their mobility, reliance on prey availability, and response to varying environmental conditions (Peterson et al. 2006). Such a precautionary, more conservative approach was also advantageous when estimating incidental take or developing mitigation requirements.

Density estimates were calculated using the online Strategic Environmental Research and Development Program (SERDP) spatial decision support system (SDSS) Marine Animal Model Mapper on Duke's Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS SEAMAP) website (http://seamap.env.duke.edu/). This online tool uses predictive habitat modeling based on survey data to estimate densities in a given area of interest (e.g., Barlow et al. 2009).

Density estimates were not available for several species via SERDP-SDSS; alternative sources were used to complete the density matrix. For the California gray whale, a species that migrates along the California coast twice annually between wintering grounds off Baja California, Mexico and its summer feeding grounds in the Bering, Beaufort, and Chukchi Seas., a seasonal (winter) density estimate was derived from NOAA's biogeographic assessment of northern and central California (NOAA 2003).

SERDP-SDSS models of cetacean densities are based on SWFSC ship line-transect data collected from 1986 to 2006. Model grid cell resolution is 25 by 25 km. The area of interest was defined by selecting the outermost 200 m isopleth boundary with deeper portions inside the 3 nmi State limit connected by the northern and southern 200 m isopleths boundary that encompassed the 3 nmi State waters boundary and included the Channel Islands.

Sea otter densities were not available on the SDSS model, therefore, densities for the only mustelid present in California waters were calculated from the USGS Western Ecological Research Center's Spring 2010 survey results (USGS 2013).

Pinniped density estimates were obtained from a single source (Koski et al. 1998) derived from population take estimates in central California. Variability in density estimates may be expected in other regions of California. To assess the likelihood of encountering pinniped species, densities from Koski et al. (1998) and the U.S. Department of Commerce NOAA/National Marine Fisheries Service – Southwest Region California pinniped map (NMFS 2008) were jointly used.

Densities of species and the sighting frequencies are presented in **Table I-1**.

Similarities in densities between the seven species vary, and sighting frequency in California State waters may or may not be similar. It is likely that environmental parameters and habitat use has more influence in the likelihood of occurrence rather than densities; however, some corresponding elements like sightability, surface time, and potential behavior changes due to low energy geophysical operations may be considered in evaluating the comparisons.

The marine mammal density data was derived for State waters <200 m deep, which covers ~98% of State waters. In cases where both species-specific summer and winter densities were available, the higher density value was used, resulting in a conservative estimate of marine mammal density.

Table I-1. Species or Guild, Stock, Species Accounts, Estimated Population Size, and Mean Density Estimates for California Marine Mammals

Species or Guild	Stock	Species Account for California Waters	N_{est}	Mean Density[a] (No./km^2)
Mysticetes				
Bryde's Whale (*Balaenoptera edeni*)	Eastern Tropical Pacific Stock	Bryde's whales along the California coast are likely part of a larger population inhabiting the eastern part of the tropical Pacific Ocean. As a result, a regular occurrence is likely to be very low. <u>Probability of encounter: very low</u>.	No estimate	0.000006 (Summer)
Sei Whale (*Balaenoptera borealis borealis*)	Eastern North Pacific Stock	Sei whales are considered rare in California waters. <u>Probability of encounter: low</u>.	126	0.000086 (Summer)
Minke Whale (*Balaenoptera acutorostrata scammoni*)	California/ Oregon/ Washington Stock	Minke whales occur year-round along shelf waters in California and in the Gulf of California, occurring south of California in the summer/fall. <u>Probability of encounter: low to medium</u>.	478	0.000276 (Winter)
Fin Whale (*Balaenoptera physalus physalus*)	California/ Oregon/ Washington Stock	Aggregations of fin whales occur year-round in Southern/Central California and the Gulf of California. Fin whale vocalizations are detected year-round off Northern California, with a peak in vocal activity between September and February. Although typically found over the slopes and continental shelves, fin whales have been regularly reported from shore during gray whale migration surveys. <u>Probability of encounter: medium</u>.	3,044	0.00473 (Summer); 0.000185 (Winter)
Blue Whale (*Balaenoptera musculus musculus*)	Eastern North Pacific	The U.S. west coast represents one of the most important feeding areas in summer and fall for blue whales. Most of this stock is believed to migrate south to Baja California, the Gulf of California, and the Costa Rica Dome during the winter and spring. <u>Probability of encounter: medium</u>.	2,497	0.005492 (Summer); 0.000114 (Winter)
Humpback Whale (*Megaptera novaeangliae*)	California/ Oregon/ Washington Stock	Humpback whales in the North Pacific feed in coastal California waters and migrate south to winter. The California/ Oregon/Washington stock includes humpback whales that feed along the U.S. west coast. Humpback whales are found throughout shelf waters, but have been reported with regularity inside the 100-m isobaths. <u>Probability of encounter: medium</u>.	2,043	0.003724 (Summer); 0.001207 (Winter)
North Pacific Right Whale (*Eubalaena japonica*)	Eastern North Pacific Stock	North Pacific right whales primarily occur in coastal or shelf waters in northern latitudes. During winter, right whales occur in lower latitudes and coastal waters where calving takes place. Sightings have been reported as far south as central Baja California in the eastern North Pacific. <u>Probability of encounter: low</u>.	31	0.000061 (Winter)

Species or Guild	Stock	Species Account for California Waters	N_{est}	Mean Density[a] (No./km^2)
California Gray Whale (*Eschrichtius robustus*)	Eastern North Pacific	Most gray whales in the Eastern North Pacific stock spend the summer feeding in the northern and western Bering and Chukchi Seas before migrating south in the fall along the coast of North America from Alaska to Baja California. The stock winters along the coast of Baja California, using shallow lagoons and bays for calving. The northbound migration generally takes place between February and May with cows and newborn calves migrating northward, primarily between March and June, well within 5 mi of the shoreline. Probability of encounter: high during some seasons, but low during others.	19,126	0.05 (Winter)
Odontocetes				
Short-Finned Pilot Whale (*Globicephala macrorhynchus*)	California/ Oregon/ Washington Stock	Short-finned pilot whales were likely residents off Southern California; however, after a strong El Niño event in 1982-83, short-finned pilot whales virtually disappeared from this region. Since then, there have been infrequent sightings of pilot whales off the California coast. Probability of encounter: low to medium, due to their gregarious nature and previous resident population.	760	0.000307 (Summer)
Killer Whale (*Orcinus orca*)	Eastern North Pacific Offshore Stock[2]	Killer whales are wide-ranging species, with this stock ranging from the outer coasts of Washington, Oregon and California. Probability of encounter: low to medium.	240	0.000709 (Summer); 0.000246 (Winter)
Striped Dolphin (*Stenella coeruleoalba*)	California/ Oregon/ Washington Stock	Striped dolphins are typically sighted 100 to 300 nm from the California coast. Probability of encounter: medium, due to their offshore tendencies.	10,908	0.001722 (Summer)
Pygmy and Dwarf Sperm Whales (*Kogia* spp.)	California/ Oregon/ Washington Stock	Pygmy and dwarf sperm whales are distributed throughout deep waters and along the continental slopes of the North Pacific; however, little population data are available for these species. *Kogia* sightings may underestimate their presence due to their inconspicuous behavior. Due to their deep diving habits, they may be more susceptible to sound impacts than other species. Probability of encounter: low to medium.	579 (pygmy) Unknown (dwarf)	0.001083 (Summer)

