National Marine Fisheries Service
Endangered Species Act Section 7 Biological Opinion and Conference Report

Action Agency: Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration

Activity Considered: Issuance of Permit No. 19116 to Dr. Brandon Southall (Southall Environmental Associates, Inc.) for Behavioral Response Studies of Pacific Marine Mammals using Controlled Sound Exposure, Research Applications to Support Management Decisions and Conservation, Pursuant to Section 10(a)(1) of the Endangered Species Act.

Consultation Conducted By: Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration

Approved: [signature] for

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Director, Office of Protected Resources

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1 INTRODUCTION

The Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat they depend on. Section 7(a)(2) of the ESA requires Federal agencies to insure that the actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. When a Federal agency's action "may affect" a protected species, that agency is required to consult formally with National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR §402.14(a)).

Federal agency shall confer with the NMFS or USFWS on any action which is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat (50 CFR §402.10). If requested by the Federal agency and deemed appropriate, the conference may be conducted in accordance with the procedures for formal consultation in §402.14.

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, or conference if combined with a formal consultation, NMFS or USFWS provide an opinion stating how the Federal agencies' actions will affect ESA-listed species and their designated critical habitat under their jurisdiction. If an incidental take is expected, section 7(b)(4) requires the consulting agency to provide an incidental take statement that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts.

The action agency for this consultation is the NMFS, Office of Protected Resources, Permits and Conservation Division (hereafter referred to as "the Permits Division"). The Permits Division proposes to issue a scientific research permit (Permit No. 19116), authorized under section 104 of the Marine Mammal Protection Act of 1972, as amended (MMPA) (16 U.S.C. 1361 et seq.), and section 10(a)(1)(A) of the ESA to Dr. Brandon Southall (hereafter referred to as "the Applicant"). The proposed permit would authorize behavioral response studies of Pacific marine mammals using controlled sound exposure, which are research applications to support management decisions and conservation.

Consultation in accordance with section 7(a)(2) of the statute (16 U.S.C 1536 (a)(2)), associated implementing regulations (50 C.F.R. §402), and agency policy and guidance (USFWS and NMFS 1998) was conducted by NMFS ESA Interagency Cooperation Division (hereafter referred to as "we").

This biological opinion conference opinion (together referred to as the "opinion"), and incidental take statement were prepared in accordance with section 7(b) of the ESA and implementing regulations at 50 CFR §402.

This document represents NMFS' final opinion on the effects of these actions on endangered and threatened species, or proposed species, and critical habitat that has been designated, or is proposed for designation, for those species. The opinion is based on the information included in the Permits Division's consultation initiation package and the best scientific and commercial data available, as found in: ESA-listing documents, recovery plans, scientific publications, past opinions, and other sources of information. A complete record of this consultation is on file at NMFS Office of Protected Resources in Silver Spring, Maryland.

1.1 Background

Behavioral Response Studies (BRS) using controlled exposure experiments of free-ranging marine mammals to simulated or real naval sonar sounds have occurred in the waters off the Bahamas, Norway, United States (California), and Mediterranean Sea. The proposed BRS project is an ongoing multi-year effort that began in 2010. It is an interdisciplinary research collaboration between scientists from the private sector, academic institutions, and Federal agencies including NMFS and the U.S. Navy. The project is designed to understand marine mammal behavior and responses to anthropogenic sound. Data and analysis will provide a better scientific basis for estimating risk and minimizing effects of active sonar for the U.S. Navy and regulatory agencies. This project is funded by the U. S. Navy, Chief of Naval Operations, Environmental Readiness Division and the Office of Naval Research. ESA section 7 consultations were done on the issuance of ESA section 10 permits for past years BRS studies conducted by the Applicant. NMFS's opinion concluded that issuing Permit No. 14534 for the SOCAL BRS is not likely to jeopardize the continued existence of the ESA-listed blue, fin, sei, humpback, or sperm whales or Guadalupe fur seals; and critical habitat that occurs within the action area is not expected to be affected by the proposed action.. For Permit No. 1121-1900 for the Bahamas BRS (at the Atlantic Undersea Testing and Evaluation Center Range), NMFS's opinion concluded that the issuance of the permit is not likely to jeopardize the continued existence of blue, fin, sei, humpback, and sperm whales.

1.2 Consultation History

This opinion is based on information provided in the Applicant's permit application, correspondence and discussions with the Permits Division, the NMFS Permit Division's *Environmental Assessment on Issuance of a Scientific Research Permit for a Behavioral Response Study on Deep Diving Odontocetes* (2007) prepared pursuant to the National Environmental Policy Act, the NMFS Office of Science and Technology's *Environmental Assessment on the Effects of Scientific Research Activities Associated with Behavioral Response Studies of Pacific Marine Mammals Using Controlled Sound Exposure* (2010), *Supplemental Environmental Assessment on the Effects of Scientific Research of Pacific Marine Mammals*

Using Controlled Sound Exposure: Research Applications to Support Conservation Management (2016), the opinion for Permit No. 14534, annual and final reports, field investigations, and other sources of information. Our communication with the Permits Division regarding this consultation is summarized as follows:

- **June 9, 2016**: Applicant submitted permit application to Permits Division
- **December 1, 2015**: Received permit application from the Permits Division for early review
- **March 3, 2016**: Permits Division sent comments to the Applicant. ESA Interagency Cooperation Division did not have any additional comments on the application
- **March 21, 2016**: Permits Division received a revised permit application from the Applicant with responses to comments
- **March 25, 2016**: Received the Permits Division's request for initiation of section 7 consultation under the ESA as well as application, draft permit, environmental assessment, draft supplemental environmental assessment, annual and final reports
- **May 13, 2016**: Permits Division deemed the application complete and opened application for public comment
- **June 13, 2016**: Public comment period closed, Marine Mammal Commission letter received
- **July 1, 2016**: Received a final permit from the Permits Division

2 Description of the Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies. The Permits Division proposes to issue Permit No. 19116 to the Applicant for directed takes[1] of ESA-listed marine mammals for scientific research purposes and unintentional takes of ESA-listed marine mammals not specifically targeted for research, but taken during the course of research activities. The permit would authorize the permit holder to temporarily attach recording tags to measure vocalization, behavior, and physiological parameters as well as photo-identification, close approaches, focal follows, sound exposure and unintentional harassment of ESA-listed cetacean and pinniped species (see Table 1). Target species include beaked whales, baleen whales, toothed whales, dolphins, and pinnipeds. The research will provide empirical measurements of behavior in marine mammals and behavioral changes as a function of sound exposure so that anthropogenic sound producers

[1] *By regulation, "take" under the MMPA is means to harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. This includes, without limitation, any of the following: The collection of dead animals, or parts thereof; the restraint or detention of a marine mammal, no matter how temporary; tagging a marine mammal; the negligent or intentional operation of an aircraft or vessel, or the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal; and feeding or attempting to feed a marine mammal in the wild. Under the ESA, a "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to do any of the preceding.*

and regulatory agencies can better understand, minimize, and manage sound impacts on protected species from a stronger scientific foundation.

The purpose of the proposed research is to measure baseline behavior and determine how human sounds, including active sonar signals, affect marine mammals. The project includes studies of sound production, passive monitoring, baseline behavior descriptions (e.g., vocalization, diving, feeding, social, and movement), and responses to sound of marine mammals, including endangered species. Some of these species are traditionally difficult to study. Data obtained on vocal characteristics has and will continue to contribute to the ability to detect and track marine mammals and inform density estimation and animal movement models. The results would be integrated with related studies and contribute to conservation management for sound producers and regulatory agencies by identifying characteristics of target species that are critical for passive monitoring, detection, and/or density estimation and by demonstrating how specific sounds, including simulated military sonar, may evoke behavioral responses in marine mammals. Behavior will be measured before, during, and after controlled exposure experiments. This project is a continuation of interdisciplinary research authorized under Permit No. 14534 as part of the Southern California Behavioral Response Study (SOCAL BRS). The experiment will build on previous successful experimental efforts in the Bahamas as well. The permit will be valid for five years (2016 to 2021) after the date of issuance and may be extended for up to one year per Federal regulation. Table 1. below, shows the proposed takes of ESA-listed marine mammals, as presented in Permit No. 19116.

Table 1. Proposed annual takes of marine mammals in the Pacific Ocean offshore of southern California.

Species	ESA Listing Unit/MMPA Stock	Life Stage	Sex	Proposed Authorized Takes/Takes Per Animal	Procedures	Details
Blue Whale	Eastern North Pacific Stock	Adult Juvenile	Male and Female	20/1	Acoustic, Active Playback/Broadcast; Acoustic, Passive Recording; Instrument, Suction-cup (e.g., VHF, TDR); Observations, Behavioral; Photo-id	Category 1 – Tag, Playback
Blue Whale	Eastern North Pacific Stock	Adult Juvenile	Male and Female	80/3	Acoustic, Passive Recording; Instrument, Suction-cup (e.g., VHF, TDR); Observations, Behavioral; Photo-id	Category 2 – Tag, No Playback
Blue Whale	Eastern North Pacific Stock	All	Male and Female	228/3	Acoustic, Passive Recording; Observations, Behavioral; Photo-id	Category 3 – No Tag, No Playback
Blue Whale	Eastern North Pacific Stock	Non-neonate	Male and Female	20/1	Acoustic, Active Playback/Broadcast; Acoustic, Passive Recording; Observations, Behavioral; Photo-id	Category 4 – No Tag, Playback
Blue Whale	Eastern North Pacific Stock	Unknown	Unknown	4/1	Acoustic, Active Playback/Broadcast; Unintentional Harassment	Category 5 – Unintentional Exposure
Fin Whale	California Oregon Washington Stock	Adult Juvenile	Male and Female	20/1	Acoustic, Active Playback/Broadcast; Acoustic, Passive Recording; Instrument, Suction-cup (e.g., VHF, TDR); Observations, Behavioral; Photo-id	Category 1 – Tag, Playback
Fin Whale	California Oregon Washington Stock	Adult Juvenile	Male and Female	80/3	Acoustic, Passive Recording; Instrument, Suction-cup (e.g., VHF, TDR); Observations, Behavioral; Photo-id	Category 2 – Tag, No Playback
Fin Whale	California Oregon Washington Stock	All	Male and Female	342/3	Acoustic, Passive Recording; Observations, Behavioral; Photo-id	Category 3 – No Tag, No Playback
Fin Whale	California Oregon Washington Stock	Non-neonate	Male and Female	40/1	Acoustic, Active Playback/Broadcast; Acoustic, Passive Recording; Observations, Behavioral; Photo-id	Category 4 – No Tag, Playback
Fin Whale	California Oregon Washington Stock	Unknown	Unknown	6/1	Acoustic, Active Playback/Broadcast; Unintentional Harassment	Category 5 – Unintentional Exposure
Humpback Whale	Eastern North Pacific Stock	Adult Juvenile	Male and Female	20/1	Acoustic, Active Playback/Broadcast; Acoustic, Passive Recording; Instrument, Suction-cup (e.g., VHF, TDR); Observations, Behavioral; Photo-id	Category 1 – Tag, Playback

Species	ESA Listing Unit/MMPA Stock	Life Stage	Sex	Proposed Authorized Takes/Takes Per Animal	Procedures	Details
Humpback Whale	Eastern North Pacific Stock	Adult Juvenile	Male and Female	80/3	Acoustic, Passive Recording; Instrument, Suction-cup (e.g., VHF, TDR); Observations, Behavioral; Photo-id	Category 2 – Tag, No Playback
Humpback Whale	Eastern North Pacific Stock	All	Male and Female	114/3	Acoustic, Passive Recording; Observations, Behavioral; Photo-id	Category 3 – No Tag, No Playback
Humpback Whale	Eastern North Pacific Stock	Non-neonate	Male and Female	40/1	Acoustic, Active Playback/Broadcast; Acoustic, Passive Recording; Observations, Behavioral; Photo-id	Category 4 – No Tag, Playback
Humpback Whale	Eastern North Pacific Stock	Unknown	Unknown	2/1	Acoustic, Active Playback/Broadcast; Unintentional Harassment	Category 5 – Unintentional Exposure
Sperm Whale	California Oregon Washington Stock	Adult Juvenile	Male and Female	20/1	Acoustic, Active Playback/Broadcast; Acoustic, Passive Recording; Instrument, Suction-cup (e.g., VHF, TDR); Observations, Behavioral; Photo-id	Category 1 – Tag, Playback
Sperm Whale	California Oregon Washington Stock	Adult Juvenile	Male and Female	40/3	Acoustic, Passive Recording; Instrument, Suction-cup (e.g., VHF, TDR); Observations, Behavioral; Photo-id	Category 2 – Tag, No Playback
Sperm Whale	California Oregon Washington Stock	All	Male and Female	86/3	Acoustic, Passive Recording; Observations, Behavioral; Photo-id	Category 3 – No Tag, No Playback
Sperm Whale	California Oregon Washington Stock	Non-neonate	Male and Female	80/1	Acoustic, Active Playback/Broadcast; Acoustic, Passive Recording; Observations, Behavioral; Photo-id	Category 4 – No Tag, Playback
Sperm Whale	California Oregon Washington Stock	Unknown	Unknown	10/1	Acoustic, Active Playback/Broadcast; Unintentional Harassment	Category 5 – Unintentional Exposure
Sei Whale	Eastern North Pacific Stock	Unknown	Unknown	6/1	Acoustic, Active Playback/Broadcast; unintentional harassment	Category 5 – Unintentional Exposure
Guadalupe Fur Seal	Mexico – Southern California Stock	Unknown	Unknown	90/1	Acoustic, Active Playback/Broadcast; Unintentional Harassment	Category 5 – Unintentional Exposure

2.1 Proposed Research Activities

Research will provide empirical measurements of behavior in marine mammals and behavioral changes as a function of sound exposure building on the relatively extensive research in the past years so that sound producers and regulatory agencies can better understand, minimize, and manage anthropogenic sound impacts on protected species from a stronger scientific foundation. A major objective of the research activities is to refine the understanding of the environmental and behavioral conditions that contribute to the probability of an animal's response to sonar and other anthropogenic and natural predator sounds. Broader analysis applying expert-scoring of the severity of a wide class of expert-identified behavioral responses was used to derive dose-response functions for low, moderate, and severe responses using Cox proportional hazard models (Harris and Thomas 2015); this type of analysis is being applied to SOCAL BRS data and would be applied to subsequent results in addition to individual-based analyses.

The overall objectives for the research activities are:

1. Identify baseline marine mammal behavioral parameters, including vocal communication, feeding, and diving behavior.
2. Measure how marine mammals respond to both natural and anthropogenic sounds. Specific research questions:
    - How do marine mammals respond to conspecific and other biological sounds, including those of potential predators?
    - How do marine mammals respond to simulated and actual military sonar?
    - How do marine mammals respond to simulated and real ship sound?
    - What are the types and contexts of exposure resulting in different kinds of behavioral responses in different species?
    - How are these responses potentially related to risk factors for more severe behavioral responses and/or injury?
    - Are there particularly sensitive and generally tolerant marine mammal species with regard to acoustic exposure?

The regulatory and environmental compliance questions in the assessment of potential sound impacts on marine mammals are:

- What kinds of vocal signals are produced by different species and what are their communicative functions?
- How well can acoustic monitoring be used in detecting animal presence and, in communication with environmental data, estimating distribution and abundance?
- What are the baseline behavioral patterns (diving, feeding, vocalization) of a number of key marine mammal species?
- How do marine mammals respond to both natural (e.g., conspecific or potential predator sounds) and various anthropogenic sounds (including military sonar and ship sound)?

- From anecdotal observation and experimental research (including SOCAL BRS) there appears to be certain particularly sensitive species (e.g., beaked whales) and a larger number of less sensitive ones. For the (considerable number of) remaining species, are there ways of testing or logically predicting based on certain life history parameters (e.g., social structure) into which general category they may fall?
- What are the biological, environmental, and sound exposure contextual variables (e.g., animal behavioral state; relative distance, orientation, and movement of animal and sound source) that affect the probability of behavioral response?