Species or Guild	Stock	Species Account for California Waters	N_{est}	Mean Density[a] (No./km^2)
Small Beaked Whales[1] (Ziphiidae)	California/ Oregon/ Washington Stock	At least five species of Mesoplodont whales have been recorded off the U.S. west coast. They are grouped here due to the infrequent records and difficulty of positive identification. Ziphid beaked whales are distributed widely throughout deep waters of all oceans, but have been seen primarily along the continental slope in western U.S. waters from late spring to early fall. They have been seen less frequently and are presumed to be farther offshore during the colder water months of November through April. Due to their deep diving habits, they may be more susceptible to sound impacts than other species. Probability of encounter: low to medium.	907-2,143 (species dependent)	0.002907 (Summer); 0.001483 (Winter)
Sperm Whale (*Physeter macrocephalus*)	California/ Oregon/ Washington Stock	Sperm whales are widely distributed across the entire North Pacific during the summer, while in winter, the majority are thought to be south of 40^o N (roughly Eureka, CA). Sperm whales are found year-round in California waters with peak abundances from April to June, and again from September to November. They are typically found on slopes in waters deeper than 200 m. Probability of encounter: medium.	971	0.000317 (Summer)
Bottlenose Dolphin (Offshore Form) (*Tursiops truncatus truncatus*)	California/ Oregon/ Washington Stock	Offshore bottlenose dolphins are evenly distributed at distances greater than a few kilometers from the mainland and throughout the Southern California Bight (SCB). Probability of encounter: medium.	1,006	0.004365 (Summer); 0.04651 (Winter)
Bottlenose Dolphin (Coastal Form) (*Tursiops truncatus truncatus*)	California Coastal	California coastal bottlenose dolphins are typically found within 1 km from shore from Point Conception south into Mexican waters. Probability of encounter: high along the South Coast region.	450	0.361173 (Year Round)
Long-Beaked Common Dolphin (*Delphinus capensis capensis*)	California Stock	Long-beaked common dolphins are commonly found within 50 nm of the coast from Southern to Central California. Probability of encounter: medium, depending on survey location.	27,046	0.0432 (Summer)
Short-Beaked Common Dolphin (*Delphinus delphis*)	California/ Oregon/ Washington Stock	Short-beaked common dolphins are the most abundant cetacean off California and can be seen in coastal and shelf waters up to 300 nm from shore. Probability of encounter: high.	411,211	0.9219 (Summer)
Northern Right Whale Dolphin (*Lissodelphis borealis*)	California/ Oregon/ Washington Stock	Northern right whale dolphins are primarily seen in shelf and slope waters with seasonal movements into California waters during the colder water months. Probability of encounter: medium.	8,334	0.03111 (Summer); 0.112739 (Winter)

Species or Guild	Stock	Species Account for California Waters	N_{est}	Mean Density[a] (No./km^2)
Dall's Porpoise (*Phocoenoides dalli dalli*)	California/ Oregon/ Washington Stock	Dall's porpoises are commonly seen in shelf, slope, and offshore waters with occurrences common off Southern California in winter. Probability of encounter: medium, depending on location and season.	42,000	0.03779 (Summer); 0.035151 (Winter)
Risso's Dolphin (*Grampus griseus*)	California/ Oregon/ Washington Stock	Risso's dolphins are commonly seen in shelf waters within the SCB and in slope and offshore waters of California. Probability of encounter: medium.	6,272	0.03303 (Summer); 0.174569 (Winter)
Pacific White-Sided Dolphin (*Lagenorhynchus obliquidens*)	California/ Oregon/ Washington Stock	Pacific white-sided dolphins are common along continental margins and offshore, with peak occurrences off California during the colder winter months. Probability of encounter: medium to high.	26,930	0.08361 (Summer); 0.22565 (Winter)
Common Dolphin – Long- and Short-Beaked Forms (*Delphinus* spp.)	California/ Oregon/ Washington Stock (short-beaked); California stock (long-beaked)	Many stock assessment and cetacean surveys list *Delphinus* species rather than distinguish between short- and long-beaked common dolphins; consequently, this species group has been considered as a whole in the density model. Probability of encounter: high.	27,046 (long-beaked); 411,211 (short-beaked)	0.05503 (Long-Beaked; Summer); 2.823 (Short-Beaked; Summer)
Harbor Porpoise (*Phocoena phocoena vomerina*)	Central California stock (incl. bay stocks & N. California/ S. Oregon Stock	Four geographic stocks in California waters are identified as separate stocks mainly due to varying fisheries pressures. The combined range extends from Southern Oregon/Northern California to Point Conception. Harbor porpoise are found almost exclusively in coastal and inland waters. Probability of encounter: high.	40,000+	1.5575 (Year Round)
Pinnipeds				
Harbor Seal (*Phoca vitulina richardsi*)	California Stock	Harbor seals inhabit nearshore coastal and estuarine areas from Baja California to the Pribilof Islands in Alaska. In California, approximately 400 to 600 harbor seal haul-out sites are widely distributed on the mainland and on offshore islands, intertidal sandbars, rocky shores, and beaches. Rookeries are located from Santa Rosa to Mexico. Probability of encounter: high.	30,196	0.023[b]

Species or Guild	Stock	Species Account for California Waters	N_{est}	Mean Density[a] (No./km^2)
Northern Elephant Seal (*Mirounga angustirostis*)	California Breeding stock	Northern elephant seals breed and give birth in California primarily on offshore islands from December to March from about San Francisco southward. Adults return to land between March and August to molt. Adults return to their feeding areas again between their spring/summer molting and their winter breeding seasons. Probability of encounter: seasonally high.	124,000	0.154[b]
Northern Fur Seal (*Callorhinus ursinus*)	San Miguel Island Stock	All northern fur seals in California waters are found along San Miguel Island off Southern California. Probability of encounter: seasonally high in the Channel Islands region.	9,968	0.030[b]
California Sea Lion (*Zalophus californianus*)	California Stock	California sea lions are distributed along the entire coastline year round, and breed on islands in Southern California. Probability of encounter: high.	153,337	NA
Northern (Steller) Sea Lion (*Eumetopias jubatus*)	Eastern US Stock	Rookeries for Steller sea lions (eastern DPS) are located between Cape Fairweather, Alaska and Ano Nuevo Island, California. Breeding takes place from May to July, outside of which they are widely dispersed. Probability of encounter: seasonally high.	52,847	NA
Guadalupe Fur Seal (*Arctocephalus townsendi*)		Guadalupe fur seals pup and breed mainly at Isla Guadalupe, Mexico, with a second rookery at Isla Benito del Este, Baja California. In 1997, a pup was born at San Miguel Island, California. Individuals have stranded or have been sighted as far north as Blind Beach, California, inside the Gulf of California, and as far south as Zihuatanejo, Mexico. Probability of encounter: extremely low.	7,408	NA
Mustelid (Fissiped)				
Southern Sea Otter (*Enhydra lutris nereis*)	California Stock	Southern sea otters occupy nearshore waters along the California coastline from San Mateo County to Santa Barbara County. A translocated colony has been established at San Nicolas Island, Ventura County. Probability of encounter: high.	2,792	1.593[c]

Footnotes:
[1] Includes *Mesoplodon* species and Ziphiidae species.
[2] Stocks overlap in some California waters; however, this stock encompasses the waters along the entire California coast.
[a] Density estimates of marine mammal species and species groups calculated using the SERDP-SDSS Density Model for the California coast to the 200 m isobath.
[b] Pinniped densities based on take assessments for Pt. Mugu exercises in southern California (Koski et al. 1998) and may not represent densities equally across the California coast.