Research methods include tagging, photo-identification, close approach, focal follow, and sound exposure. The experimental design involves temporarily attaching archival recording tags to measure vocalization, behavior, and physiological parameters of marine mammals as well as sound exposure. Behavior will be measured before, during, and after carefully controlled exposures of sound in conventional playback experiments. Tagged animals will be exposed to received sound levels up to 180 decibel (dB) re: 1μPa (root mean square [rms]). This study will involve various activities that could take animals by harassment, including close approaches, attachment of tags, and sound exposure. Small fragments of sloughed skin, which often remain attached to retrieved tags, would be collected and used for genetic analyses. Target species include ESA-listed cetaceans and pinnipeds with a focus on mysticetes and odontocetes (especially beaked whales); other marine species may be unintentionally impacted by the research. The proposed activities will be conducted in identical coastal and offshore areas of the Southern California Bight as in previous studies. Actual sound sources operated by the U.S. Navy for these studies will be from typical training operations conducted under an existing MMPA incidental take authorization and ESA opinion for Hawaii-Southern California Training and Testing, and operational requirements for mitigation and monitoring, with sonar hours counting against their authorized allocated total.

Given these specific manners of taking marine mammals, a total of five take categories are defined (as in the previous permit) and the methods of determining requested permit takes according to analytical methods are specified here. Animals that are taken by close approach, tag attachment, photo-identification, focal follow, and playback during the course of the proposed research activity fall under Category one. Category two is animals taken by close approach, photo-identification, tag attachment, and focal follow (but no playback) during the course of the proposed research activity. Category three is animals taken by close approach, photo-identification, and focal follow (but no tagging or playback). Category four is animals taken by intentional playbacks to non-tagged animals. Category five refers to those animals that may be taken by unintentional sound exposure to playback. Adults and juveniles of either sex may be taken although any groups of animals that include neonates will be excluded from playback experiments. These categories are described in greater detail in the exposure analysis in Section 6.3.

This project will occur in spring and through fall months annually for five years. The permit application includes a suite of mitigation measures for this activity including: taxa-specific guidelines on how long after tagging Controlled Exposure Experiments (CEE) may begin, halt of experimentation in the presence of dependent calves or calves less than six months, avoiding playback exposures when other vessels are within 1 kilometer (km) (0.5 nautical miles [nmi]) of the focal animals, and total transmission time of no more than 30 minutes with a ramp-up in three dB increments per transmission to maximum output level. Shutdown criteria have also been established during cessation of activity for: marine mammals within 200 meters (m) (656 feet [ft]) of simulated sound source transmission, visual detections of focal group or incidentally exposed mammals exhibiting unusual surface behavior, disorientation, dramatic changes in cohesion, or separation of calves from mothers.

2.1.1 Tag Attachment Vessels

Tag attachment vessels are relatively small and maneuverable for tag attachment. They are typically 5 to 7 m (16 to 23 ft) rigid hull inflatable boats (RHIBs) outfitted with bow pulpits that allow for greater visibility and height above the water to deploy tags, similar to what has been used successfully for tag attachment in a number of other projects. Animals are approached at a slow to moderate speed and as slowly as practical, depending on their behavioral state or speed of travel. Approaches are made at an angle so as not to place the tagging boat over any part of the animal, specifically the flukes, and are never made directly towards the head of the animal. Thus, approaches are generally made from the five or seven and 7 o'clock position relative to the animal. Tags are deployed using a 6 to 8 m (20 to 26 ft) hand-held carbon-fiber pole. The tag is situated in a housing at the end of the pole and placed on the dorsal surface of the animal. The method for approaching and successfully deploying tags of this nature has been done many hundreds of times on over 20 species of marine mammals over the past 15 years (Deruiter et al. 2013; Friedlander et al. 2009; Goldbogen et al. 2013c; Johnson and Tyack 2003). It has been shown that tagging in this method minimizes disturbance to animals and that they generally return to their pre-tagging behavior within one or two dive cycles (Nowacek et al. 2007). The tag attachment vessel must come within 2 to 8 m for attachment using hand-held poles depending on the species. For smaller vessel-attracted delphinids, they are generally less than 5 m (16 ft). For larger baleen whales, the distance is generally at the extent of the pole's reach. The Applicant on the tag attachment vessels also collects photographs for individual identification. The tag attachment vessel must come within 10 to 100 m (33 to 328 ft) for these activities. Photographs for identification are typically collected just before and after tagging and in the context of typical visual focal follow procedures.

2.1.2 Whale Observation or Tag Tracking Vessels

Whale observation or tag tracking vessels are larger research vessels or a yacht (20 m [66 ft] or greater) with adequate height capabilities for antenna placement on tall masts and for visual observations from a crow's nest. Antennas are used to help track tagged animals via Very High Frequency (VHF) transmitters that activate when they are out of the water. This gives the observing and tracking team additional capabilities to help maintain a focal follow and desired proximity to the tagged animal. The vessels will also have cabin and lab space for crew to operate 24 hours a day, storage for receivers and data logging instruments required for tags, and the ability to deploy a hydrophone array for passive acoustic monitoring (PAM) for detecting and tracking animals. For the playback component of the project, accurate assessment of range from the playback speaker to the focal individual is important for protection, so the Applicant will measure the angle between a surfacing animal and the horizon using either reticle binoculars, mini-big-eye binoculars, or laser range-finding binoculars to calculate range for animals visually sighted at the sea surface from these vessels. These vessels will typically remain at least several hundred meters from animals being followed, and will maintain sufficient distance so as not to influence the behavior of the animals. Marine mammal interactions with the whale observation or tracking vessels are not likely because observers on these research vessels are constantly and purposely on the lookout for these animals.

2.1.3 Playback Vessels – Simulated

The playback vessel would be used to deploy the simulated sound sources (mid-frequency active sonar [MFAS] or ship sound) and transmit the experimental playback sounds as part of the CEEs. Sound sources will involve either a multi-element vertical line array sound source vessels or a large underwater single element transducer, such as a U.S. Navy J-13 or J-15 for playbacks of recorded ship sound. The vessel must have hardware for deploying and towing either of these types of sources as well as suitable deck or laboratory space for the source equipment and for sound generation electronics. This vessel would have a relatively quiet propulsion system to minimize potentially confounding vessel sound. Playback vessels will have observers onboard to site and avoid marine mammals. Playback vessels will remain several hundred meters or more from the animals, and will maintain a sufficient distance that it is unlikely to be visible to the animals, particularly CEEs where ranges will be on the order of 1 to 20 km (0.5 to 11 nmi).

2.1.4 Playback Vessels – Realistic

The playback vessel used for CEEs using actual MFAS will be operational U.S. Navy vessels. U.S. Navy vessels are not provided for exclusive use during the SOCAL BRS project, but are operating in the context of regular operational training in areas where they are authorized to conduct such work. Direct coordination and real-time communication between SOCAL BRS and the U.S. Navy vessel will occur to ensure MFAS exposures occur within experimental design protocols and all mitigation measures are implemented. Sound propagation modeling will be used to position U.S. Navy ships relative to tagged animals using standard acoustic modeling methods to meet experimental objectives. A simple straight-line course of U.S. Navy ships that is generally approaching focal animals is selected based on sound propagation conditions in order to result in a relatively consistent gradual increase in received levels. All ship sound CEEs will involve simulated sources rather than actual vessels.

2.1.5 Passive Acoustic Monitoring and Focal Follows

Real time PAM is proposed to be undertaken partly by using existing U.S. Navy hydrophones to locate and monitor target marine mammals in the action area described below. The combined listening capabilities available on the Southern California Offshore Range (SCORE) and the proven identification and localization of marine mammals using these bottom-mounted sensors will be one of the principal tools used in locating target species and in monitoring real-time responses of animals during CEEs. Passive acoustic monitoring equipment will also be deployed from vessels and are proposed to include towed hydrophone arrays or sonobuoys. Once animals have been detected and range determined (and conditions are suitable for CEEs), the Applicant may begin closely pursuing target animals. These close pursuits directed at single target animals are known as focal follows. Vessels using PAM will have relatively quiet propulsion systems for low sound recording and to minimize potentially confounding vessel sound. The PAM data will be integrated with navigation logging, classification logging, and geographic information systems (GIS) mapping in a format that allows integration with the visual observation data. Focal follows are defined as the close and targeted prolonged approach and pursuit of individual animals or groups of individuals.

2.1.6 Close Approaches

An "approach" is defined as a continuous sequence of maneuvers involving a vessel or equipment, including drifting, directed toward a cetacean or group of cetaceans closer than 100 yards for ESA-listed whales. “Close approaches” are defined as “a continuous sequence of maneuvers involving a vessel, aircraft, or the Applicant’s body in the water, including drifting, directed toward a cetacean or group of cetaceans for the purposes of conducting authorized research, including approaches to less than 10 to 15 m (33 to 49 ft) to allow for tag attachment and/or photo-identification, which involves one or more instances of coming closer than 100 yards to the cetacean or group of cetaceans.” Close approaches using relatively small, quiet boats are proposed to be made within less than 10 m to allow for photographs to be taken and for the attachment of tags. These close approaches are proposed to be done slowly, deliberately, and for as short a time as necessary to complete photographing and tagging activities. The boats are pre-positioned relatively close to where the animals will surface. If animals show signs of disturbance, the Applicant will break-away and find another group of animals. The number of close approaches will be limited to three within a day for any one group.

2.1.7 Tagging

Multi-sensor archival acoustic recording tags will be used during the SOCAL BRS project as they have for previous work in the Bahamas and other projects. Target animals are proposed to be fitted with the latest version of digital archival recording tags (DTAGs) to measure received sound exposure, animal vocalizations, behavior and physiology. They include sensors that record pressure, pitch, roll, heading, surfacing events, depth, and ambient temperature of the tagged animal. Two hydrophones allow the tag to record continuous acoustic data. The DTAG is a high data rate recording tag and is designed to be attached to an animal for relatively short periods of time. The tags are attached in a non-invasive manner by the use of four 60 millimeters (mm) (2.4 inches [in]) diameter suction cups made from medical grade silicone. Before deployment the suction cups are cleaned and sterilized prior to attachment to avoid the risk of possible pain, infection or disease transfer. This will also prevent contamination of any thin layer of skin that may adhere to the tag after release. The dimensions of the tags are approximately 20 cm x 8 cm x 5 cm (7.9 x 3.2 x 2 in) for the tag in its fairing housing (used to reduce drag) and it weighs 200 grams. The tag is slightly positively buoyant in the water to allow for retrieval after detachment from the target animal. The current version of the DTAG has a housing that is designed to provide a low drag hydrodynamic attachment, and is suitable for tagging a range of cetacean body sizes. The DTAG contains programming and a release mechanism that allows the user to determine the duration of the deployment or the time of day after which the tag should be released. An embedded VHF radio transmitter allows for tracking of the tag when it is at the surface (either on the animal or once it has been shed). Radio tracking gear, including radio receivers and directional antennas that detect sounds from the tag when at the surface, allows crew on the vessels to track the tagged animals.

Bio-acoustic probe tags (Acousonde 3B or B-Probes) are also proposed to be attached to target animals. B-Probes are electronic data-logging tags that record calibrated acoustic pressure, temperature, depth, two-axis acceleration, and body orientation (i.e., tilt and roll) of the tagged animal (see Goldbogen et al. 2006). During the course of the permit, the Applicant expects to use the next generation B-Probes, which will provide higher acoustic sampling rates (up to 200 kiloHertz [kHz]), a three-axis accelerometer, and a compass. These tags are generally similar to DTAGs in terms of sensor package, method of deployment, tracking, recovery, and data offload, but only have a single hydrophone and do not have a programmable release mechanism. The use of these probes will allow for three-dimensional tracking of target animals relative to the passing research boat. B-Probe tags are approximately 33 cm (13 in) long and 6 cm (2.4 in) in diameter[2.] They are equipped with a flotation device and VHF radio transmitter to allow for recovery after detachment from the whale (Burgess et al. 1998). The B-Probes tag is also tracked in an identical manner to the DTAG with the same equipment and protocols.

Tags will be attached to the animals via non-invasive silicon suction cups. These suction cups have been engineered and tested to maximize suction on the skin of marine mammals, while minimizing any unnecessary impact to the animal. Tags will be attached on the whale or dolphins dorsal surface, general around the dorsal fin and caudal to behind the blowhole or any other potentially sensitive areas. No pinnipeds are proposed to be tagged for this permit. Tags have been deployed for up to 36 hours, which is likely toward the limits of the suction cups ability to remain on a moving animal. All tags are proposed to be attached by using a hand-held carbon fiber pole 6 to 8 m (20 to 26 ft) in length from the vessel with a customized tag cradle at one end. The hand-held pole gives the tagger the greatest flexibility to deploy the tag on animals

[2] *Scripps Institute Whale Acoustics Laboratory: http://cetus.ucsd.edu/technologies_AcousticTag.html*

from a number of angles, distances, and positions as well as a greater ability to control the amount of force required to successfully attach the tag than is possible with other methods such as longer cantilevered poles or remote, launched tags from compressed airguns. Tagging for baseline and CEEs will focus on all sex and age-class individuals of focal species, except neither tagging nor CEEs will be conducted on neonate calves (i.e., individuals six months old or younger for ESA-listed species and individuals with fetal folds for non-ESA-listed species) or on mothers or groups containing neonate calves.

DTAGs have the potential to be deployed for over 24 hours, but are generally deployed for 5 to 8 hours on baleen whales. The archival tags can release from the animal by: (1) dislodging it by rapid movements or breaching, by rubbing it, on the seafloor, or by contact with another animal; (2) slow leakage of the seal between the suction cup and the animal's skin, repeated diving (i.e., pressure changes) working the suction cup loose, some other mechanical failure, or natural sloughing of skin; or (3) a mechanism that uses an electrically corrosive wire assembly to release the tag from the animal. As the tag is attached caudal to the blowhole, it has not chance of interfering with breathing as the tag migrates rearward as the animal moves through the water. The entire tag releases from the animal in one piece, leaving no equipment near the animal. Tags can be re-programmed in the field to a desired timeframe based on changing environmental conditions and target animals.

As new technology develops, there are likely to be novel sensor packages that can be incorporated into tag shape, size, and design. The Applicant intends to pursue these potentially new tags as their development matures during the period of the permit and will discuss the use of them directly with NMFS's Office of Protected Resources before deployment in the field.

2.1.8 Tagging Protocol

The tagging protocol will follow a general model, but may differ for each species according to its morphology and environmental conditions.

- Where possible, a whale observation/tag tracking vessel will use visual observation and PAM to follow an animal selected for tagging. Observers will monitor the animal as closely as possible before tagging to test for an effects.
- The tag attachment vessel will approach the animal as cautiously as possible while still achieving a position to allow attachment of the tag.
- During and after attachment of the tag, the whale observation/tag tracking or tag attachment vessel will track and observe the tagged animal when it is at the surface for the duration of the tag attachment, as well as a post-tagging period, where possible, to ensure both that the data collected during the tag deployment represent as normal a repertoire as possible and that the tag had no visible effects on the animal. Sightings from the whale observation/tag tracking vessel are used to reference the animal's track in geographical space.
- Either the whale observation/tag tracking or tag attachment vessel will recover the tag after it releases from the animal.

- Where playbacks are planned, they will be conducted after a pre-exposure period (of at least 30 minutes for most species) to monitor the animal's reaction to the tagging and to establish a pre-exposure behavioral baseline, once prey-mapping surveys have been conducted.

Photographs and video of all tag attempts and animals tagged will be taken (as well as tag location), where possible, to identify the tagged animal and compare to known catalogues. This will prevent duplicative tagging and evaluate tagging approaches to ensure accurate reporting requirements for the permit.

2.1.9 Sloughed Skin Collection

Fragments of sloughed epidermis (i.e., skin), which often remain attached to suction cups from tags, would be collected and used for genetic analyses in carefully controlled laboratories by the team and collaborators (Amos et al. 1992). These small samples will be preserved in dimethyl sulfoxide and sealed in vials. Skin samples would be shared between local biologists located in the study area, international experts in marine mammal genetics, the National Marine Mammal Tissue Bank, or other NMFS-designated facilities.

2.1.10 Photo-Identification

The cameras used for photo-identification are standard high-resolution digital single lens reflex cameras equipped with zoom telephoto lenses or with longer fixed focal length telephoto lenses with an option of adding teleconverters. The identification photographs are organized into a catalog that will be maintained on the vessel and matched visually for re-sighting analysis.