Species or Guild	**Stock**	**Species Account for California Waters**	**N_{est}**	**Mean Density[a] (No./km^2)**
[c] Otter densities based on U.S. Geological Survey/U.S. Fish and Wildlife Service (USGS/USFWS) Western Ecological Research Center's Spring 2010 survey; N_{est} based on 2012 survey results, using the three-year average. Notes: **BOLD** entries indicate species whose range varies regionally along the California coast; therefore, densities will vary on a survey-specific basis. Probability of encounter during low energy geophysical surveys is based on population estimates and distribution facts in the National Oceanic and Atmospheric Administration (NOAA) Stock Assessment Reports and the density calculations from the SER-SDSS density models but are not referenced from the NOAA Stock Assessment Reports. NA – not available.				

I.3 Marine Mammals Hearing Groups and Thresholds

Radii to the regulatory thresholds of interest (i.e., SPLs of 190, 180, 160, 140, and 120 dB re 1 µPa rms) were calculated for five pieces of low energy geophysical equipment, as provided by JASCO (see **Appendix G**). Both unweighted and M-weighted radii were calculated to address the frequency-dependent sensitivities of marine mammals, per Southall et al. (2007).

Table I-2 summarizes the five marine mammal hearing groups as developed by Southall et al. (2007).

Table I-2. Marine Mammal Functional Hearing Groups and Estimated Functional Hearing Ranges (Adapted from: Southall et al. 2007)

Functional Hearing Group	Estimated Auditory Bandwidth	Genera Represented (Number Species/Subspecies)	Frequency-Weighting Network
Low-frequency Cetaceans	7 Hz to 22 kHz	*Balaena, Caperea, Eschrichtius, Megaptera, Balaenoptera* (13 species/subspecies)	M_{lf}
Mid-frequency Cetaceans	150 Hz to 160 kHz	*Steno, Sousa, Sotalia, Tursiops, Stenella, Delphinus, Lagenodelphis, Lagenorhynchus, Lissodelphis, Grampus, Peponocephala, Feresa, Pseudorca, Orcinus, Globicephala, Orcacella, Physeter, Delphinapterus, Monodon, Ziphius, Berardius, Tasmacetus, Hyperoodon, Mesoplodon* (57 species/subspecies)	M_{mf}
High-frequency Cetaceans	200 Hz to 180 kHz	*Phocoena, Neophocaena, Phocoenoides, Platanista, Inia, Kogia, Lipotes, Pontoporia, Cephalorhynchus* (20 species/subspecies)	M_{hf}
Pinnipeds (in water)	75 Hz to 75 kHz	*Arctocephalus, Callorhinus, Zalophus, Eumetopias, Neophoca, Phocarctos, Otaria, Erignathus, Phoca, Pusa, Halichoerus, Histriophoca, Pagophilus, Cystophora, Monachus, Mirounga, Leptonychotes, Ommatophoca, Lobodon, Hydrurga, Odobenus* (41 species/subspecies)	M_{pw}
Pinnipeds (in air)	75 Hz to 30 kHz	*Arctocephalus, Callorhinus, Zalophus, Eumetopias, Neophoca, Phocarctos, Otaria, Erignathus, Phoca, Pusa, Halichoerus, Histriophoca, Pagophilus, Cystophora, Monachus, Mirounga, Leptonychotes, Ommatophoca, Lobodon, Hydrurga, Odobenus* (41 species/subspecies)	M_{pa}

Abbreviations: lf: low-frequency cetaceans; mf: mid-frequency cetaceans; hf: high-frequency cetaceans; pw: pinnipeds in water; pa: pinnipeds in air.

Most of the marine mammals likely to be present in California state waters are cetaceans, with several pinnipeds and a single fissiped (mustelid) also present. Hearing group designations for each of California's marine mammals are shown in **Table I-3**.

Table I-3. California Marine Mammals – Habitat and Hearing Group Classification

Taxonomic Classification and Common Name	Scientific Name	Habitat	Hearing Group
Mysticetes – Baleen Whales			
Family: Eschrichtiidae (gray whales)			
California gray whale	*Eschrichtius robustus*	CN	LF
Family: Balaenopteridae (rorquals)			
Minke whale	*Balaenoptera acutorostrata scammoni*	CN, O	LF
Sei whale	*Balaenoptera borealis borealis*	O	LF
Bryde's whale	*Balaenoptera edeni*	O	LF
Blue whale	*Balaenoptera musculus musculus*	CN, O	LF
Fin whale	*Balaenoptera physalus physalus*	CN, O	LF
Humpback whale	*Megaptera novaeangliae*	CN, O	LF
Family: Balaenidae (right whales)			
North Pacific right whale	*Eubalaena japonica*	CN, O	LF
Odontocetes – Toothed Whales			
Family: Delphinidae (dolphins)			
Short-beaked common dolphin	*Delphinus delphis*	CN, O	MF
Long-beaked common dolphin	*Delphinus capensis*	CN	MF
Short-finned pilot whale	*Globicephala macrorhynchus*	O	MF
Risso's dolphin	*Grampus griseus*	CN, O	MF
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	CN, O	MF
Northern right whale dolphin	*Lissodelphis borealis*	CN, O	MF
Killer whale	*Orcinus orca*	CN, O	MF
False killer whale	*Pseudorca crassidens*	CN, O	MF
Striped dolphin	*Stenella coeruleoalba*	O	MF
Bottlenose dolphin	*Tursiops truncatus*	CN, O	MF
Family: Phocoenidae (porpoises)			
Dall's porpoise	*Phocoenoides dalli*	CN, O	HF
Harbor porpoise	*Phocoena phocoena*	CN, O	HF
Family: Physeteridae (sperm whales)			
Pygmy sperm whale	*Kogia breviceps*	O	HF
Dwarf sperm whale	*Kogia sima*	O	HF
Sperm whale	*Physeter macrocephalus*	O	MF
Family: Ziphiidae (beaked whales)			
Baird's beaked whale	*Berardius bairdii*	O	MF
Hubbs' beaked whale	*Mesoplodon carlhubbsi*	O	MF
Blainville's beaked whale	*Mesoplodon densirostris*	O	MF
Ginkgo-toothed beaked whale	*Mesoplodon ginkgodens*	O	MF
Perrin's beaked whale	*Mesoplodon perrini*	O	MF
Pygmy beaked whale	*Mesoplodon peruvianus*	O	MF
Stejneger's beaked whale	*Mesoplodon stejnegeri*	O	MF

Taxonomic Classification and Common Name	Scientific Name	Habitat	Hearing Group
Cuvier's beaked whale	*Ziphius cavirostris*	O	MF
Pinnipeds – Seals and Sea Lions			
Family: Otariidae (eared seals)			
Guadalupe fur seal	*Arctocephalus townsendi*	CN	PW
Northern fur seal	*Callorhinus ursinus*	CN	PW
Northern (Steller) sea lion	*Eumetopias jubatus*	CN, O	PW
California sea lion	*Zalophus californianus*	CN	PW
Family: Phocidae (earless seals)			
Northern elephant seal	*Mirounga angustirostris*	CN, O	PW
Harbor seal	*Phoca vitulina*	CN	PW
Mustelid – Sea Otter			
Family: Mustelidae (weasels)			
Southern sea otter	*Enhydra lutris nereis*	CN	Broad

Habitat: CN = coastal and/or nearshore; O = offshore and/or deep water.

Hearing Group (Frequency Weighted Network), per Southall et al. (2007) for all marine mammals except southern sea otter: LF (M_{lf}) = low-frequency cetacean; 7 Hz to 22 kHz; MF (M_{mf}) = mid-frequency cetacean; 150 Hz to 160 kHz; HF (M_{hf}) = high-frequency cetacean; 200 Hz to 180 kHz; PW (M_{pw}) = pinnipeds in water; 75 Hz to 75 kHz; Broad = sea otter; hearing range between 0.125-32kHz, per Ghoul and Reichmuth (2012).

California's baleen whales are found in the low-frequency hearing group, while California's odontocetes are routinely found in the mid-frequency hearing group, with minor exception (i.e., porpoises, pygmy and dwarf sperm whales). For some of these species (e.g., bottlenose dolphins), relatively good information exists about hearing and behavioral responses to some types of sounds (e.g., Nowacek et al. 2001).

The injury criteria proposed by Southall et al. (2007), and the general conclusions on behavioral response associated with acoustic exposure are considered to be applicable for most of the mid-frequency cetacean species, including the endangered sperm whale; direct recent information on behavioral responses in sperm whales to other forms of anthropogenic noise are available as well (e.g., Miller et al. 2009).

I.4 Sound Source Modeling

Equipment modeled included a single beam echosounder, multibeam echosounder, side-scan sonar, subbottom profiler, and boomer. Selection of the equipment modeled not only included those equipment types most frequently used, but also identified those sources with the highest sound source levels.

The following low energy geophysical equipment was modeled:

- Odom CV-100 Single beam echosounder
- R2Sonic multibeam echosounder
- Klein 3000 Digital side-scan sonar

- EdgeTech X-Star subbottom profiler (SB-216/SB-424)
- AP3000 triple plate boomer system

An approach similar to that employed during the Coastal Central California Seismic Imaging Project (CSLC 2012) was followed, where single pulse and cumulative exposure were considered.

Oceanographic conditions were representative of a central and southern California location, consistent with regions (i.e., Regions I and II) where the vast majority of recent low energy geophysical surveys have taken place, and where near-term future surveys are expected.

The location for modeling of single pulse exposure was located 3 km offshore over sandy sediments. A similar location was modeled for the cumulative exposure scenario, however, for the cumulative exposure analysis the survey tracklines extended from the outer edge of the surf zone to the 3 nmi line, using a three trackline grid with 75 m between each line. The cumulative scenario considered maximum daylight operations (i.e., 14 hr), with 10 hr of equipment operation, considered a worst case scenario for routine, daytime low energy geophysical survey operations.

The cumulative exposure scenario and analysis, as summarized in the MND, produced estimates of cumulative sound exposure (cSEL) for a multi-equipment survey. In contrast, the incidental take analysis considered in this appendix calculated incidental take for each equipment type within a total survey area (i.e., three tracklines, 75 m apart, 5.5 km long, extending from just beyond the surf zone to the 3 nm offshore) considered representative of a low energy geophysical survey; the present analysis also utilized the sound pressure level (SPL) metric. The merits and shortcomings of SPL and SEL metrics are addressed further in Section 3.3.4 of the MND.

Site-specific acoustic fields resulting from representative low energy sound sources were modeled with JASCO's Marine Operations Noise Model (MONM). Sound fields for each equipment type were calculated, producing SPL-based radial distances for each threshold of interest (**Table I-4**). Modeling parameters and results, and discussion of beam theory, are provided in **Appendix G**.

The incidental take analysis considered a worst case scenario, using the total area surveyed and radial distances to SPL isopleths of interest (i.e., 190/180 dB and 160 dB) to estimate total area ensonified. However, additional calculations further integrated several weighting or correction factors to accommodate marine mammal habitat and seasonal presence, probability of presence in State waters, behavioral avoidance reactions, habitat activity patterns, and equipment-specific beam width variability, as detailed below.

Table I-4. SPL Thresholds (dB re 1 μPa, rms) for Various Pieces of Equipment. Results Shown for Both Maximum (R_{max}, m) and 95% ($R_{95\%}$, m) Horizontal Distances from the Source to Modeled Maximum-Over-Depth Sound Level Thresholds, with and without M-Weighting Applied

SPL Threshold	No Weighting		M-Weighted							
			LF Cetaceans		MF Cetaceans		HF Cetaceans		Pinnipeds (in Water)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
Single Beam Echosounder										
190	-	-	-	-	-	-	-	-	-	-
180	<20	<20	-	-	-	-	-	-	-	-
160	29	29	-	-	<20	<20	<20	<20	<20	<20
140	127	123	<20	<20	72	71	79	76	34	34
120	391	365	34	34	275	250	290	267	138	133
Multibeam Echosounder										
190	28	28	-	-	<20	<20	<20	<20	<20	<20
180	71	71	<20	<20	35	35	35	35	<20	<20
160	290	258	<20	<20	205	184	219	191	85	85
140	612	477	85	85	467	396	495	403	332	283
120	933	612	318	279	778	548	803	559	626	492
Side-Scan Sonar										
190	130	124	<20	<20	73	68	96	88	31	31
180	257	243	<20	<20	187	181	209	195	102	96
160	682	576	110	102	611	512	625	526	441	399
140	1,106	690	455	413	1,007	689	1,021	696	837	675
120	1,544	917	880	683	1,445	860	1,445	867	1,261	795
Subbottom Profiler										
190	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
180	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
160	36	36	32	32	36	36	36	36	36	36
140	607	292	240	225	607	291	607	291	602	283
120	6,699	5,439	6,151	4,888	6,699	5,424	6,699	5,426	6,689	5,383
Boomer										
190	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
180	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
160	50	45	45	45	45	45	45	45	45	45
140	2,329	1,567	2,329	1,563	2,228	1,462	2,224	1,393	2,329	1,538
120	28,110	19,229	28,110	19,184	27,820	18,446	27,818	17,909	28,110	18,968

I.5 Calculation of Area Ensonified and Raw Take Estimates

Using SPL radial distances (i.e., maximum horizontal distances from source; **Table I-4**) for each of the appropriate M-weighting categories, calculations of total area ensonified were completed for the cumulative exposure scenario – three transect lines spaced 75 m apart and positioned perpendicular to the shoreline, extending 3 nmi (i.e., conservatively from shore to the State water boundary offshore). The basic calculation of area ensonified was based upon the following formula:

$$\text{Area Ensonified (km}^2\text{)} = [\{\text{radius (m) x 2}\} / \text{1,000 m/km] x 5.556 km x 3}$$

Once calculations of total area ensonified were developed, species-specific density estimates (**Table I-1**) were applied to produce raw take estimates for each equipment type. These calculations represent take estimates without mitigation, and without application of biological and equipment-specific correction or weighting factors.