2.1.11 Visual Monitoring – Shore-based Team

In some scenarios where group behavior is being studied and tagging may be more challenging, tagging efforts will be complimented in studying potential group responses, a shore-based team will conduct visual monitoring. The team will consist of up to four observers and data recorders to conduct visual observations with high-power binoculars, spotting scopes, and record locations using theodolites. Visual surveys will consist of systematic scans of the research area visible from elevated cliffs (greater than 25 m [82 ft]) on offshore islands (e.g., Catalina, San Clemente, or Santa Barbara Islands), in areas where all focal delphinid species occur close to shore (less than 1 km) regularly.

2.1.12 Visual Monitoring – Offshore-based Team

The visual monitoring team for the CEEs will use big-eye binoculars (e.g., Fujinon 25 x 150) and hand-held binoculars with reticles that allow range to the animal to be calculated. Customized software packages will record data categories such as range, bearing, position, time, and sighting number that generate data tables as well as real-time georeferenced locations and tracks in a GIS platform. These data can be integrated in a computer display that also includes navigation data from the ship and data from PAM localization.

2.1.13 Playbacks

After the baseline behavior of target animals has been observed and recorded, playback experiments are proposed. These CEEs would project a variety of natural (e.g. killer whale) and manmade (e.g. real and simulated military active mid-frequency sonar as well as ship) sounds. These playbacks are proposed to be conducted by using an underwater speaker that is capable of being rapidly deployed, controlled in real-time, and recovered from a research vessel. Sound sources will involve either a multi-element vertical line array sound source or a large single element transducer. Sonar signals will be intermittent and ship sound signals will include continuous recordings of actual ship sound for 5 to 10 minutes around the closest point of approach of a ship to an underwater recorder.

The sound source is able to generate relatively broadband acoustic signals at relatively high output levels (up to a maximum of 212 dB re: 1µPa-m source level) across the mid-frequency band (up to 1 to 10 kHz). Simulated MFAS sonar signals will be projected from a ten element vertical array source with 0.5 second linear frequency modulated upsweep from 3.5 to 3.6 kHz, a 0.5 second constant frequency tone at 3.75 kHz, a 0.1 silent interval, and a 0.5 second frequency tone at 4.05 kHz. Sounds are typically transmitted once every 25 seconds (to mimic the output characteristics typical of many 53C systems), transmitting at a maximum source level of 210 dB re: 1µPa. Simulated ship sound will be projected through either the J-13 or J-15 sound sources and will involve recordings of actual ship sound played back at a maximum source levels of up to 190 dB re: 1µPa for 5 to 10 minute durations. Realistic MFAS will be used from several different U.S. Navy vessels with standard 53C sonar systems using signals typical ongoing sonar training operations. These MFAS transmissions from U.S. Navy vessels will be transmitted for a maximum of 60 minutes at a constant source level, nominal 235 dB re: 1µPa using typical waveforms (3 to 4 kHz) and duty cycles (approximately 30 second repetition rate). No additional sound sources will be active from real U.S. Navy ships during the CEEs. Killer whale signals may be transmitted over a larger bandwidth (1 to 20 kHz) at a low duty cycle for up to 30 minutes (at a source level no greater than 180 re: 1µPa-m).

All sound sources will be tested in advance at a specialized acoustic facility to measure output performance and will be tested and calibrated in situ in the operational area outside the context of a CEE. The sound sources will be controlled in real-time by engineers, as part of the Applicant’s research team, aboard the research vessel with the capability to terminate acoustic exposures if certain conditions occur (e.g., specific changes in foraging/vocal behavior of focal animals or any strong adverse behavioral responses). For animals observed at the sea surface, any playback would be stopped if a strong aversive behavioral response is observed by visual observers on any platform. In all cases involving simulated sonar, ship sound, or killer whale CEE’s, transmissions will be immediately terminated if any marine mammal comes within a radius conservatively estimated to result in an exposure to levels exceeding 180 dB re: 1µPa.

Active Acoustics for Prey Mapping

Prey mapping is planned to occur as it provides contextual and environmental data concurrent with tag deployments and CEEs with marine mammals. The data is important for predictive ecological models and explanatory models quantifying the behavioral response of tagged marine mammals to sound. The investigators propose to use Simrad EK60 split-beam echosounders with sources operating at 38 kHz, 70 kHz, and/or 120 kHz to map prey species in the vicinity of tagged animals. The transducers for this echosounder have a 7 or 12 degree beam (for 38 and 120 kHz respectively) and a maximum continuous input of 30 to 40 Watts (W) with a maximum instantaneous pulse output of 1 to 4 kiloWatts (kW). The echosounders have a sound pressure level at 38 kHz of 183 dB re: 1µPa-m. The maximum source level is estimated to be 202 dB re: 1µPa-m. The duration of pulses is typically less than 1 millisecond (msec) to allow for discrimination of small targets.

2.2 Action Area

The *action area* means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 CFR 402.02). The proposed action would occur primarily in the summer and fall (approximately March through October) in the waters off Southern California within the U.S. Navy's Southern California Range Complex, and primarily near the vicinity of San Clemente Island and Catalina Island where previous research has occurred (e.g., outside the Channel Islands National Marine Sanctuary). The research is funded by the U.S. Navy, however it will be conducted by the Applicant of Southall Environmental Associates, Inc., an international company with extensive experience in science research, engineering, conservation management, public education, and biological monitoring and mitigation of adverse environmental impacts created by human industries. While the Applicant proposes extending the overall area covered by the permit slightly further north than the previous permit to include the Monterey Bay and San Francisco Bay areas, these areas would only be used for baseline tagging. There would be no sonar transmissions of any kind within any portion of Monterey Bay National Marine Sanctuary or any other National Marine Sanctuary. All CEEs with simulated or real U.S. Navy sources would only occur in the same areas off Southern California and with the same restrictions and mitigation measures as under the previous permit. There is no intention for active sonar transmissions outside those areas off SOCAL in which sonar exposure is common and use is already authorized for the U.S. Navy by NMFS.

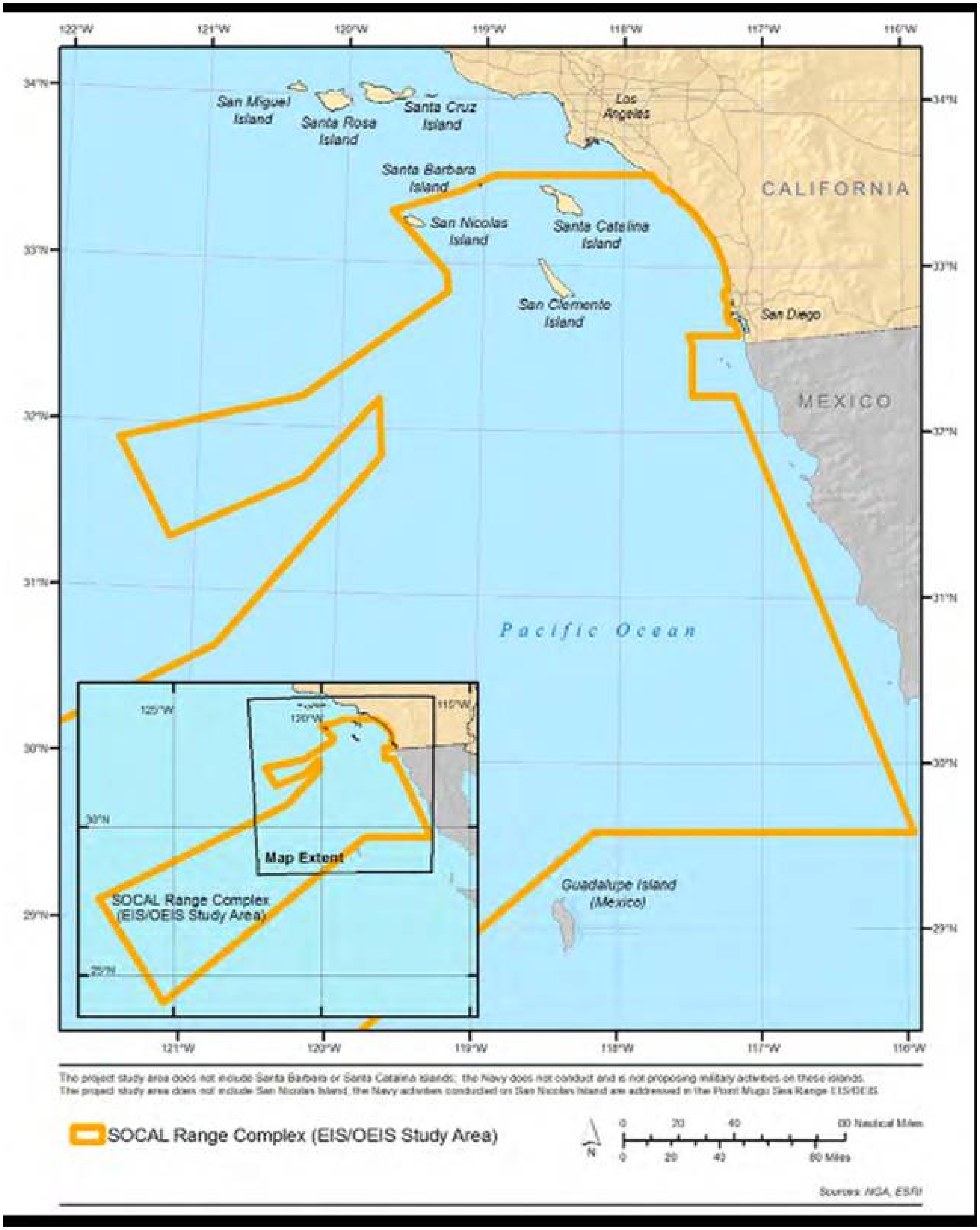

Figure 1. Map of the U.S. Navy's Southern California Range Complex which is the action area for this consultation.

2.3 Permit Terms and Conditions

The Permits Division proposes to include conditions in Permit No. 19116 for the SOCAL BRS project. Below is the permit text based on what was provided to the ESA Interagency Cooperation Division in the consultation initiation package and subsequent updates from the Permits Division.

> The activities authorized herein must occur by the means, in the areas, and for the purposes set forth in the permit application, and as limited by the Terms and Conditions specified in this permit, including attachments and appendices. Permit noncompliance constitutes a violation and is grounds for permit modification, suspension, or revocation, and enforcement action.

A. Duration of Permit

1. Personnel listed in Condition C.1 of this permit (hereinafter "the Applicant") may conduct activities authorized by this permit through June 30, 2021. This permit expires on the date indicated and is non-renewable. This permit may be extended by the Director, NMFS Office of Protected Resources, pursuant to applicable regulations and the requirements of the MMPA and ESA.

2. The Applicant must immediately stop permitted activities and the Permit Holder must contact the Chief, NMFS Permits and Conservation Division (hereinafter "Permits Division") for written permission to resume:

    a. If serious injury or mortality[3] of protected species occurs.

    b. If authorized take[4] is exceeded in any of the following ways:

        i. More animals are taken than allowed in Table 1 of Appendix 1.

        ii. Animals are taken in a manner not authorized by this permit.

        iii. Protected species other than those authorized by this permit are taken.

    c. Following reporting requirements at Condition E.2.

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[3] *This permit does not allow for unintentional serious injury and mortality caused by the presence or actions of the Applicant. This includes, but is not limited to: deaths of dependent young by starvation following research-related death of a lactating female; deaths resulting from infections related to sampling procedures; and deaths or injuries sustained by animals during capture and handling, or while attempting to avoid the Applicant or escape capture. Note that for marine mammals, a serious injury is defined by regulation as any injury that will likely result in mortality.*

[4] *By regulation, a take under the MMPA means to harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. This includes, without limitation, any of the following: The collection of dead animals, or parts thereof; the restraint or detention of a marine mammal, no matter how temporary; tagging a marine mammal; the negligent or intentional operation of an aircraft or vessel, or the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal; and feeding or attempting to feed a marine mammal in the wild. Under the ESA, a take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to do any of the preceding.*

3. The Permit Holder may continue to possess biological samples[5] acquired[6] under this permit after permit expiration without additional written authorization, provided the samples are maintained as specified in this permit.

B. Number and Kind(s) of Protected Species, Location(s) and Manner of Taking

1. The table in Appendix 1 outlines the number of protected species, by species authorized to be taken, and the locations, manner, and time period in which they may be taken.

2. The Applicant working under this permit may collect visual images (e.g., photographs, video) in addition to the photo-identification or behavioral photo-documentation authorized in Appendix 1 as needed to document the permitted activities, provided the collection of such images does not result in takes.

3. The Permit Holder may use visual images and audio recordings collected under this permit, including those authorized in Table 1 of Appendix 1, in printed materials (including commercial or scientific publications) and presentations provided the images and recordings are accompanied by a statement indicating that the activity was conducted pursuant to Permit No. 19116. This statement must accompany the images and recordings in all subsequent uses or sales.

4. The Chief, Permits Division may grant written approval for personnel performing activities not essential to achieving the research objectives (e.g., a documentary film crew) to be present, provided:

   a. The Permit Holder submits a request to the Permits Division specifying the purpose and nature of the activity, location, approximate dates, and number and roles of individuals for which permission is sought.

   b. Non-essential personnel/activities (e.g., film, media, etc.) will not influence the conduct of permitted activities or result in takes of protected species.

   c. Persons authorized to accompany the Applicant for the purpose of such non-essential activities will not be allowed to participate in the permitted activities.

   d. The Applicant does not require compensation from the individuals in return for allowing them to accompany for the research activities.

[5] *Biological samples include, but are not limited to: carcasses (whole or parts); and any tissues, fluids, or other specimens from live or dead protected species; except feces, urine, and spew collected from the water or ground.*
[6] *Authorized methods of sample acquisition are specified in Appendix 1.*

5. The Applicant must comply with the following conditions related to the manner of taking:

Counting and Reporting Takes

a. No individual cetacean may be taken more than three times in one day.

b. Any "approach"[7] of a cetacean constitutes a take and must be counted and reported regardless of whether an animal reacts.

c. During an approach, the Applicant may attempt the procedures in a take table row once.

d. For Level A procedures:

Within an approach, each additional attempt to tag or sample constitutes a new take and must be counted and reported against that row of takes. Attempts include:

- Misses
- Successful hits
- Hits with no data collected or tag

e. Any marine mammal observed during sound playback must be counted as a take by harassment and reported.

General

f. To minimize disturbance of the subject animals the Applicant must exercise caution when approaching animals and must retreat if behaviors indicate the approach may be interfering with reproduction, feeding, or other vital functions.

g. Where females with calves are authorized to be taken, the Applicant:

i. Must immediately terminate efforts if there is any evidence that the activity may be interfering with pair bonding or other vital functions;
ii. Must not position the research vessel between the mother and calf;
iii. Must approach mothers and calves gradually to minimize or avoid any startle response; and
iv. Must discontinue an approach if a calf is actively nursing.

Tagging

h. Only adults and juveniles may be tagged, including females with calves.

[7] *An "approach" is defined as a continuous sequence of maneuvers involving a vessel or equipment, including drifting, directed toward a cetacean or group of cetaceans closer than 100 yards for baleen and sperm whales and 50 yards for all other cetaceans.*

i. Before attempting to tag an individual, the Applicant must take reasonable measures (e.g., compare photo-identifications) to avoid unintentional repeated sampling of any individual.

j. A tag attachment attempt must be discontinued if an animal exhibits repetitive, strong, adverse reactions to the activity or the vessel.

k. The Applicant must not attempt to tag a cetacean anywhere forward of the pectoral fin.

Active Acoustics

l. Playback studies must be limited to 30 minutes in duration, not exceed a received level greater than 180 dB re: 1µPa at the marine mammal.

m. A playback episode must be discontinued if an animal exhibits repetitive strong adverse reactions to the playback activity or the vessel.