In instances where modeling results indicated a radial distance of <20 m, a value of 15 m was employed in the raw take calculations. In instances where no measurable value was noted for a radial distance ("-" in the tables), a value of 5 m was employed. Both methods are considered to introduce a conservative component into the raw take estimates.

I.6 Biological and Equipment-Specific Correction or Weighting Factors

Correction or weighting factors were subsequently applied to account for (a) marine mammal presence in California waters; (b) preferred water depth range and/or habitat (e.g., offshore, deep vs. nearshore and coastal); (c) probability of presence in California State waters, including seasonality; (d) behavioral avoidance reactions (BAR, per Wood et al. 2012); (e) species- or group-specific habitat activity patterns (e.g., active throughout the water column, or deep divers, vs. surface active species); and (f) factors to account for equipment-specific beam width variability.

Using raw take estimates, a series of biological and equipment-specific factors were applied sequentially to further refine the estimates of Level A and Level B take arising from equipment-specific operations.

I.6.1 Biological Factors

The rationale for biological factors included the need to account for the likelihood of species-specific presence, both offshore California and within California State waters, as well as seasonal presence; water depth and/or habitat preferences; and behavioral reaction to anthropogenic sound. Activity patterns for each species were also characterized (e.g., active throughout the entire water column, or predominantly surface active). Activity patterns may influence the effectiveness of mitigation measures involving visual observers, specifically availability and perception biases (Marsh and Sinclair 1989; Laake et al. 1997). Animals present but under the water surface and not available for sighting are subject to availability bias; animals at the surface but not detected due to sightability issues (e.g., poor visibility; glare; elevated sea state) or observer fatigue are subject to detection bias. Using the characteristics of species-specific activity patterns, an estimation of mitigation effectiveness was developed. Factors to account for habitat preference, presence, avoidance, activity, and mitigation effectiveness are presented in **Table I-5**.

The determination of species presence in California waters was based on SERDPSDSS model data (i.e., SWFSC ship line-transect data, 1986 to 2006). Exceptions included 1) sea otter densities calculated from the USGS WERC Spring 2010 survey results (USGS 2010); and 2) pinniped density estimates from Koski et al. (1998). Classifications, based on description presented in **Table I-1**, included irregular, infrequent, common, rare, and seasonal. Geographic distribution was also noted, as appropriate. Several marine mammal species have limited or restricted distribution in California State waters (e.g., southern sea otter; northern elephant seal; several porpoise and dolphin species).

Water depth and habitat preferences were also determined for each species. Broad preference categories included offshore (i.e., deeper water) and nearshore and/or coastal. Presence correction factors, accounting for range/distribution, seasonal presence, and habitat/water depth preferences, ranged from 0.1 to 1.0.

Behavioral avoidance reaction (BAR) factors were identical to those utilized by Wood et al. (2012). BAR factors were generally set at 90% (i.e., 10% of the individuals do not respond to noise by actively avoiding the noise source), except for all beaked whales and harbor porpoise. These latter species/species groups were set at 99% (i.e., 1% of individuals do not respond and actively avoid the noise source). The BAR factor was only applied to the Level A take estimates.

For activity patterns, species that are active throughout the water column are more likely to pass within the beam of low energy geophysical equipment; these species were assigned an activity factor of 0.8. Surface active species that may also dive are less likely to be present immediately below the equipment; these species were assigned an activity factor of 0.3.

Activity patterns also have the potential to influence mitigation effectiveness. Species active throughout the water column, including deep diving species, were assigned a mitigation effectiveness factor of 0.3, representing an estimate that 70% of the individuals of these species would be sighted during visual monitoring. Species that were characterized as surface active, including dolphins and porpoises, were assigned a mitigation effectiveness factor of 0.2, based on an estimate that 80% of the individuals would be sighted during visual monitoring.

1 **Table I-5. Habitat, Presence and Distribution, Avoidance, Activity, and Mitigation Effectiveness Factors**

Species	Presence and Distribution	Habitat	Presence	BAR Value	Activity	Activity %	Mitigation
Bryde's whale	Irregular	O	0.1	0.1	Entire	0.8	0.3
Sei whale	Rare	O	0.05	0.1	Entire	0.8	0.3
Minke whale	Common	CN,O	0.75	0.1	Entire	0.8	0.3
Fin whale	Common; Southern/Central CA	CN,O	0.75	0.1	Entire	0.8	0.3
Blue whale	Seasonal; Summer and Fall	CN,O	0.5	0.1	Entire	0.8	0.3
Humpback whale	Common	CN,O	0.75	0.1	Entire	0.8	0.3
North Pacific right whale	Rare	CN,O	0.1	0.1	Entire	0.8	0.3
California gray whale	Seasonal; Northbound Feb-May, Cows/Newborns Mar-Jun; Southbound Nov-Jan	CN	0.5	0.1	Surface	0.3	0.2
Short-finned pilot whale	Irregular	O	0.1	0.1	Surface	0.3	0.2
Killer whale	Common	CN,O	0.75	0.1	Surface	0.3	0.2
Striped dolphin	Common	O	0.25	0.1	Surface	0.3	0.2
Pygmy & dwarf sperm whales	Common	O	0.25	0.1	Entire	0.8	0.3
Small beaked whales (Ziphiidae)	Infrequent	O	0.1	0.01	Entire	0.8	0.3
Sperm whale	Common; Peak Abundances Apr-Jun, Sept-Nov	O	0.25	0.1	Entire	0.8	0.3
Bottlenose dolphin (offshore)	Common; Southern CA	O	0.25	0.1	Surface	0.3	0.2
Bottlenose dolphin (coastal)	Common; Southern CA	CN	1.0	0.1	Surface	0.3	0.2
Long-beaked common dolphin	Infrequent	CN	0.5	0.1	Surface	0.3	0.2
Short-beaked common dolphin	Common	CN,O	0.75	0.1	Surface	0.3	0.2
Northern right whale dolphin	Seasonal	CN,O	0.5	0.1	Surface	0.3	0.2
Dall's porpoise	Common; Southern CA	CN,O	0.75	0.1	Surface	0.3	0.2
Risso's dolphin	Common; Southern CA	CN,O	0.75	0.1	Surface	0.3	0.2
Pacific white-sided dolphin	Common	CN,O	0.75	0.1	Surface	0.3	0.2
Common dolphin (long- and short-beaked)	Common	CN,O	0.75	0.1	Surface	0.3	0.2
Harbor porpoise	Common	CN,O	0.75	0.01	Surface	0.3	0.2
Harbor seal	Common	CN	1.0	0.1	Surface	0.3	0.2
Northern elephant seal	Common; Seasonal; Offshore Islands, Dec-Mar, San Francisco Southward; Adults on Land Mar-Aug	CN,O	0.5	0.1	Surface	0.3	0.2
Northern fur seal	Common; Seasonal; Southern CA	CN	0.5	0.1	Surface	0.3	0.2
California sea lion	Common	CN	1.0	0.1	Surface	0.3	0.2
Northern (Steller) sea lion	Seasonal; Northern CA-Ano Nuevo Is. Breed May-Jul	CN,O	0.5	0.1	Surface	0.3	0.2
Guadalupe fur seal	Rare	CN	0.25	0.1	Surface	0.3	0.2
Southern sea otter	Common; San Mateo County to Santa Barbara County	CN	0.25	0.1	Surface/Raft	0.3	0.2

2 Abbreviations: BAR – behavioral avoidance reaction(s) – only applied to Level A take estimates; CN – coastal, nearshore; O – offshore; Entire = entire water column;
3 Surface = surface active.