Pinniped Conditions:

n. The Applicant must not conduct any activities near pinniped rookeries until after peak pupping season for all species present, when mother-pup bonds are well-established or pups are weaned, whichever occurs first.

o. The Applicant must take reasonable steps to identify and avoid disturbance of pregnant and lactating females. If a lactating female dies as a result of the research activities and her dependent pup can be identified, the Applicant must immediately contact the NMFS Regional Stranding Network Coordinator (Justin Viezbicke, Justin.Viezbicke@noaa.gov, Phone: (562) 980-3230 and proceed as directed.

p. The Applicant must exercise caution when approaching all pinnipeds, particularly mother/pup pairs. Efforts to approach a particular pinniped or mother/pup pair must be immediately terminated if there is any evidence that the activities may be life-threatening to the animals.

q. To the maximum extent practical without causing further disturbance of marine mammals, the Applicant must monitor study sites following any disturbance (e.g., surveys or sampling activities) to determine if any marine mammals have been killed or injured or pups abandoned. Any observed serious injury to or death of a marine mammal is to be reported as indicated in Condition B.2 above. Any observed abandonment of a dependent marine mammal pup is to be reported.

For surveys (aerial, ground, vessel):

r. For pinnipeds, a behavioral response to an approach or other permitted activity constitutes a take and must be counted and reported.

6. The Permit Holder must comply with the following conditions and the regulations at 50 CFR 216.37, for biological samples acquired or possessed under authority of this permit.

a. The Permit Holder is ultimately responsible for compliance with this permit and applicable regulations related to the samples unless the samples are permanently transferred according to NMFS regulations governing the taking and importing of marine mammals (50 CFR 216.37) and the regulations governing the taking, importing, and exporting of endangered and threatened species (50 CFR 222.308).

b. Samples must be maintained according to accepted curatorial standards and must be labeled with a unique identifier (e.g., alphanumeric code) that is connected to on-site records with information identifying the:

i. species and, where known, age and sex;
ii. date of collection, acquisition, or import;
iii. type of sample (e.g., blood, skin, bone);
iv. origin (i.e., where collected or imported from); and
v. legal authorization for original sample collection or import.

c. Biological samples belong to the Permit Holder. The Permit Holder remains responsible for the samples, including any reporting requirements.

d. Sample recipients must have authorization pursuant to 50 CFR 216.37 prior to permanent transfer of samples and transfers for purposes not related to the objectives of this permit.

e. Samples cannot be bought or sold, including parts transferred pursuant to 50 CFR 216.37.

f. After meeting the permitted objectives, the Permit Holder may continue to possess and use samples acquired under this permit, without additional written authorization, provided the samples are maintained as specified in the permit and findings are discussed in the annual reports (See Condition E.3).

C. <u>Qualifications, Responsibilities, and Designation of Personnel</u>

1. At the discretion of the Permit Holder, the following the Applicant may participate in the conduct of the permitted activities in accordance with their qualifications and the limitations specified herein:

a. Principal Investigator (PI) – Dr. Brandon Southall;

b. Co-Investigators – See Appendix A for list of names and corresponding activities.

c. Research Assistants – any personnel identified by the Permit Holder or Principal Investigator and qualified to act pursuant to Conditions C.2, C.3, and C.4 of this permit.

2. Individuals conducting permitted activities must possess qualifications commensurate with their roles and responsibilities. The roles and responsibilities of personnel operating under this permit are as follows:

   a. The Permit Holder is ultimately responsible for activities of individuals operating under the authority of this permit. Where the Permit Holder is an institution/facility, the Responsible Party (i.e., Dr. Brandon Southall) is the person at the institution/facility who is responsible for the supervision of the Principal Investigator.

   b. The PI is the individual primarily responsible for the taking, import, export and related activities conducted under the permit. The PI must be on site during activities conducted under this permit unless a Co-Investigator named in Condition C.1 is present to act in place of the PI.

   c. Co-Investigators (CIs) are individuals who are qualified to conduct activities authorized by the permit, for the objectives described in the application, without the on-site supervision of the PI. CIs assume the role and responsibility of the PI in the PI's absence.

   d. Research Assistants (RAs) are individuals who work under the direct and on-site supervision of the PI or a CI. RAs cannot conduct permitted activities in the absence of the PI or a CI.

3. Personnel involved in permitted activities must be reasonable in number and essential to conduct of the permitted activities. Essential personnel are limited to:

   a. Individuals who perform a function directly supportive of and necessary to the permitted activity (including operation of vessels or aircraft essential to conduct of the activity);

   b. Individuals included as backup for those personnel essential to the conduct of the permitted activity; and

   c. Individuals included for training purposes.

4. Persons who require state or Federal licenses or authorizations (e.g., veterinarians, pilots) to conduct activities under the permit must be duly licensed/authorized and follow all applicable requirements when undertaking such activities.

5. Permitted activities may be conducted aboard vessels or aircraft, or in cooperation with individuals or organizations, engaged in commercial

activities, provided the commercial activities are not conducted simultaneously with the permitted activities.

6. The Permit Holder cannot require or receive direct or indirect compensation from a person approved to act as PI, CI, or RA under this permit in return for requesting such approval from the Permits Division.

7. The Permit Holder or PI may add CIs by submitting a request to the Chief, Permits Division that includes a description of the individual's qualifications to conduct and oversee the activities authorized under this permit. If a CI will only be responsible for a subset of permitted activities, the request must also specify the activities for which they would provide oversight.

8. Where the Permit Holder is an institution/facility, the Responsible Party (i.e., Dr. Brandon Southall, also the Applicant) may request a change of PI by submitting a request to the Chief, Permits Division that includes a description of the individual's qualifications to conduct and oversee the activities authorized under this permit.

9. Submit requests to add CIs or change the PI by one of the following:

   a. the online system at https://apps.nmfs.noaa.gov;
   b. an email attachment to the permit analyst for this permit; or
   c. a hard copy mailed or faxed to the Chief, Permits Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Room 13705, Silver Spring, MD 20910; phone (301) 427-8401; fax (301) 713-0376.

D. Possession of Permit

1. This permit cannot be transferred or assigned to any other person.

2. The Permit Holder and persons operating under the authority of this permit must possess a copy of this permit when:

   a. Engaged in a permitted activity.
   b. A protected species is in transit incidental to a permitted activity.
   c. A protected species taken under the permit is in the possession of such persons.

3. A duplicate copy of this permit must accompany or be attached to the container, package, enclosure, or other means of containment in which a protected species or protected species part is placed for purposes of storage, transit, supervision or care.

E. Reports

1. The Permit Holder must submit annual, final, and incident reports containing the information and in the format specified by the Permits Division.

   a. Reports must be submitted to the Permits Division by one of the following:

i. the online system at https://apps.nmfs.noaa.gov;
ii. an email attachment to the permit analyst for this permit; or
iii. a hard copy mailed or faxed to the Chief, Permits Division.

b. The Permit Holder must contact the permit analyst for a reporting form if you do not submit reports through the online system.

2. Incident reports: must be submitted within two weeks of serious injury and mortality events or exceeding authorized takes, as specified in Conditions A.2 and B.1.

a. The incident report must include a complete description of the events and identification of steps that will be taken to reduce the potential for additional serious injury and research-related mortality or exceeding authorized take.

b. In addition to the written report, the Permit Holder must contact the Permits Division by phone (301-427-8401) as soon as possible, but no later than within two business days of the incident.

c. The Permits Division may grant authorization to resume permitted activities based on review of the incident report and in consideration of the Terms and Conditions of this permit.

3. Annual reports describing activities conducted during the previous permit year (from July 1 to June 30) must:

a. be submitted by November 1st each year for which the permit is valid, and

b. include a tabular accounting of takes and a narrative description of activities and effects.

4. A final report summarizing activities over the life of the permit must be submitted by (December 31, 2021), or, if the research concludes prior to permit expiration, within 180 days of completion of the research.

5. Research results must be published or otherwise made available to the scientific community in a reasonable period of time. Copies of technical reports, conference abstracts, papers, or publications resulting from permitted research must be submitted the Permits Division.

F. Notification and Coordination

1. The Permit Holder must provide written notification of planned field work to the applicable NMFS Region at least two weeks prior to initiation of each field trip/season. If there will be multiple field trips/seasons in a permit year, a single summary notification may be submitted per year.

a. Notification must include the:

i. locations of the intended field study and/or survey routes;
ii. estimated dates of activities; and

iii. number and roles of participants (for example: PI, CI, veterinarian, boat driver, safety diver, animal restrainer, Research Assistant "in training").

b. Notification must be sent to the following Assistant Regional Administrator for Protected Resources in the location of your activity:

For activities in Washington, Oregon, California, and Antarctic:

West Coast Region, NMFS, 501 West Ocean Blvd., Suite 4200, Long Beach, CA 90802-4213; phone (562) 980-4005; fax (562) 980-4027

E-mail (*preferred*): WCR.research.notification@noaa.gov;

2. To the maximum extent practical, the Permit Holder must coordinate permitted activities with activities of other Permit Holders conducting the same or similar activities on the same species, in the same locations, or at the same times of year to avoid unnecessary disturbance of animals. Contact the Regional Office listed above for information about coordinating with other Permit Holders.

G. Observers and Inspections

1. NMFS may review activities conducted pursuant to this permit. At the request of NMFS, the Permit Holder must cooperate with any such review by:

a. Allowing an employee of NMFS or other person designated by the Director, NMFS Office of Protected Resources to observe permitted activities; and

b. Providing all documents or other information relating to the permitted activities.

H. Modification, Suspension, and Revocation

1. Permits are subject to suspension, revocation, modification, and denial in accordance with the provisions of subpart D [Permit Sanctions and Denials] of 15 CFR part 904.

2. The Director, NMFS Office of Protected Resources may modify, suspend, or revoke this permit in whole or in part:

a. In order to make the permit consistent with a change made after the date of permit issuance with respect to applicable regulation prescribed under section 103 of the MMPA and section 4 of the ESA;

b. In a case in which a violation of the terms and conditions of the permit is found;

c. In response to a written request[8] from the Permit Holder;

d. If NMFS determines that the application or other information pertaining to the permitted activities (including, but not limited to, reports pursuant to Section E of this permit and information provided to NMFS personnel pursuant to Section G of this permit) includes false information; and

e. If NMFS determines that the authorized activities will operate to the disadvantage of threatened or endangered species or are otherwise no longer consistent with the purposes and policy in section 2 of the ESA.

3. Issuance of this permit does not guarantee or imply that NMFS will issue or approve subsequent permits or amendments for the same or similar activities requested by the Permit Holder, including those of a continuing nature.

I. Penalties and Permit Sanctions

1. A person who violates a provision of this permit, the MMPA, ESA, or the regulations at 50 CFR 216 and 50 CFR 222-226 is subject to civil and criminal penalties, permit sanctions, and forfeiture as authorized under the MMPA, ESA, and 15 CFR part 904.

2. The NMFS Office of Protected Resources shall be the sole arbiter of whether a given activity is within the scope and bounds of the authorization granted in this permit.

a. The Permit Holder must contact the Permits Division for verification before conducting the activity if they are unsure whether an activity is within the scope of the permit.

b. Failure to verify, where the NMFS Office of Protected Resources subsequently determines that an activity was outside the scope of the permit, may be used as evidence of a violation of the permit, the MMPA, the ESA, and applicable regulations in any enforcement actions.

[8] *The Permit Holder may request changes to the permit related to: the objectives or purposes of the permitted activities; the species or number of animals taken; and the location, time, or manner of taking or importing protected species. Such requests must be submitted in writing to the Permits Division in the format specified in the application instructions.*

2.4 Mitigation to Minimize or Avoid Exposure

The research project is designed to minimize the potential for stress, pain or suffering. Precautionary measures include:

1. Use of small (5 to 7 m), relatively quiet boats to minimize disturbance. The close-approach vessel propellers are fitted with a preventive cover to ensure no injury if in the remote chance that contact were to occur.
2. Each close approach would last a few minutes, and individuals would not be approached more than three times a day.
3. Close approaches would be conducted slowly, deliberately, and for as short a duration as necessary to tag and photograph the target whale.
4. The Applicant would shut down the source transmissions if the target animal, or any other marine mammal, is observed to be within 200 m of the sound source.
5. The Applicant would cease the approach and select a different target if an animal attempts to avoid the approaching tagging vessel or exhibits a moderate or strong reaction (as classified by Weinrich et al. 1992a).
    - Moderate reaction: animal modified its behavior in a moderately forceful manner (e.g., trumpet blows, hard tail flicks, etc.) but gave no prolonged evidence of behavioral disturbance.
    - Strong reaction: animal modified its behavior to a succession of forceful activities (e.g., continuous surges, tail slashes, numerous trumpet blows, etc.).
6. For tag attachment, the investigators would cease their attempts after three unsuccessful close approaches and select a different target for tagging.
7. The Applicant would attach tags to the whale using suction-cups, which are temporary and non-invasive.
8. The Applicant would disinfect suction cups prior to attachment to avoid possible infection or disease transfer.
9. Tags are designed to dislodge easily via rapid movements in response to irritation.
10. The Applicant would compare the movements and vocal behavior of whales exposed to playbacks versus silent control baseline conditions to establish the minimum exposures necessary to produce detectable responses.
11. The Applicant designed the playbacks to avoid sound levels that could cause hearing damage. The maximum received level of 180 dB would be used for playback signals (after Southall et al. 2007a).
12. The Applicant would limit the exposure of animals to playbacks to the shortest duration required to elicit identifiable behavioral reactions.
13. The Applicant would follow playback subjects after exposure to monitor the whale's return to baseline behavior. They would modify the playback protocol if there is any evidence of longer term changes.
14. The Applicant would add a margin of error for safety to account for the possibility that the acoustic models used to predict received level at the animal are not correct. They

would determine and validate this margin of error by comparing estimated levels to received levels measured during the course of the playback experiments.

15. The Applicant would suspend playbacks if they observe prolonged responses that might pose a risk of injury (e.g., panicked flight toward shallow water). They would contact the Permits Division to develop a protocol which ensures that future playbacks would limit future exposure to levels below those likely to expose animals to any such risk.

2.5 Conservation and Management Efforts

Several conservation and management efforts have been undertaken for listed marine mammals in the action area. Recovery plans under the ESA help guide the protection and conservation of listed species and final plans are in place for the humpback whale (NMFS 1991b) and the blue whale (NMFS 1998c). Recovery plans are in development for the sperm whale (NMFS 2006) and the fin whale (NMFS 1998b). NMFS implements conservation and management activities for these species through its Regional Offices and Fishery Science Centers in cooperation with states, conservation groups, the public, and other federal agencies.

In the Pacific, several conservation measures have been implemented to help reduce entanglements and other threats to marine mammals. These include placing observers aboard driftnet fishing vessels and those engaged in seismic activities. These observers record and monitor any takes of protected species. In addition, the Pacific Offshore Cetacean Reduction Plan has been implemented and, among other measures, requires the use of acoustic pingers to help repel marine mammals from fishing operations.

NMFS, in cooperation with the U.S. Coast Guard and the National Ocean Service's Channel Islands National Marine Sanctuary, has helped implement the broadcasting of speed advisories to vessels in the Santa Barbara Channel when blue whales are present. This effort is intended to lessen the possibility of ship strikes to blue whales, but will benefit other whale species as well.

Various efforts are underway with other Agencies and non-federal entities to monitor and record the status of whale populations. The Structure Levels of Abundance and Status of Humpbacks project is an international effort to understand the population structure of humpback whales in the North Pacific. In the North Atlantic, a similar effort called More North Atlantic Humpbacks project seeks to population size of North Atlantic humpback whales that visit West Indian calving grounds. In addition, the status of other protected whale species is monitored by surveys conducted every three years.

2.6 Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on that action for their justification. *Interdependent* actions are those that do not have independent use, apart from the action under consideration. NMFS determined that there are not interrelated actions outside the scope of this consultation.

3 APPROACH TO THE ASSESSMENT

Section 7 (a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to insure that their actions either are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat.

"To jeopardize the continued existence of an ESA-listed species" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02). The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts on the conservation value of designated critical habitat.

The section 7 assessment involves the following steps:

1. We identify the proposed action and those aspects (or stressors) of the proposed action that are likely to have direct or indirect effects on the physical, chemical, and biotic environment within the action area, including the spatial and temporal extent of those stressors.

2. We identify the ESA-listed species and designated critical habitat that are likely to co-occur with those stressors in space and time.

3. We describe the environmental baseline in the action area including: past and present impacts of Federal, state, or private actions and other human activities in the action area; anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation, impacts of state or private actions that are contemporaneous with the consultation in process.

4. We identify the number, age (or life stage), and gender of ESA-listed individuals that are likely to be exposed to the stressors and the populations or subpopulations to which those individuals belong. This is our exposure analysis.

5. We evaluate the available evidence to determine how those ESA-listed species are likely to respond given their probable exposure. This is our response analyses.

6. We assess the consequences of these responses to the individuals that have been exposed, the populations those individuals represent, and the species those populations comprise. This is our risk analysis.

7. The adverse modification analysis considers the impacts of the proposed action on the critical habitat features and conservation value of designated critical habitat.

8. We describe any cumulative effects of the proposed action in the action area.

Cumulative effects, as defined in our implementing regulations (50 CFR §402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation.

9. We integrate and synthesize the above factors by considering the effects of the action to the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:

    a. Reduce appreciably the likelihood of both survival and recovery of the ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; or

    b. Reduce the conservation value of designated or proposed critical habitat. These assessments are made in full consideration of the status of the species and critical habitat.

10. We state our conclusions regarding jeopardy and the destruction or adverse modification of designated critical habitat.

If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence or recovery of ESA-listed species or destroy or adversely modify designated critical habitat, we must identify a reasonable and prudent alternative (RPA) to the action. The RPA must not be likely to jeopardize the continued existence of ESA-listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements.

3.1 Stressor Identified from the Proposed Action

The SOCAL BRS is part of ongoing and evolving research that has various scientific and technical reports that have been released since its inception in 2010 (Friedlaender et al. 2015; Friedlaender et al. 2016; Goldbogen et al. 2013a; Goldbogen et al. 2013b; 2013c; Goldbogen et al. 2014; Southall 2011; Southall 2016; Southall et al. 2013a; Southall et al. 2013b; Southall et al. 2012a; Southall et al. 2011b; Southall 2012c; Southall 2014; Southall 2015; Southall et al. 2012b). The documents are available at www.socal-brs.org and a few of the documents address specific topics such as blue whale diving acrobatics (Goldbogen et al. 2013a); using accelerometers to examine bioacoustics (Goldbogen et al. 2014); and feeding performance of blue and fin whales on shared prey sources (Friedlaender et al. 2015). Several distinct operational phases have been previously conducted under another permit for SOCAL BRS, during which the Applicant observed, photographed, and tracked thousands of individuals of many marine mammal species. Controlled exposure experiments were performed on focal species. Study equipment and methods were similar throughout, however each subsequent study was modified according to the previous study results (Southall 2012b). Numerous safety protocols including a stranding response plan were implemented in order to ensure the experiments were completed safely without causing harm to the animals being investigated or others in the area. Focal species that have been successfully tagged include: blue whale, fin whale, minke whale (*Balaenoptera acutorostrata*), Risso's dolphin (*Grampus griseus*), Cuvier's beaked whale (*Ziphius cavirostris*), Baird's beaked whale (*Berardius bairdii*), sperm whale, and humpback whale (Southall 2015). During the MFAS experiments in SOCAL 2013, behavioral responses ranged from no observable response to temporary avoidance (Southall 2014).

Stressors for ESA-listed species from the SOCAL BRS include:

- Vessel sound
- Vessel discharge
- Vessel approach and focal follows
- Vessel strike
- Tagging
- Active acoustics (e.g., MFAS, recorded playbacks, and prey mapping)

3.2 Application of the Approach to the Assessment in this Consultation

To comply with our obligation to use the best scientific and commercial data available, we used the information provided by the Permits Division and the Applicant; conducted internet searches for relevant new scientific publications on marine mammal behavioral responses to sound; examined final reports of take from initial phase of this study conducted under the previous permit (i.e., Permit No. 14534) and searched for information on effects of sound on other marine species that may be affected by the proposed action to draw conclusions about the likely risks to the continued existence of these species and the conservation value of their designated critical habitat.

During the consultation, first we reviewed information provided by the Permits Division to describe the action. We also described the action area, which includes all areas affected directly and indirectly by the action.

Second, we evaluated the status of ESA-listed species and designated critical habitat that occur within the action area. We also evaluated the environmental baseline (i.e., past and present anthropogenic impacts within the action area) to determine how species and designated critical habitat are likely to be affected by the action.

Third, we evaluated the direct and indirect effects of the action on ESA-listed species and designated critical habitat. Indirect effects are those that could be caused by the proposed action later in time, but still are reasonably certain to occur. We assessed:

- The exposure to physical, chemical, or biotic stressors produced by the proposed action.
- Whether such exposure is likely to reduce the survival and reproduction of individuals.
- Whether fitness reductions would threaten the viability of populations and species.

- Whether the action is likely to reduce the conservation value of designated critical habitat.

We also evaluated the cumulative effects of non-Federal activities (i.e., state and private) that are reasonably certain to occur within the action area.

For all analyses, we used the best available scientific and commercial data. For this consultation, we relied on:

- information submitted by the Permits Division
- government reports
- past survey reports for similar research activities
- general scientific literature

During the consultation, we conducted electronic searches of the general scientific literature using the following search engines and websites:

- BioOne Abstracts and Indexes
- Google Scholar
- ScienceDirect
- Web of Science
- PubMed
- http://sea-inc.net/socal-brs/

4 Status of ESA-listed Species and Designated Critical Habitat

This section identifies the ESA-listed species that potentially occur within the action area (Table 2) that may be affected by the Applicant's research activities on marine mammals in the waters off of Southern California (Figure 1). It then summarizes the biology and ecology of those species and what is known about their life histories in the action area.

Table 2. Species and designated critical habitat listed under the Endangered Species Act that occur in the action area for the Southern California behavioral response studies.

Species – Population[1]	ESA Status[2]	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Blue Whale (*Balaenoptera musculus)*	E – 35 FR 18319	N/A	07/1998
Fin Whale (*Balaenoptera physalus)*	E – 35 FR 18319	N/A	75 FR 47538 08/2010
Humpback Whale (*Megaptera novaeangliae*) – Mexico DPS, Central America DPS	E – 35 FR 18319 Not at risk T - 80 FR 22304 (Proposed)	N/A	55 FR 29646 11/1991
North Pacific Right Whale (*Eubalaena japonica*)	E – 35 FR 18319 E – 73 FR 12024	71 FR 38277 73 FR 19000	78 FR 34347 06/2013
Gray Whale (*Eschrichtius robustus*) – Western North Pacific population	E – 35 FR 18319 Eastern North Pacific population was delisted in 1994 – 59 FR 31094	N/A	N/A
Sei Whale (*Balaenoptera borealis*)	E – 35 FR 18319	N/A	76 FR 43985 12/2011
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18319	N/A	75 FR 81584 12/2010
Killer Whale (*Orcinus Orca*) – Southern Resident DPS	E -- 70 FR 69903	71 FR 69054	73 FR 4176 11/2006
Marine Mammals – Pinnipeds			
Guadalupe Fur Seal (*Arctocephalus townsendi*)	T – 50 FR 51252	N/A	N/A
Sea Turtles			
Green Turtle (*Chelonia mydas*) – East Pacific DPS	T – 81 FR 20057	63 FR 46693	63 FR 28359 05/1998
Hawksbill Turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 46693	63 FR 28359 05/1998
Leatherback Turtle (*Dermochelys coriacea*)	E – 61 FR 17	44 FR 17710 77 FR 4170	63 FR 28359 05/1998
Loggerhead Turtle (*Caretta caretta*) – North Pacific DPS	E – 76 FR 58868	79 FR 39855 Nesting beaches	63 FR 28359 05/1998
Olive Ridley Turtle (*Lepidochelys olivacea*)	T – 43 FR 32800	N/A	63 FR 28359 05/1998
Fish			
Steelhead Trout (*Oncorhynchus mykiss*) – Southern California DPS	E – 71 FR 834	70 FR 52488	01/2012
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Eastern Pacific DPS	E – 79 FR 38213	N/A	N/A
Marine Invertebrates			
White Abalone (*Haliotis sorenseni*)	E -- 66 FR 29046	66 FR 29046 (Not prudent, no critical habitat designated)	73 FR 62257 10/2008
Black Abalone (*Haliotis cracherodii*)	E -- 74 FR 1937	76 FR 66806	N/A

[1]DPS = distinct population segment, [2]ESA Status: E = endangered species; T = threatened species
N/A = Not available

4.1 Species and Designated Critical Habitat Not Likely to be Adversely Affected

NMFS uses two criteria to identify the ESA-listed or designated critical habitat that are not likely to be adversely affected by the proposed action, as well as the effects of activities that are interrelated to or interdependent with the Federal agency's proposed action. The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If we conclude that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, we must also conclude that the species or designated critical habitat is not likely to be adversely affected by those activities.

The second criterion is the probability of a response given exposure. ESA-listed species or designated critical habitat that is exposed to a potential stressor but is likely to be unaffected by the exposure is also not likely to be adversely affected by the proposed action. We applied these criteria to the ESA-listed species in Table 2 and we summarize our results below.

An action warrants a "may affect, not likely to be adversely affected" finding when its effects are wholly *beneficial, insignificant* or *discountable*. *Beneficial* effects have an immediate positive effect without any adverse effects to the species or habitat. Beneficial effects are usually discussed when the project has a clear link to the ESA-listed species or its specific habitat needs and consultation is required because the species may be affected.

Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but will not rise to the level of constituting an adverse effect. That means the ESA-listed species may be expected to be affected, but not harmed or harassed.

Discountable effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact an ESA-listed species), but it is very unlikely to occur.

4.1.1 North Pacific Right Whale

The likelihood of a North Pacific right whale being present in the action area is highly unlikely as this species has generally just been observed on rare occasions in the Bering Sea and U.S. Gulf of Alaska in recent years, so they are unlikely to be found outside of this particular area. Although individuals may travel south from the high-latitudes to lower-latitudes, animals that have been sighted in waters off British Columbia, Hawaii or tropical Mexico have been considered extralimital for this species (Brownell Jr. et al. 2001). The most recent estimated population for the North Pacific right whale is between 28 to 31 individuals and although this estimate may be reflective of a Bering Sea subpopulation, the total eastern North Pacific population is unlikely to be much larger (Wade et al. 2010). The only recorded sighting of a right whale in the SOCAL BRS action area occurred in March 1992 approximately 70 km (43 mi) off the southern end of San Clemente Island (Carretta et al. 1994). Sightings off California are rare, and there is no evidence that the western coast of the United States was ever highly frequented habitat for this species (Brownell Jr. et al. 2001). We conclude that the proposed activities may affect, but are not likely to adversely affect endangered North Pacific right whale because it is highly unlikely for this species to be present in the action area and the probability of being exposed to stressors capable of eliciting a negative response is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion.

4.1.2 Western North Pacific Gray Whale

Western North Pacific gray whales exhibit extensive plasticity in their occurrence, shifting use areas within and between years, as well as over longer time frames, such as in response to oceanic climate cycles (e.g., El Nino-Southern Oscillation, Pacific Decadal Oscillation, and Arctic Oscillation) (Gardner and Chavez-Rosales 2000; Meier et al. 2007; Tyurneva et al. 2009; Vladimirov et al. 2006a; Vladimirov et al. 2006b; Vladimirov et al. 2005; Vladimirov et al. 2008; Vladimirov et al. 2009; Vladimirov et al. 2010; Weller et al. 2012b; Yablokov and Bogoslovskaya 1984; Yakovlev and Tyurneva 2005). Species distribution extends south along Japan, the Koreas, and China from the Kamchatka Peninsula (IWC 2003; Kato and Kasuya. 2002; Omura 1988; Reeves et al. 2008; Weller et al. 2003). Other possible range states include Vietnam, the Philippines, and Taiwan, although only historical whaling records support occurrence in these areas (Henderson 1990; Ilyashenko 2009). The range has likely contracted from the Koreas and other southern portions of the range versus pre-whaling periods. Prey availability and, to a lesser extent, sea ice extent, are probably strong influences on the habitats used by western North Pacific gray whales (Clarke and Moore 2002; Moore 2000).

Eastern and Western North Pacific gray whales were once considered geographically separated along either side of the ocean basin, but recent photo-identification, genetic, and satellite tracking data refute this. Two western North Pacific gray whales have been satellite tracked from Russian foraging areas east along the Aleutian Islands, through the Gulf of Alaska, and south to the Washington State and Oregon coasts in one case (Mate et al. 2011) and to the southern tip of Baja California and back to Sakhalin Island in another (IWC 2012). Comparisons of eastern and western North Pacific gray whale catalogues have thus far identified 23 western gray whales occurring on the eastern side of the basin during winter and spring (Weller et al. 2013). Of those 23 individuals, only 15 were recorded from far enough south to have passed through the SOCAL BRS action area. Burdin et al. (2011) found an additional individual. During one field season off Vancouver Island, western North Pacific gray whales were found to constitute 6 of 74 (8.1 percent) of photo-identifications (Weller et al. 2012a). In addition, two genetic matches of western gray whales off Santa Barbara, California have been made (Lang et al. 2011). Individuals have also been observed migrating as far as Central Baja Mexico (Weller et al. 2012b).

Group sizes vary, but are roughly two (range one to 14) for non-calf groups and slightly larger for groups containing calves (Weller et al. 2007; Weller et al. 2004; Weller et al. 2006; Weller et al. 1999; Yakovlev and Tyurneva 2004).

The most recent abundance estimate of the western North Pacific gray whale population is 140 individuals (Carretta et al. 2015). The population was believed to be extinct in the 1970's (Bradford et al. 2003). At least 1,700 to 2,000 individuals were commercially harvested from the late 1800's to the mid-20th century (Commission 2004; IWC 2003). Findings that eastern North Pacific gray whales may be found within the range of western North Pacific gray whales may mean that even fewer individuals compose the western population, as individuals formerly believed to be western individuals may actually be part of the eastern population (Lang et al. 2010).

Fortunately, the latest data on population growth indicates a positive trajectory for available data over 1994 through 2007 of roughly 2.5 to 3.2 percent growth per year (Bradford et al. 2008; Cooke et al. 2008; Cooke et al. 2007; Cooke et al. 2006). In 2009, Burdin et al. (2010) reported 26 mature females observed since 1995. Genetic findings have found that although genetic diversity is relatively high in western North Pacific gray whales considering their population size, significant portions of this diversity are retained in a few or single individuals (IWC 2003). Clapham et al. (1999) conducted a review of western North Pacific gray whales, among other endangered whales, and found that this population matches in virtually all characteristics that would make a small population extinction-prone.

No data are available regarding western North Pacific gray whale hearing or communication. We assume that eastern North Pacific gray whale communication is representative of the western population and present information stemming from this population. Individuals produce broadband sounds within the 100 Hz to 12 kHz range (Dahlheim et al. 1984; Jones and Swartz 2002; Thompson et al. 1979b). The most common sounds encountered are on feeding and breeding grounds, where "knocks" of roughly 142 dB re: 1μPa at 1 m (source level) have been recorded (Cummings et al. 1968; Jones and Swartz 2002; Thomson and Richardson 1995a). However, other sounds have also been recorded in Russian foraging areas, including rattles, clicks, chirps, squeaks, snorts, thumps, knocks, bellows, and sharp blasts at frequencies of 400 Hz to 5 kHz (Petrochenko et al. 1991). Estimated source levels for these sounds ranged from 167 to 188 dB re: 1μPa at 1 m (Petrochenko et al. 1991). Low frequency (less than 1.5 kHz) "bangs" and "moans" are most often recorded during migration and during ice-entrapment (Carroll et al. 1989; Crane and Lashkari. 1996). Sounds vary by social context and may be associated with startle responses (Rohrkasse-Charles et al. 2011). Calves exhibit the greatest variation in frequency range used, while adults are narrowest; groups with calves were never silent while in calving grounds (Rohrkasse-Charles et al. 2011). Based upon a single captive calf, moans were more frequent when the calf was less than a year old, but after a year, croaks were the predominant call type (Wisdom et al. 1999).