I.6.2 Equipment Factors

Based on equipment specifications and the beam pattern analysis conducted as part of the modeling exercise (**Figures I-1** through **I-5**), weighting factors were developed to account for the narrow or focused beam characteristics of each piece of modeled equipment.

The rationale for inclusion of this weighting factor is based on several considerations: 1) low energy geophysical equipment exhibits considerable variability in beam pattern between equipment types (i.e., potential for noise exposure impacts to sensitive resources vary between equipment types due to variations evident in beam patterns); 2) modeling calculations estimate the **maximum** horizontal (radial) distance to isopleths of interest (e.g., SPLs of 190, 180, and 160 dB re 1μPa rms), and do not represent uniformly shaped spheres or cylinders; and 3) using maximum horizontal radial distances and total transect length, without consideration of narrow beam pattern, produce estimations of take (i.e., raw take estimates) which are not representative of the sound fields created by these equipment types.

To account for beam characteristics, the lobe patterns (**Figures I-1** through **I-5**) were scanned and digitized, and the area within each lobe was calculated as a percentage of the total area present. In several cases, beam pattern either varies between along- and across-track directions (i.e., multibeam echosounder, side scan sonar) or as a function of the frequency of the equipment output (i.e., boomer). Termed lobe percentages, these values were either used directly (i.e., single beam echosounder, subbottom profiler) or further refined (i.e., multibeam echosounder, side scan sonar, boomer) as equipment weighting factors (**Table I-6**).

The weighting factor for side scan sonar represents an average of along-track and across-track lobe percentages. For the multibeam echosounder, the average of the along-track and across track lobe percentages (25.5%) was increased to 35%, a conservative step implemented to account for increasing ping rate and/or frequency division multiplexing (i.e., where two pings are transmitted in rapid succession, one down towards nadir, the other steered forward in the along-track direction, resulting in interleaved swaths from pings in the two separate frequency bands). Developing a weighting factor for the boomer was problematic, as the frequency of the pulse is adjusted by individual operators to account for water depth, target, and ambient sound levels. For this analysis, the boomer weighting factor was conservatively set at 0.3333, an approximate average of the low- and high-frequency lobe percentages.

I.7 Take Estimation

Level A and Level B take were calculated without mitigation as the product of marine mammal density estimates and equipment specific radii, producing raw take estimates. Correction and weighting factors were then applied, including probability of presence, BAR value (avoidance), habitat, activity patterns, and equipment weighting factor.

Figure I-1. Calculated Beam Pattern Vertical Slice for the Odom CV-100 Single Beam Echosounder Operating at 200 kHz

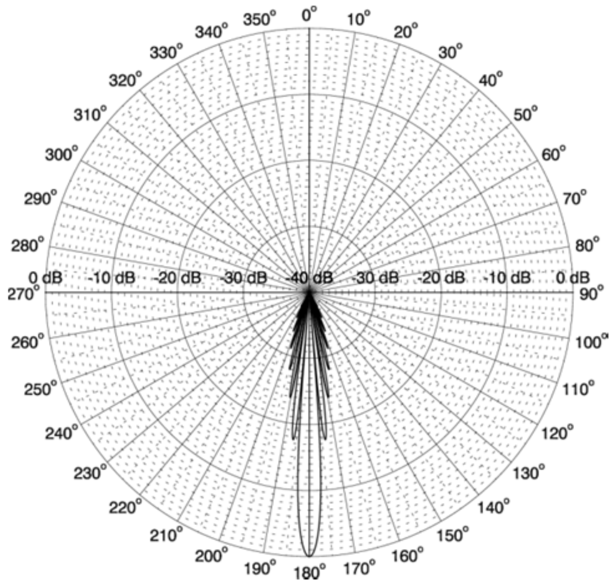

Figure I-2. Vertical Beam Pattern Calculated for the R2Sonic 2022 Multibeam Echosounder with 256 Beams of 2° × 2° Width in the Along- (left) and Across-Track (Right) Directions

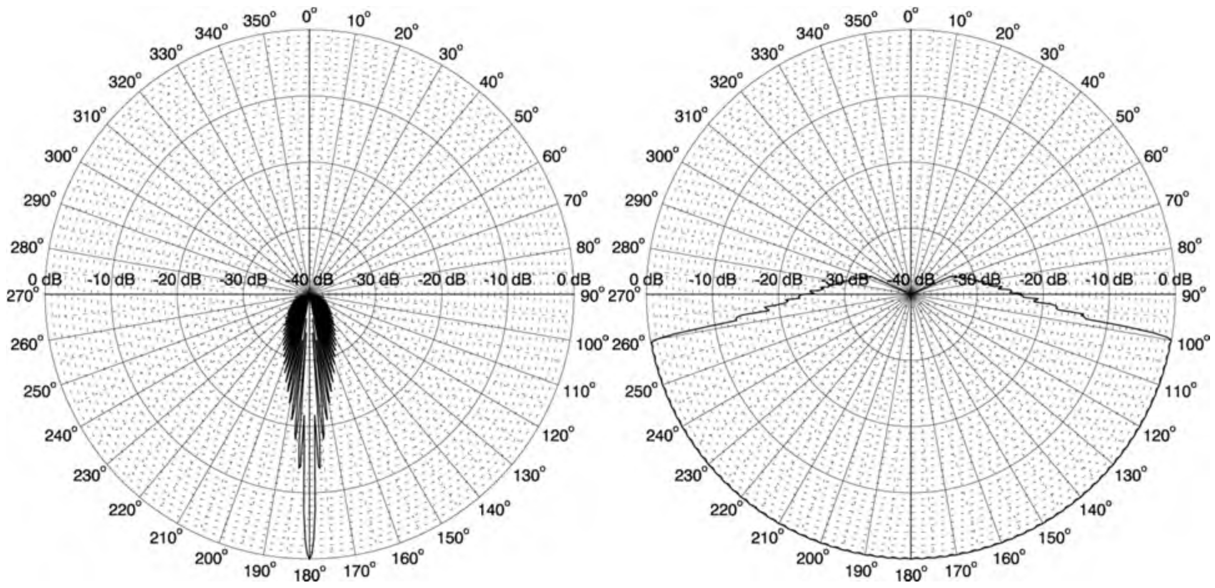

Figure I-3. Vertical Beam Pattern Calculated for the Klein 3000 Side-Scan Sonar with Two Beams of 40° × 1° Width in the Along- (Left) and Across-Track (Right) Directions