Auditory structure suggests hearing is attuned to low frequencies (Ketten 1992a; Ketten 1992b). Responses of free-ranging and captive individuals to playbacks in the 160 Hz to 2 kHz range demonstrate the ability of individuals to hear within this range (Buck and Tyack 2000; Cummings and Thompson 1971a; Dahlheim and Ljungblad 1990; Moore and Clark 2002; Wisdom et al. 2001). Responses to low-frequency sounds stemming from oil and gas activities also support low-frequency hearing (Malme et al. 1986; Moore and Clark 2002).

We conclude that the proposed activities may affect, but are not likely to adversely affect endangered Western North Pacific gray whales because it is highly unlikely for this species to be present in the action area and the probability of being exposed to stressors capable of eliciting a negative response is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion.

4.1.3 Southern Resident Killer Whales

Three discrete forms, or ecotypes, of killer whales occur along the Eastern North Pacific Coast of the United States: southern resident, offshore, and transient. Of these, only the southern resident killer whales are listed as under the ESA. Southern resident killer whales primarily occur in the inland waters of Washington State and southern Vancouver Island, although individuals from this population have been observed off the Queen Charlotte Islands (north of their traditional range) and off coastal California in Monterey Bay, near the Farallon Islands, and off Point Reyes (NMFS 2005b).

The Southern Resident DPS is not likely to occur in the action area. Southern Resident killer whales regularly visit coastal sites off Washington State and Vancouver Island (Ford et al. 1994) and in the winter are known to travel as far south as Monterey off central California (Black 2011). It is possible that this species could travel as far south as the action area, but that would only occur during winter months. The proposed activities are not planned to be conducted during winter months.

Photo-identification of individual whales through the years has resulted in a substantial understanding of this stock’s structure, behaviors, and movements in inland waters. The current abundance estimate for this stock is 85 whales (Carretta et al. 2013b).

Killer whales produce a wide variety of clicks, whistles, and pulsed calls (Ford 1989; Schevill and Watkins 1966; Thomsen et al. 2001). Their clicks are relatively broadband, short (0.1 to 25 milliseconds), and range in frequency from 8 to 80 kHz with an average center frequency of 50 kHz and an average bandwidth of 40 kHz (Au et al. 2004). Killer whales apparently use these signals to sense objects in their environment, such as prey; whales foraging on salmon produce these signals at peak-to-peak source levels ranging from 195 to 225 dB re: 1μPa at 1 m (Au et al. 2004).

Killer whale whistles are tonal signals that have longer duration (0.06 to 18 seconds) and frequencies ranging from 0.5 to 10.2 kHz (Thomsen et al. 2001). Killer whales are reported to whistle most often while they have been engaged in social interactions rather than during foraging and traveling (Thomsen et al. 2002). Northern resident killer whales whistles have source levels ranging from 133 to 147 dB re: 1µPa at 1 m (Miller 2006).

Killer whale pulsed calls are the most commonly observed type of signal associated with killer whales (Ford 1989). With both northern and southern resident killer whales, these signals are relatively long (600 to 2,000 ms) and range in frequency between 1 and 10 kHz; but may contain harmonics up to 30 kHz (Ford 1989). The variable calls of killer whales have source levels ranging from 133 to 165 dB while stereotyped calls have source levels ranging from 135 to 168 dB re: 1µPa at 1 m (Miller 2006). Killer whales use these calls when foraging and traveling (Ford 1989).

Southern Resident killer whales are expected mainly to occur far north of the action area during the months that the proposed action would be conducted. We conclude that the proposed activities may affect, but are not likely to adversely affect endangered Southern resident DPS killer whales because the probability of being exposed to stressors is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion.

4.1.4 Sea Turtles

Green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles may be present in the action area during the proposed activities. There is no designated critical habitat adjacent to the action area for any sea turtle species. Studies of green and loggerhead sea turtles demonstrate that these species are sensitive to sounds at low frequencies with a maximum efficiency at about 250 to 700 Hz (Bartol et al. 1999c; Lenhardt et al. 1983; Lenhardt et al. 1985; Ridgeway et al. 1969). Bartol and Ketten (2006) measured the auditory responses of green and Kemp's ridley -a congener of Olive Ridley- sea turtles and found their hearing to be in a similar range of 100 to 500 Hz with their most sensitive hearing between 100 to 200 Hz. While the hearing ability and sensitivity for leatherback and hawksbill sea turtles is largely unknown, these species share a similar auditory anatomy. It is therefore reasonable to assume that they have similar hearing ranges.

4.1.4.1 Green Sea Turtle

East Pacific green turtles appear to prefer waters that usually remain around 20° C in the coldest month. During warm spells (e.g., El Niño), green turtles may be found considerably north of their normal distribution (Stinson (1984a). Further, green turtles seem to occur preferentially in drift lines or surface current convergences, probably because of the prevalence of cover and higher densities of their food items associated with these oceanic phenomena. Underwater resting sites include coral recesses, the underside of ledges, and sand bottom areas that are relatively free of strong currents and disturbance from natural predators and humans. Available information indicates that green turtle resting areas are in proximity to their feeding areas (NMFS and USFWS 1998b).

Green sea turtles are widely distributed in the subtropical coastal waters of southern Baja California, Mexico, and Central America, several hundred kms south of the action area (NMFS and USFWS 1998b). The main group of eastern Pacific Ocean green turtles is found on the breeding grounds of Michoacán, Mexico, from August through January and year-round in the feeding areas, such as those on the western coast of Baja California, along the coast of Oaxaca, and in the Gulf of California (the Sea of Cortez) (NMFS and USFWS 1998b). Bahía de Los Angeles in the Gulf of California has been identified as an important foraging area for green turtles (Seminoff et al. 2003). Eastern Pacific Ocean green turtles have been reported as far north as British Columbia (48.15° North) (Eckert 1993b; NMFS and USFWS 1998b). The western coasts of Central America, Mexico, and the United States constitute a shared habitat for this population (NMFS and USFWS 1998b). The green turtle is not known to nest on Southern California beaches.

In general, turtle sightings in the eastern Pacific Ocean increase during summer as warm water moves northward along the coast (NMFS and USFWS 1998b). Sightings may also be more numerous in warmer years compared to colder years. In waters south of Point Conception, Stinson found this seasonal sighting pattern to be independent of inter-year temperature fluctuations (Stinson 1984a). More sightings occurred during warmer years north of Point Conception. Stinson also reported that more than 60 percent of eastern Pacific Ocean green turtles observed in California were in areas where the water was less than 50 m (165 ft) deep, often observed along shore in areas of eelgrass.

San Diego Bay is home to a resident sub-population of green turtles (Dutton and McDonald 1990; Stinson 1984a). A 20-year monitoring program of these turtles indicates an annual abundance of between 16 and 61 turtles (Eguchi et al. 2010). Eelgrass beds and marine algae are particularly abundant in the southern half of the bay, and green turtles are frequently observed foraging on these items (Dutton et al. 2002). Until December 2010, the southern part of San Diego Bay was warmed by the effluent from the Duke Energy power plant, a fossil fuel power generation facility in operation since 1960. Green sea turtles are known to congregate in this area. The closure of the power plant may impact these resident turtles and alter movement patterns. Ultrasonic tracking studies have shown that green turtles in southern San Diego Bay have relatively small home ranges (Dutton et al. 2002). Between 2009 and 2011, MacDonald et al. (2012) used acoustic telemetry to track 25 green turtles in San Diego Bay. The results of the study suggest that resident turtles likely do not spend much, if any, time foraging in central or northern San Diego Bay, where human activities are greatest (including U.S. Naval activities). A few sea turtles have been observed in northern San Diego Bay, but these are likely transient green turtles that enter the bay in warmer months (MacDonald et al. 2012). Another green turtle population resides in Long Beach, California, although less is known about this population (Eguchi et al. 2010).

Ocean waters off Southern California and northern Baja California are also designated as areas of occurrence because of the presence of rocky ridges and channels and floating kelp habitats suitable for green turtle foraging and resting (Stinson 1984a); however, these waters are often at temperatures below the thermal preferences of this primarily tropical species.

The green sea turtles that use waters off southern California for feeding originate from the endangered breeding population along the Pacific coast of Mexico. Green turtles are thought to be declining throughout the Pacific Ocean, with the exception of Hawaii, as a direct consequence of a historical combination of overexploitation and habitat loss (Eckert 1993a; Seminoff 2004).

Sea turtles do not appear to use sound for communication, and there are no published recordings of green turtle vocalizations. Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 Hz to 2,000 Hz, with a range of maximum sensitivity between 100 Hz and 800 Hz (Bartol et al. 1999b; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Several studies have been conducted to measure green turtle hearing sensitivity, each using a slightly different methodology. Ridgway et al. (1969) studied the auditory evoked potentials of three green turtles (in air and through direct mechanical stimulation of the inner ear) and concluded that their maximum sensitivity occurred from 300 Hz to 400 Hz with rapid declines for tones at lower and higher frequencies. They reported an upper limit for cochlear potentials without injury of 2000 Hz and a practical limit of about 1000 Hz.

Bartol and Ketten (2006) measured auditory brainstem responses (short latency auditory evoked potentials) to aerial tones in partially submerged green turtles and documented hearing between 100 Hz and 800 Hz, with maximum sensitivity between 600 Hz and 700 Hz in Atlantic juvenile greens, and100 Hz and 500 Hz with maximum sensitivity between 200 Hz and 400 Hz in Pacific sub-adult greens (Moein Bartol and Ketten 2006).

Dow Piniak et al. (2012) recorded auditory evoked potential in response to both aerial and underwater acoustic stimuli. Green turtles detected acoustic stimuli in both media, responding to underwater signals between 50 and 1,600 Hz (turtles completely submerged) and aerial signals between 50 and 800 Hz, with maximum sensitivity between 200 and 400 Hz underwater and 300 and 400 Hz in air (Piniak et al. 2012). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994).

We conclude that the proposed activities may affect, but are not likely to adversely affect threatened East Pacific green sea turtles because the probability of being exposed to stressors, such as acoustic playbacks, capable of eliciting a negative response is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion.

4.1.4.2 Hawksbill Turtle

Hawksbill sea turtles occur in tropical and subtropical seas of the Atlantic, Pacific and Indian Oceans. Hawksbill sea turtles occupy different habitats depending on their life history stage. After entering the sea, hawksbill turtles occupy pelagic waters and occupy weed-lines that accumulate at convergence points. When they grow to about 20 to 25 cm (7.9 to 9.8 in) carapace length, hawksbill turtles re-enter coastal waters where they inhabit and forage in coral reefs as juveniles, sub-adults and adults. Hawksbill sea turtles also occur around rocky outcrops and high energy shoals, where sponges grow and provide forage, and they are known to inhabit mangrove-fringed bays and estuaries, particularly along the eastern shore of continents where coral reefs are absent.

Hawksbills are considered the most coastal of the sea turtles that inhabit the action area, with juveniles and adults preferring coral reef habitats (NMFS 2010b). Reefs provide shelter for resting hawksbills day and night, and they are known to visit the same resting spot repeatedly. Hawksbills are also found around rocky outcrops and high-energy shoals—optimum sites for sponge growth—as well as in mangrove-lined bays and estuaries (NMFS and USFWS 2013).

Hatchling and early juvenile hawksbills have also been found in the open ocean, in floating mats of seaweed (Musick and Limpus 1997). Although information about foraging areas is largely unavailable due to research limitations, juvenile and adult hawksbills may also be present in open ocean environments (NMFS and USFWS 2007).

Water temperature in the Southern California region of the action area is generally too low for hawksbills, and they are rare in this region. Nesting is rare in the eastern Pacific Ocean region, and does not occur along the U.S. West Coast (NMFS and USFWS 1998b; Witzell 1983). Stinson (1984b) did not mention the hawksbill turtle in her summary of sea turtle occurrences in eastern north Pacific waters from Baja California to the Gulf of Alaska, and no hawksbill sightings have been confirmed along the U.S. West Coast in recent history (Eckert 1993b; NMFS and USFWS 2007). If hawksbills were to occur in the Southern California region of the action area, it would most likely be during an El Niño event, when waters along the California current are unusually warm.

The eastern Pacific Ocean population may be the most endangered sea turtle population in the world (Gaos et al. 2008). Hawksbills sometimes nest in the southern part of the Baja Peninsula, while juveniles and sub-adults are seen foraging in coastal waters regularly. No nesting occurs on the U.S. West Coast. Hawksbills in the U.S. Pacific region nest only on eastern beaches of the Island of Hawaii (5 to 10 nesting females annually, although 13 were reported in 2011 (Rivers 2011), as well as in the Northwestern Hawaiian Islands (NMFS and USFWS 2013). Hawksbill turtles, like green turtles, are thought to be declining globally as a direct consequence of a historical combination of overexploitation and habitat loss.

Sea turtles do not appear to use sound for communication, and there are no published recordings of hawksbill turtle vocalizations. Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 Hz to 2,000 Hz, with a range of maximum sensitivity between 100 Hz and 800 Hz (Bartol et al. 1999b; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten

2006; Ridgway et al. 1969). Recent research measuring hatchling hawksbill turtle auditory evoked potentials has shown that aerial and underwater acoustic stimuli elicited auditory evoked potential responses between 50 Hz and 1,600 Hz (underwater fully submerged and in air), with maximum sensitivity between 200 Hz and 400 Hz in hatchling hawksbills (Dow Piniak et al. 2011).

Aspects of the designated critical habitat areas that are important for hawksbill sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for hawksbill sea turtle prey. This designated critical habitat does not occur within the action area.

We conclude that the proposed activities may affect, but are not likely to adversely affect endangered hawksbill sea turtles because the probability of being exposed to stressors, such as acoustic playbacks, capable of eliciting a negative response is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion.

4.1.4.3 Leatherback Turtle

Leatherback turtles are found on the western and eastern coasts of the Pacific Ocean, with nesting aggregations in Mexico and Costa Rica (eastern Pacific) and Malaysia, Indonesia, Australia, the Solomon Islands, Papua New Guinea, Thailand, and Fiji (western Pacific). In the Atlantic Ocean, leatherback nesting aggregations have been documented in Gabon, Sao Tome and Principe, French Guiana, Suriname, and Florida.

Leatherback turtles are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Eckert and Eckert 1988; Eckert 1999; Morreale et al. 1994). In a single year, a leatherback may swim more than 10,000 km (Eckert 1998). Pacific leatherbacks have been found in waters ranging from 7 to 27.2° C and have the most extensive range of any living reptile. Sighting reports have come from all pelagic waters of the Pacific between 71° North and 47° South latitude and in all other major pelagic ocean habitats (NMFS and USFWS 1998a). Leatherback turtles lead a completely pelagic existence, foraging widely in temperate waters except during the nesting season, when gravid females return to tropical beaches to lay eggs. Males are rarely observed near nesting areas, and it has been hypothesized that leatherback turtles probably mate outside of tropical waters, before females swim to their nesting beaches (Eckert and Eckert 1988).

In the eastern North Pacific Ocean, leatherback turtles are broadly distributed from the tropics to as far north as Alaska, where 19 occurrences were documented between 1960 and 2001 (Eckert 1993a; Eckert 1993b; Hodge and Wing 2000). Stinson (Stinson 1984a) concluded that the leatherback was the most common sea turtle in U.S. waters north of Mexico. Aerial surveys off California, Oregon, and Washington indicate that most leatherbacks occur in waters over the continental slope, with a few beyond the continental shelf (Eckert 1993a). While the leatherback is known to occur throughout the California Current Large Marine Ecosystem, it is not known to nest anywhere along the U.S. Pacific Ocean coast. In general, turtle sightings increase during summer, as warm water moves northward along the coast (Stinson 1984a). Sightings may also be more numerous in warm years than in cold years.

Leatherback turtles are regularly seen off the U.S. West Coast, with the greatest densities found off central California. Off central California, sea surface temperatures are highest during the summer and fall, and oceanographic conditions create favorable habitat for leatherback turtle prey (jellyfish). This higher density area is to the north and generally outside of the action area.

Throughout the Pacific, leatherbacks are seriously declining at all major nesting beaches (NMFS USFWS 2013). Leatherback sea turtles appear to be in a critical state of decline in the North Pacific Ocean. The leatherback population that nests along the Pacific Ocean was estimated to be over 91,000 adults in 1980 (Spotila et al. 1996) or greater than 39,000 nests (NMFS and USFWS 2013), but is now estimated to number 3,172 total nests (NMFS and USFWS 2013). Leatherback turtles have experienced major declines at all major Pacific basin rookeries.