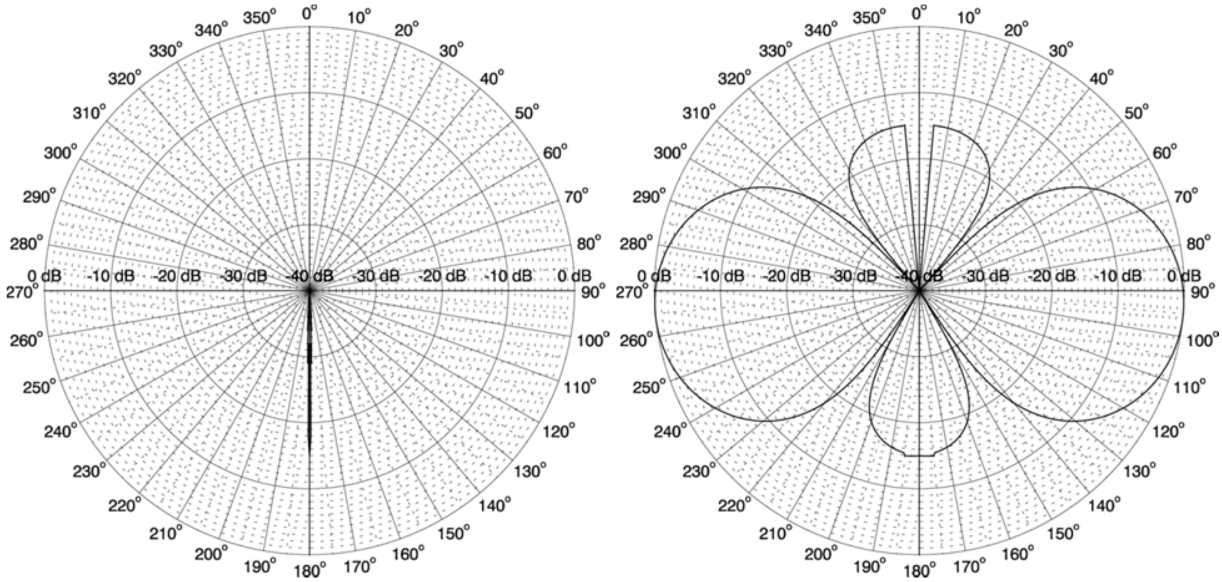

Figure I-4. Calculated Beam Pattern Vertical Slice for the EdgeTech SBP-216 Sub-Bottom Profiler at a Central Frequency of 9 kHz

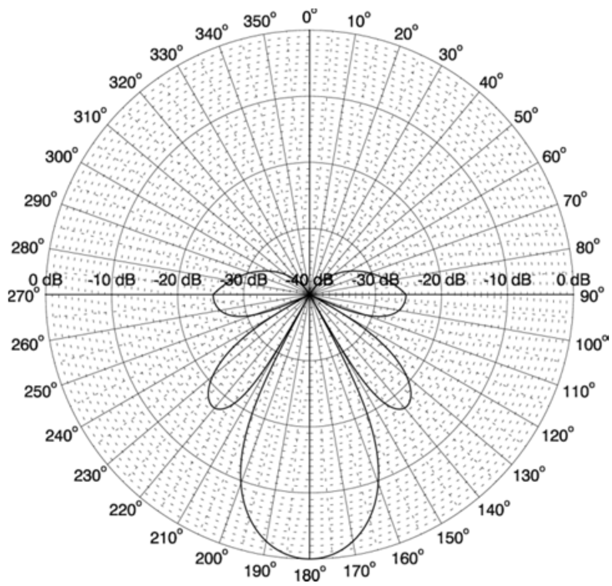

Figure I-5. Calculated Beam Pattern Vertical Slice for the AA202 Boomer Plate at (a) 1.25 and (b) 16.0 kHz Across-Track Direction

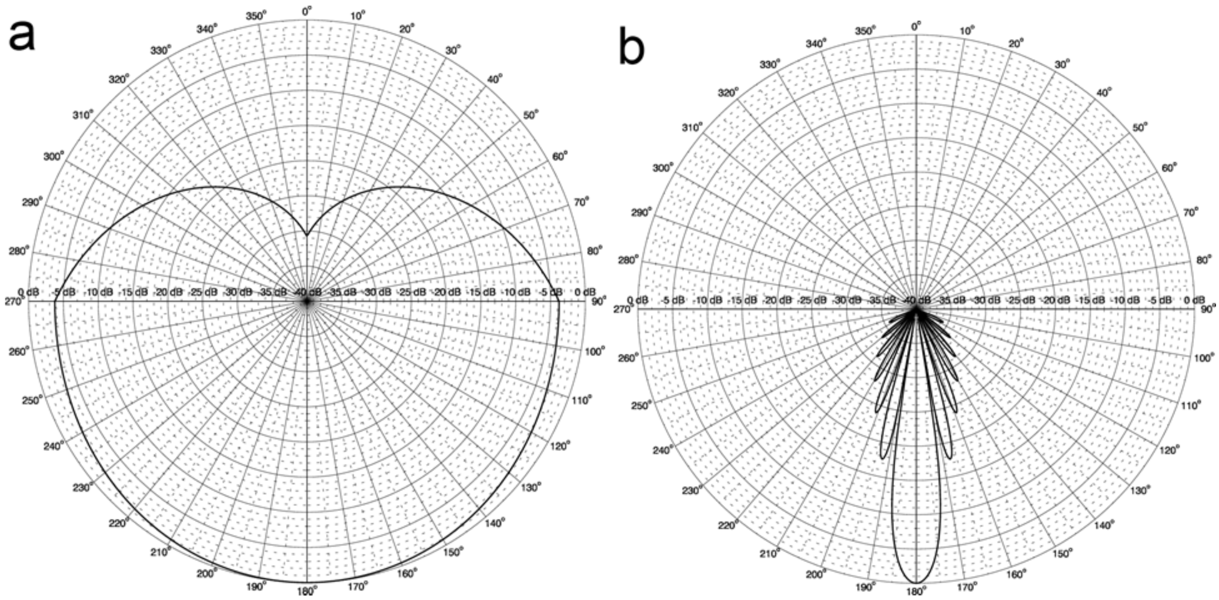

Table I-6. Weighting Factors for Low Energy Geophysical Survey Equipment

Appendix I Figure	Lobe Percentage of Total	Equipment	Equipment Weighting Factor
I-1	3.17	Single beam echosounder	0.0317
I-2, Left	3.67	Multibeam echosounder, along-track	0.3500
I-2, Right	47.40	Multibeam echosounder, across-track	
I-3, Left	0.43	Side scan sonar, along-track	0.2570
I-3, Right	50.96	Side scan sonar, across-track	
I-4	17.30	Subbottom profiler	0.1730
I-5, (a)	63.62	Boomer, low frequency	0.3333
I-5, (b)	5.85	Boomer, high frequency	

Mitigation effectiveness was subsequently applied to estimate both Level A and Level B take with mitigation. Mitigation effectiveness considered species-specific activity patterns, including whether species were typically surface active, and whether they tended to be solitary, or travel in small or large groups. Activity patterns play a significant role in marine mammal sightability by observers (i.e., those species that are more surface active, or occur in larger groups, are more likely to be observed by marine wildlife monitors).

Results of the Level A and Level B take calculations are provided in the **Tables I-7** and **I-8**, respectively, reflecting the initial raw take estimates, and the iterative process of applying biological and equipment correction and weighting factors.