In the Pacific Ocean, leatherback turtles are endangered as a direct consequence of a historical combination of overexploitation and habitat loss. The information available suggests that leatherback turtles have high probabilities of becoming extinct in the Pacific Ocean unless they are protected from the combined threats of entanglements in fishing gear, overharvests, and loss of their nesting habitat. The limited data available suggests that leatherback turtles exist at population sizes small enough to be classified as “small” populations (that is, populations that exhibit population dynamics that increase the extinction probabilities of the species or several of its populations) as evidenced by biases in the male to female ratios in the Pacific. The status of leatherback turtles in the Atlantic Ocean appears to be stable (NMFS and USFWS 2013).

The designated critical habitat is essential for nesting, which has been increasingly threatened since 1979, when tourism increased significantly, bringing nesting habitat and people into close and frequent proximity. On January 26, 2012, the NMFS designated critical habitat for leatherback sea turtles in waters along Washington State and Oregon (Cape Flattery to Cape Blanco; 64,760 km^2) and California (Point Arena to Point Arguello; 43,798 km^2). The essential features of these areas includes the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (*Chrysaora, Aurelia*, *Phacellophora*, and *Cyanea*), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks.

The SOCAL BRS activities are not expected to alter or reduce the occurrence of prey species of the leatherback turtle. The study’s associated stressors are not likely to exclude leatherback turtles from designated critical habitat or alter the essential features of the critical habitat.

We conclude that the proposed activities may affect, but are not likely to adversely affect endangered leatherback sea turtles because the probability of being exposed to stressors, such as acoustic playbacks, capable of eliciting a negative response is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion.

4.1.4.4 Loggerhead Turtle

Loggerheads are circumglobal, inhabiting continental shelves, bays, estuaries, and lagoons in temperate, subtropical, and tropical waters. Major nesting grounds are generally located in temperate and subtropical regions, with scattered nesting in the tropics (NMFS and USFWS 1998c).

Loggerhead nesting is confined to lower latitudes, concentrated in temperate zones and subtropics; the species generally does not nest in tropical areas (NMFS and USFWS 1991; NRC 1990; Witherington et al. 2006). Loggerhead turtles travel to northern waters during spring and summer as water temperatures warm, and southward and offshore toward warmer waters in fall and winter; loggerheads are noted to occur year round in offshore waters of sufficient temperature.

Under the ESA, loggerhead sea turtles are divided into nine distinct population segments: the threatened Northwest Atlantic Ocean DPS, South Atlantic Ocean DPS, Southeast Indo-Pacific Ocean DPS, and Southwest Indian Ocean DPS, and the endangered Northeast Atlantic Ocean DPS, Mediterranean Sea DPS, North Indian Ocean DPS, North Pacific Ocean DPS, and South Pacific Ocean DPS. Only individuals from the North Pacific Ocean DPS are likely to occur in the action area. Within the DPS, the population structure of loggerhead turtles is usually based on the distribution of their nesting aggregations. In the Pacific Ocean, loggerhead turtles have nesting aggregations in Japan (Hatase et al. 2002), Australia (Great Barrier Reef and Queensland), New Caledonia, New Zealand, Indonesia, and Papua New Guinea. One of the largest loggerhead nesting aggregations in the world is found in Oman, in the Indian Ocean.

The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560 (Spotila 2004). All loggerheads inhabiting the North Pacific Ocean are derived primarily, if not entirely, from Japanese beaches (although low level nesting may occur in areas around the South China Sea) (Chan et al. 2007). Available evidence indicates that due to loss of adult and juvenile mortalities from fishery bycatch and, to a lesser degree the loss of nesting habitat, the North Pacific loggerhead population is declining.

In addition, loggerheads uncommonly occur in U.S. Pacific waters, and there were no documented strandings of loggerheads on the Hawaiian Islands in the 20 years from 1982 to 1999 (stranding data).. Overall, Gilman (2009) estimated that the number of loggerheads nesting the Pacific has declined by 80 percent in the past 20 years.

Two studies have been conducted to measure loggerhead turtle hearing sensitivity, each using a slightly different methodology. Vibratory stimuli delivered directly to the tympanun produced auditory brainstem responses in loggerheads between 250 Hz and 750 Hz (Bartol et al. 1999a). Underwater tones elicited behavioral responses to frequencies between 50 and 800 Hz and auditory evoked potential responses between 100 Hz and 1,131 Hz in one adult loggerhead (Martin et al. 2012). The lowest threshold recorded in this study was 98 dB re: 1µPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerheads responded to sounds in the range of 50 Hz to 800 Hz while juveniles responded to sounds in the range of 50 Hz to 1,000 Hz. Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

We conclude that the proposed activities may affect, but are not likely to adversely affect endangered North Pacific loggerhead sea turtles because the probability of being exposed to stressors, such as acoustic playbacks, capable of eliciting a negative response is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion.

4.1.4.5 Olive Ridley Turtle

In the eastern Pacific Ocean, olive ridley turtles are found from the Galapagos Islands north to California. While Pacific ridley turtles have a generally tropical to subtropical range, individual turtles have been reported as far as the U.S. Gulf of Alaska (Hodge and Wing 2000).

Olive ridley turtles nest along continental margins and oceanic islands. The second most important nesting area occurs in the eastern Pacific along the West Coast of Mexico and Central America. Most records of olive ridley turtles are from protected, relative shallow marine waters. Nevertheless, olive ridley turtles have also been observed in the open ocean. Since olive ridley turtles throughout the eastern Pacific Ocean depend on rich upwelling areas off South America for food, Pacific ridley turtles sighted offshore may have been foraging.

Sea turtles do not appear to use sound for communication, and there are no published recordings of olive ridley turtle vocalizations. There is no information on olive ridley turtle hearing. However, we assume that their hearing sensitivities will be similar to those of green, hawksbill, leatherback and loggerhead turtles: their best hearing sensitivity will be in the low frequency range, with maximum sensitivity below 400 Hz and an upper hearing range not likely to exceed 2,000 Hz. Olive ridley sea turtle critical habitat has not been designated.

We conclude that the proposed activities may affect, but are not likely to adversely affect endangered Eastern Pacific olive ridley sea turtles because the probability of being exposed to stressors, such as acoustic playbacks, capable of eliciting a negative response is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion.

4.1.5 Marine and Anadromous Fish

Pacific salmon (*Oncorhynchus* spp.) and green sturgeon (*Acipenser medirostris*) may occur in the action area. However, because of the small sizes, slow operating speeds and maneuverability of the boats proposed to be used, the proposed activities should not negatively impact any ESA-listed fish species from vessel operation activities.

Proposed audio playback and prey survey activities are unlikely to affect ESA-listed fish species because the frequencies used in these activities are over an order of magnitude higher than the optimal hearing range for many anadromous fish (Hawkins and Johnstone 1978). The proposed activities are therefore not likely to adversely affect ESA-listed fish species. These species are therefore not considered in this consultation.

4.1.5.1 Southern California Steelhead Trout and its Designated Critical Habitat

Steelhead trout (*Oncorhynchus mykiss*) tend to move immediately offshore on entering the marine environment, although, in general, steelhead tend to remain closer to shore than other Pacific salmon species (Beamish et al. 2005). They generally remain within the coastal waters of the California Current (Beamish et al. 2005). The ocean distributions for listed steelhead are not known in detail, but steelhead are caught only rarely in ocean salmon fisheries. Studies suggest that steelhead do not generally congregate in large schools as do other Pacific salmon species (Burgner et al. 1992; Groot et al. 1991).

Popper (2003) and Hastings and Popper (2005) presented evidence that establishes that most fish only detect sounds within the 1 to 3 kHz range, which would make them sensitive to the lower end of the frequency range of mid-frequency active sonar. The U.S. Navy's Biological Evaluation for the Northwest Training Range Complex (Navy 2008a; Navy 2008b) provided a thorough review of the information available on the probable responses of endangered and threatened fish to active sonar. We have extracted most of the narratives that follow from that review, although we have made a few corrections and clarifications and supplemented the analyses with a few additional studies.

Jørgensen et al. (2005) exposed fish larvae and juveniles representing four species (of three families) to sounds that were designed to simulate mid-frequency sonar transmissions (1 to 6.5 kHz) to study the effects of the exposure on the survival, development, and behavior of the larvae and juveniles (the study used larvae and juveniles of Atlantic herring (*Clupea harengus*) Atlantic cod (*Gadus morhua*), saithe (*Pollachius virens),* and spotted wolffish (*Anarhichas minor*). The researchers placed the fish in plastic bags three meters from the sound source and exposed them to between four and 100 pulses of one-second duration of pure tones at 1.5, 4, and 6.5 kHz. The fish in only two groups out of the 42 tested exhibited adverse effects beyond a behavioral response. These two groups were both composed of herring, a hearing specialist, and were tested with sound pressure levels of 189 dB re: 1µPa, which resulted in a post-exposure mortality of 20 to 30 percent. In the remaining 40 tests, there were no observed effects on behavior, growth (length and weight), or the survival of fish that were kept as long as 34 days post exposure. While statistically significant losses were documented in the two groups impacted, the researchers only tested that particular sound level once, so it is not known if this increased mortality was due to the level of the test signal or to other unknown factors. (Halvorsen et al. 2012) exposed rainbow trout to simulated MFA (2.8 to 3.8 kHz) sonar at received sound pressure levels of 210 dB re: 1uPa, resulting in cumulative sound exposure levels of 220 dB re: 1uPa. The authors did not observe any mortality or hearing sensitivity changes in rainbow trout and suggested that the frequency range of MFA sonar may be above the most sensitive hearing range of the species. Similarly, Kane et al. (2010) found that low-and mid-frequency exposure caused no acute, gross or histopathology, nor any mortality to rainbow trout, a close relative to the steelhead.

Hastings et al. (1996) studied the effects of low frequency underwater sound on fish hearing. The authors exposed a teleost fish (*Astronotus ocellatus*) to sound of varying frequencies (60 or 300 Hz), duty cycles (20 percent or continuous), and intensity (100, 400, or 180 dB re: 1uPa). The only treatment where the authors observed some limited damage to sensory hair cells was with one hour of continuous exposure at 300 Hz and 180 dB re: 1uPa, but this result was inconsistent. The authors recommended caution if attempting to extrapolate these result to other species or other sound sources, and also suggested that damage would be even more limited with shorter term stimulation or if fish were free to leave the site of stimulation. More recently, Popper et al. (2008; 2007; Popper and Hastings 2009) investigated the effects of exposing several fish species to the U.S. Navy's low frequency active sonar (LFAS), focusing on the hearing and on non-auditory tissues. Their study exposed the fish to LFAS pulses for time intervals that would be substantially longer than what would occur in nature, but the fish did not experience mortalities or damage to body tissues at the gross or histological level. Some fish experienced temporary losses in their hearing sensitivity but they recovered within several days of exposure.

Behavioral reactions of steelhead to non-impulsive acoustic sources could include temporary disruption or alteration of natural activities such as swimming, schooling, feeding, and migrating. Gearin et al. (2000) studied the effects of exposing fish to sounds produced by acoustic deterrent devices, which produce sounds in the mid frequency range. Adult sockeye salmon exhibited an initial startle response to the placement of inactive acoustic alarms but resumed their normal swimming pattern within ten to 15 seconds. After 30 seconds, the fish approached the inactive alarm to within 30 cm (1 ft). When the experiment was conducted with an alarm active, the fish exhibited the same initial startle response from the insertion of the alarm into the tank; but were swimming within 30 cm of the active alarm within 30 seconds. After five minutes, the fish did not show any reaction or behavior change except for the initial startle response. In contrast, Doksaeter et al. (2009) observed no significant escape reactions from herring (*Clupea harengus*) in response to mid-frequency sonar transmissions. Based on the studies discussed above, if Southern California steelhead were exposed non-impulsive acoustic stressors (i.e., sonar), we would not expect this to result in direct mortality or injury. Behavioral disruptions could occur, but we would expect these impacts to be temporary and for individuals to resume normal activity shortly after exposure. We do not expect temporary behavioral reactions (e.g., cessation of feeding) to impact individual fitness as individuals would resume feeding upon cessation of the sound exposure and unconsumed prey would still be available in the environment.

Sounds from U.S. Navy and research vessels is also not expected to impact Southern California steelhead as available evidence does not suggest that ship sound can injure or kill a fish (Popper et al. 2014). Further, we would expect the species to engage in avoidance behavior if vessels are moving in their direction. Misund (1997) found that fish ahead of a ship, that showed avoidance reactions, did so at ranges of 48.8 to 149.4 m (160 to 490 ft). When the vessel passed over them, some species of fish responded with sudden escape responses that included lateral avoidance or downward compression of the school. We do not expect temporary behavioral reactions (e.g., temporary cessation of feeding) to impact individual fitness as individuals will resume feeding upon cessation of the sound exposure and unconsumed prey will still be available in the environment.

In summary, the information available suggests extremely low abundance of Southern California steelhead in the action area. The only fish observed in a watershed that drains into the action area were in San Mateo Creek in 2002. Additionally, watersheds further north have very low documented abundance, with surveys indicating annual returns of less than 10 fish. Southern California steelhead eggs, fry, or juveniles still in freshwater habitats will not be exposed to behavioral response research activities. Due to the low number of ESA-listed steelhead that are expected to occur over the relatively large action area, the infrequent and intermittent nature of the research activities, and the proximity in which a steelhead in the marine environment would need to be located in order to be negatively effected by those activities, we conclude that these activities may affect, but are not likely to adversely affect endangered steelhead in the Southern California Evolutionary Significant Unit (ESU) because the probability of being exposed to stressors capable of eliciting a negative response is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion.

A total of 1,139 km (708 miles) of stream habitat was designated as critical habitat from the 32 watersheds within the range of this ESU. Designated critical habitat for the Southern California Steelhead ESU includes most, but not all, occupied habitat from the Santa Maria River in southern San Luis Obispo County to San Mateo Creek in northern San Diego County, but excludes some occupied habitat based on economic considerations and all military lands with occupied habitat. Critical habitat was not designated for most of the watersheds south of Malibu Creek with the exception of San Juan Creek and San Mateo Creek.

The critical habitat designation specifically excluded military areas, which includes the SOCAL BRS action area, for Southern California steelhead and the proposed activities would not occur in freshwater areas or affect the essential features for steelhead. Therefore, the activities the

Applicant proposes to conduct in the SOCAL BRS action area will not affect the designated critical habitat for Southern California steelhead. As a result, we will not consider Southern California steelhead designated critical habitat in the remainder of this opinion.

The proposed activities may occur within the designated critical habitat of the ESA-listed steelhead trout. The areas designated for this species includes multiple riverine and nearshore marine areas along the U.S. West Coast[9]. The essential features for Pacific salmon species include adequate spawning sites, food resources, water quality and quantity and riparian vegetation. The proposed activities involve audio playbacks and vessel based survey and monitoring activities. No effects are expected to spawning sites, food resources, water quality and quantity and riparian vegetation. These actions should therefore have no effect on any ESA-listed species' essential features and therefore have no effect on the conservation value of any species' designated critical habitat.

We conclude that the proposed activities may affect, but are not likely to adversely affect endangered Southern California DPS of steelhead trout and not effect its designated critical habitat because the probability of being exposed to stressors capable of eliciting a negative response is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion.

4.1.5.2 Scalloped Hammerhead Shark

Unless otherwise noted, the information presented below was obtained from the Status Review Report for the Scalloped Hammerhead Shark (Miller et al. 2014).

The scalloped hammerhead shark can be found in coastal warm temperate and tropical seas worldwide. In the eastern Pacific the scalloped hammerhead can be found from southern California to Peru, including the Gulf of California. The SOCAL BRS action area overlaps with the extreme northern-most extent of the Eastern Pacific DPS of the scalloped hammerhead shark's range.