Level A take calculations for all species or species groups, with mitigation, were below unity; no Level A acoustic take is expected during OGPP surveys when marine wildlife monitors are being used and mitigation is effective. Level B take was <1 for all species; species with highest calculated take estimates included harbor porpoise and California sea lion associated with the use of multibeam echosounder or side scan sonar equipment.

I.8 Conclusions

In the absence of a detailed and more sophisticated modeling exercise, a basic model was developed to utilize radial distances to sound pressure levels (SPL) of regulatory concern for impulsive sound – 190 dB for pinnipeds in water (injury), 180 dB for cetaceans (injury), and 160 dB for marine mammals (behavioral modification). The basic model employed survey-based marine mammal densities and total area ensonified to various levels to estimate incidental take associated with a representative low energy geophysical survey in California State waters. The analysis produced incidental take estimates (i.e., Level A and Level B) for each of five equipment types operating within a survey area represented by three tracklines, spaced 75 m apart and measuring 5.5 km long, extending from just beyond the surf zone to the 3 nm offshore.

The incidental take analysis, based on the SPL metric and using total area surveyed (i.e., radial distances to SPL isopleths of interest; total survey transect length) and species-specific density estimates, initially produced raw take numbers (i.e., take without mitigation). Raw take estimates were subsequently modified to account for several weighting or correction factors. Factors considered included marine mammal habitat (i.e., habitat preference) and seasonal presence offshore California, probability of presence in State waters, behavioral avoidance reactions, habitat activity patterns, and equipment-specific beam width variability, along with mitigation effectiveness – all of which were used to estimate take with mitigation. Mitigation effectiveness was based on marine mammal activity patterns and an estimate of the likelihood that biological observers will visually recognize marine mammal activity, allowing for cessation of low energy survey operations.

Level A take calculations for all species or species groups, with mitigation, were below unity; no Level A acoustic take is expected during OGPP surveys when marine wildlife monitors are being used and mitigation is effective. Similarly, Level B take, with mitigation, was below unity for all low energy geophysical survey equipment.

Table I-7. Estimated Level A Take – Raw Calculations and Corrected Take Estimates, by Equipment Type

Species or Group	Single Beam Echosounder		Multibeam Echosounder		Side-Scan Sonar		Subbottom Profiler		Boomer	
	Raw	Corrected	Raw	Corrected	Raw	Corrected	Raw	Corrected	Raw	Corrected
Bryde's whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sei whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minke whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fin whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blue whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Humpback whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Pacific right whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
California gray whale	0.01	0.00	0.03	0.00	0.03	0.00	0.03	0.00	0.03	0.00
Short-finned pilot whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Killer whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Striped dolphin	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Pygmy and dwarf sperm whales	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Small beaked whales	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Sperm whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bottlenose dolphin (offshore)	0.01	0.00	0.05	0.00	0.28	0.00	0.02	0.00	0.02	0.00
Bottlenose dolphin (coastal)	0.06	0.00	0.42	0.00	2.18	0.00	0.18	0.00	0.18	0.00
Long-beaked common dolphin	0.01	0.00	0.05	0.00	0.26	0.00	0.02	0.00	0.02	0.00
Short-beaked common dolphin	0.15	0.00	1.08	0.00	5.56	0.01	0.46	0.00	0.46	0.00
Northern right whale dolphin	0.02	0.00	0.13	0.00	0.68	0.00	0.06	0.00	0.06	0.00
Dall's porpoise	0.01	0.00	0.04	0.00	0.25	0.00	0.02	0.00	0.02	0.00
Risso's dolphin	0.03	0.00	0.20	0.00	1.05	0.00	0.09	0.00	0.09	0.00
Pacific white-sided dolphin	0.04	0.00	0.26	0.00	1.36	0.00	0.11	0.00	0.11	0.00
Common dolphin (long & short bk)	0.47	0.01	0.06	0.00	0.33	0.00	0.03	0.00	0.03	0.00
Harbor porpoise	0.26	0.00	1.82	0.00	10.12	0.00	0.78	0.00	0.78	0.00
Harbor seal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern elephant seal	0.00	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.00
Northern fur seal	0.03	0.00	0.08	0.00	0.16	0.00	0.08	0.00	0.08	0.00
California sea lion	0.25	0.00	0.75	0.00	1.55	0.01	0.75	0.00	0.75	0.00
Northern (Steller) sea lion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Guadalupe fur seal	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Southern sea otter	0.27	0.00	0.80	0.00	1.65	0.00	0.80	0.00	0.80	0.00

ND = no density data available; gray shaded entries indicate a take level >1.

1 **Table I-8. Estimated Level B Take – Raw Calculations and Corrected Take Estimates, by Equipment Type**

Species or Group	Single Beam Echosounder		Multibeam Echosounder		Side-Scan Sonar		Subbottom Profiler		Boomer	
	Raw	Corrected	Raw	Corrected	Raw	Corrected	Raw	Corrected	Raw	Corrected
Bryde’s whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sei whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minke whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fin whale	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.01	0.00
Blue whale	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.01	0.00
Humpback whale	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00
North Pacific right whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
California gray whale	0.01	0.00	0.03	0.00	0.17	0.00	0.05	0.00	0.08	0.00
Short-finned pilot whale	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Killer whale	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Striped dolphin	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Pygmy and dwarf sperm whales	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Small beaked whales	0.00	0.00	0.02	0.00	0.05	0.00	0.00	0.00	0.00	0.00
Sperm whale	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Bottlenose dolphin (offshore)	0.02	0.00	0.29	0.00	0.79	0.00	0.06	0.00	0.07	0.00
Bottlenose dolphin (coastal)	0.18	0.00	2.22	0.05	6.16	0.10	0.43	0.00	0.54	0.01
Long-beaked common dolphin	0.02	0.00	0.26	0.00	0.74	0.01	0.05	0.00	0.06	0.00
Short-beaked common dolphin	0.15	0.00	1.08	0.02	5.56	0.06	0.46	0.00	0.46	0.01
Northern right whale dolphin	0.06	0.00	0.69	0.01	1.92	0.01	0.14	0.00	0.17	0.00
Dall's porpoise	0.02	0.00	0.24	0.00	0.66	0.01	0.05	0.00	0.06	0.00
Risso's dolphin	0.09	0.00	1.07	0.02	2.98	0.03	0.21	0.00	0.26	0.00
Pacific white-sided dolphin	0.11	0.00	1.38	0.02	3.85	0.04	0.27	0.00	0.34	0.01
Common dolphin (long & short bk)	1.41	0.00	0.34	0.01	0.94	0.01	0.07	0.00	0.08	0.00
Harbor porpoise	0.78	0.00	9.92	0.16	27.31	0.32	1.87	0.01	2.34	0.04
Harbor seal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern elephant seal	0.01	0.00	0.07	0.00	0.31	0.00	0.03	0.00	0.03	0.00
Northern fur seal	0.08	0.00	0.44	0.00	2.05	0.02	0.18	0.00	0.23	0.00
California sea lion	0.75	0.00	4.25	0.09	19.96	0.31	1.80	0.02	2.25	0.04
Northern (Steller) sea lion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Guadalupe fur seal	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Southern sea otter	0.80	0.00	4.51	0.02	21.19	0.08	1.91	0.00	2.39	0.01

2 ND = no density data available; gray shaded entries indicate a take level >1.

I.9 References

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