Scalloped hammerhead sharks are highly mobile and partly migratory. Migration is common along continental margins and between oceanic islands in tropical waters. Adult migratory movements are generally less than 200 km (108 nmi), but this species is also capable of moving much greater distances up to approximately 2,000 km (1,080 nmi). Juvenile movements are likely much shorter. Juveniles and adults occur as solitary individuals, pairs, or in schools, and there is evidence of site fidelity to known hot spots. A population of scalloped hammerhead sharks in the Gulf of California is known to school during the day and forage greater distances for food at night (Klimley and Nelson 1984). Based on the observation of 19 juveniles in 1997, it

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[9] *See for details: http://www.nmfs.noaa.gov/pr/species/criticalhabitat.htm*

has been suggested the southern San Diego Bay may serve as a pupping ground and warm water refuge during warm water years (Lea and Rosenblatt 2000, Shane 2001), although NMFS would require further substantiation of this claim before identifying San Diego Bay as a pupping ground or nursery for this species.

Scalloped hammerhead sharks, like all fish, have an inner ear capable of detecting higher frequency sounds and a lateral line capable of detecting water motion caused by low frequencies (Hastings and Popper 2005; Popper and Schilt 2009). Data for cartilaginous fish suggest detection of sounds from 20 to 1000 Hz, with the highest sensitivity to sounds at the lower ranges (Casper et al. 2003; Casper and Mann 2006). Scalloped hammerhead sharks lack a swim bladder which likely decreases their ability to detect or be affected by sound and explosive shockwaves (Young 1991).

The waters of the Pacific Ocean off the coast of southern California are relatively cold and rarely approach 22° C, which is likely why the SOCAL BRS action area barely overlaps the known range for scalloped hammerhead sharks. Only 23 specimens have been verifiably recorded from southern California and 19 of those specimens were juveniles collected during a single extremely warm El Niño event in 1997 when sea water temperatures were 3 to 4° C above normal. An analysis of hourly ocean temperature data averaged over each month from October 2013 through September 2014 indicates the months of June, July, August, and September had mean monthly temperatures of 20.2, 21.1, 21.8, and 20.8° C, respectively.

It is expected that water temperatures within the SOCAL BRS waters will not exceed 22° C except during extreme weather events such as the 1997 El Niño. Although climate change may lead to warmer Pacific temperatures off the coast of southern California, it is not expected to raise the temperature 3 to 4° C within the foreseeable future because the heat buffering capacity of water will likely cause ocean temperatures to rise at a slower pace than global air and land temperatures. Global air temperatures are expected to rise by less than 4.8 °C while global ocean temperatures within 100 m of the ocean's surface are expected to rise by less than 2.0° C by the year 2100 (IPCC 2013).

The scalloped hammerhead shark is primarily a shallow water, coastal species. Research activities primarily occur during the day when this species is more likely to be closer to shore. This suggests the co-occurrence of these activities with this species is unlikely even in the rare event water temperatures are sufficiently warm within the action area to support the species. Also, the activities are expected to occur over a relatively large action area, the infrequent and intermittent nature of the research activities, and the proximity in which a scalloped hammerhead shark in the marine environment would need to be located in order to be negatively effected by those activities, we conclude that these activities may affect, but are not likely to adversely affect endangered scalloped hammer head sharks in the eastern Pacific DPS because the probability of being exposed to stressors capable of eliciting a negative response is sufficiently low as to be discountable.

We conclude that the proposed activities may affect, but are not likely to adversely affect endangered scalloped hammerhead sharks in the eastern Pacific DPS because the probability of being exposed to stressors capable of eliciting a negative response is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion.

4.1.6 Marine Invertebrates

ESA-listed white and black abalone (*Haliotis* spp.) may occur in the action area. Because of the small sizes and the corresponding low draft and maneuverability of the vessels proposed to be used, the proposed activities should not adversely affect the benthic habitat where these species are found. The proposed audio playback and prey mapping activities are also not likely to adversely affect ESA-listed invertebrate species and the probability of being exposed to stressors capable of eliciting a negative response is sufficiently low as to be discountable.

We conclude that the proposed activities may affect, but are not likely to adversely affect endangered black abalone because the SOCAL BRS will be conducted in offshore waters and the probability of being exposed to stressors capable of eliciting a negative response is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion. Similarly, we do not expect essential features associated with black abalone designated critical habitat to be destroyed or adversely modified and do not consider black abalone designated critical habitat further in this opinion.

We conclude that the proposed activities may affect, but are not likely to adversely affect endangered white abalone because the probability of occurring in the action area and being exposed to stressors capable of eliciting a negative response is sufficiently low as to be discountable. Therefore, this species will not be considered in greater detail in the remainder of this opinion.

4.2 Species and Designated Critical Habitat Likely to be Adversely Affected

This opinion examines the status of each species that would be affected by the proposed action. The status is determined by the level of risk that the ESA-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the Federal Register, status reviews, recovery plans, and on these NMFS websites: http://www.nmfs.noaa.gov/pr/species/index.htm.

The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

4.2.1 Blue Whale

The blue whale is a cosmopolitan species of baleen whale. It is the largest animal ever known to have lived on Earth: adults in the Antarctic have reached a maximum body length of about 33 m (108 ft) and can weigh more than 150,000 kg (330,700 lbs). The largest blue whales reported from the North Pacific are a female that measured 26.8 m (88 ft) taken at Port Hobron in 1932 (Reeves et al. 1985) and a 27.1 m (89 ft) female taken by Japanese pelagic whaling operations in 1959 (NMFS 1998d).

As is true of other baleen whale species, female blue whales are somewhat larger than males. Blue whales are identified by the following characteristics: a long-body and comparatively slender shape; a broad, flat "rostrum" when viewed from above; a proportionately smaller dorsal fin than other baleen whales; and a mottled gray color pattern that appears light blue when seen through the water.

Distribution

Blue whales inhabit all oceans and typically occur near the coast, over the continental shelf, although they are also found in oceanic waters. Blue whales are highly mobile, and their migratory patterns are not well known (Perry et al. 1999a; Reeves et al. 2004). Blue whales migrate toward the warmer waters of the subtropics in the fall to reduce energy costs, avoid ice entrapment, and reproduce (NMFS 1998a).

In the North Pacific Ocean, blue whales have been recorded off the island of Oahu in the main Hawaiian Islands and off Midway Island in the western edge of the Hawaiian Archipelago (Barlow 2006; Northrop et al. 1971; Thompson and Friedl 1982b), although blue whales are rarely sighted in Hawaiian waters and have not been reported to strand in the Hawaiian Islands.

The West Coast of North America is known to be a feeding area for this species during summer and fall (Carretta et al. 2010a). This species has frequently been observed in waters off Southern California (Carretta et al. 2010a; Navy 2011). Photographs of blue whales in California have been matched to individuals photographed off the Queen Charlotte Islands in northern British Columbia and the northern Gulf of Alaska (Calambokidis et al. 2009a). Three blue whale high-use areas occur during the summer along the coast of California near the western part of the Channel Islands, near the Gulf of Farallones, and at the northern part of Cape Mendocino (Irvine et al. 2014), although each of these areas are north of the action area. In the Southern California Bight, the highest densities of blue whales occurred along the 200-m isobath in waters with high surface chlorophyll concentrations (Redfern et al. 2013), although blue whale visual sightings and acoustic detections can occur across the entire Bight (Navy 2012; Navy 2013).

Blue whales observed in the spring, summer, and fall off California, Washington, and British Columbia are known to be part of a group that returns to feeding areas off British Columbia and Alaska (Calambokidis and Barlow 2004; Calambokidis et al. 2009b; Gregr et al. 2000; Mate et al. 1999; Moore et al. 2002; Stafford et al. 1999). These animals have shown site fidelity, returning to their mother's feeding grounds on their first migration (Calambokidis and Barlow 2004). Blue whales off the coast of California typically depart from near-shore U.S. Exclusive Economic Zone waters from mid-October to mid-November (Irvine et al. 2014). They are known to migrate to waters off Mexico and as far as the Costa Rica Dome (Calambokidis and Barlow 2004; Calambokidis et al. 2009b). Winter migration movements south along the Baja California, Mexico coast to the Costa Rica Dome indicate that the Costa Rica Dome may be a calving and breeding area (Mate et al. 1999). Blue whales belonging to the western Pacific stock may feed in summer, south of the Aleutians and in the Gulf of Alaska, and migrate to wintering grounds in lower latitudes in the western Pacific and central Pacific, including Hawaii (Stafford et al. 2004; Watkins et al. 2000a; Watkins et al. 2000b; Watkins et al. 2000c).

Blue whales in the eastern Pacific winter from California south (Carretta et al. 2013a); in the western Pacific, they winter from the Sea of Japan, the East China and Yellow Seas, and the Philippine Sea. Blue whales occur in summer foraging areas in the Chukchi Sea, the Sea of Okhotsk, around the Aleutian Islands, and the Gulf of Alaska. Nishiwaki (1966) reported that blue whales occur in the Aleutian Islands and in the Gulf of Alaska. An array of hydrophones, deployed in October 1999, detected two blue whale call types in the Gulf of Alaska (Stafford 2003). Fifteen blue whale sightings off British Columbia and in the Gulf of Alaska have been made since 1997 (Calambokidis et al. 2009a). Three of these photographically verified sightings were in the northern Gulf of Alaska within 131.5 km (71 nmi) of each other and were less than 185.2 km (100 nmi) offshore (Calambokidis et al. 2009a).

Population Structure

For this and all subsequent species, the term "population" refers to groups of individuals whose patterns of increase or decrease in abundance over time are determined by internal dynamics (births resulting from sexual interactions between individuals in the group and deaths of those individuals) rather than external dynamics (immigration or emigration). This definition is a reformulation of definitions articulated by Futuymda (1986) and Wells and Richmond (1995) and is more restrictive than those uses of 'population' that refer to groups of individuals that co-occur in space and time but do not have internal dynamics that determine whether the size of the group increases or decreases over time (see review by Wells and Richmond 1995). The definition we apply is important to section 7 consultations because such concepts as 'population decline,' 'population collapse,' 'population extinction,' and 'population recovery' apply to the restrictive definition of 'population' but do not explicitly apply to alternative definitions. As a result, we do not treat the different whale "stocks" recognized by the International Whaling Commission (IWC) or other authorities as populations unless those distinctions were clearly based on demographic criteria. We do, however, acknowledge those "stock" distinctions in these narratives.

At least three subspecies of blue whales have been identified based on body size and geographic distribution (*B. musculus intermedia*, which occurs in the higher latitudes of the Southern Oceans, *B. m. musculus*, which occurs in the Northern Hemisphere, and *B. m. brevicauda* which occurs in the mid-latitude waters of the southern Indian Ocean and north of the Antarctic convergence), but this consultation will treat them as a single entity. Readers who are interested in these subspecies will find more information in Gilpatrick et al. (1997), Kato et al. (1995), Omura et al. (1970), and Ichihara (1966).

In addition to these subspecies, the IWC's Scientific Committee has formally recognized one blue whale population in the North Pacific (Donovan 1991), although there is increasing evidence that there may be more than one blue whale population in the Pacific Ocean (Gilpatrick et al. (1997), Barlow et al. (1995), Mizroch et al. (1984a), Ohsumi and Wada (1972)). For example, studies of the blue whales that winter off Baja California and in the Gulf of California suggest that these whales are morphologically distinct from blue whales of the western and central North Pacific (Gilpatrick et al. 1997), although these differences might result from differences in the productivity of their foraging areas more than genetic differences (Barlow et al. 1997b; Calambokidis et al. 1990; Sears 1987). A population of blue whales that has distinct vocalizations inhabits the northeast Pacific from the Gulf of Alaska to waters off Central America (Gregr et al. 2000; Mate et al. 1998; Stafford 2003).

Natural Threats

Natural causes of mortality in blue whales are largely unknown, but probably include predation and disease (not necessarily in order of importance). Blue whales are known to become infected with the nematode *Carricauda boopis* (Baylis 1928), which are believed to have caused fin whales to die as a result of renal failure (Lambertsen 1986b); (see additional discussion under Fin whales). Killer whales and sharks are also known to attack, injure, and kill very young or sick fin and humpback whales and probably hunt blue whales as well (Perry et al. 1999a).

Anthropogenic Threats

Two human activities are known to threaten blue whales; whaling and shipping. Historically, whaling represented the greatest threat to every population of blue whales and was ultimately responsible for listing blue whales as an endangered species. As early as the mid-seventeenth century, the Japanese were capturing blue, fin, and other large whales using a fairly primitive open-water netting technique (Tonnessen and Johnsen 1982). In 1864, explosive harpoons and steam-powered catcher boats were introduced in Norway, allowing the large-scale exploitation of previously unobtainable whale species.

From 1889 to 1965, whalers killed about 5,761 blue whales in the North Pacific Ocean (Hill et al. 1999). Comparitively, (Monnahan et al. 2014b) estimates 3,411 (95 percent confidence interval (CI): 2,593 to 4,114) and 6,362 (95 percent CI: 5,659 to 7,180) blue whales were caught from 1905 to 1971 from the eastern North Pacific population and western North Pacific population, respectively. From 1915 to 1965, the number of blue whales captured declined continuously (Mizroch et al. 1984a). Evidence of a population decline was seen in the catch data from Japan. In 1912, whalers captured 236 blue whales; in 1913, 58 blue whales; in 1914, 123 blue whales; from 1915 to 1965, the number of blue whales captured declined continuously (Mizroch et al. 1984a). In the eastern North Pacific, whalers killed 239 blue whales off the California coast in 1926. And, in the late 1950s and early 1960s, Japanese whalers killed 70 blue whales per year off the Aleutian Islands (Mizroch et al. 1984a).

Although the IWC banned commercial whaling in the North Pacific in 1966, Soviet whaling fleets continued to hunt blue whales in the North Pacific for several years after the ban. Surveys conducted in these former-whaling areas in the 1980s and 1990s failed to find any blue whales (Forney and Brownell Jr. 1996). By 1967, Soviet scientists wrote that blue whales in the North Pacific Ocean (including the eastern Bering Sea and Prince William Sound) had been so overharvested by Soviet whaling fleets that some scientists concluded that any additional harvests were certain to cause the species to become extinct in the North Pacific (Latishev 2007). Although whaling reduced blue whales to a fraction of their historic population size, whaling currently does not threaten blue whale populations.

Shipping is considered one of the primary threats to blue whales. Studies have shown that blue whales respond to approaching ships in a variety of ways, depending on the behavior of the animals at the time of approach, and speed and direction of the approaching vessel. While feeding, blue whales react less rapidly and with less obvious avoidance behavior than whales that are not feeding (Sears 1983). In 1980, 1986, 1987, and 1993, ship strikes were implicated in the deaths of blue whales off California (Barlow 1997a). More recently, Berman-Kowalewski et al. (2010) reported that between 1988 and 2007, 21 blue whale deaths were reported along the California coast, typically one or two cases annually. In addition, several photo-identified blue whales from California waters were observed with large scars on their dorsal areas that may have been caused by ship strikes. In 2007, NMFS declared an Unusual Mortality Event for endangered blue whales in Southern California as a result of commercial vessel ship strikes in that year. Available data from NMFS indicate that in waters off California between 1991 and 2010, there were 14 ship strikes involving blue whales (NMFS Southwest Region Stranding Database 2011). Of these, three occurred in the same waters as the action area, of which two were from commercial/research ships and one from U.S. Navy. Of the 14 blue whale strikes in California, 79 percent were in water north of the action area. Although commercial fisheries using large gill nets or other large set gears poses some entanglement risk to marine mammals, there is little direct evidence of blue whale mortality from fishing gears. Therefore it is difficult to estimate the numbers of blue whales killed or injured by gear entanglements. The offshore drift gillnet fishery is the only fishery that is likely to take blue whales from this stock, but no fishery mortalities or serious injuries have been observed. In addition, the injury or mortality of large whales due to interactions or entanglements in fisheries may go unobserved because large whales swim away with a portion of the net or gear. Fishermen have reported that large whales tend to swim through their nets without becoming entangled and cause little damage to nets (Carretta et al. 2008b).

Status and Trends

It is difficult to assess the current status of blue whales globally because (1) there is no general agreement on the size of the blue whale population prior to whaling and (2) estimates of the current size of the different blue whale populations vary widely. We may never know the size of the blue whale population in the North Pacific prior to whaling, although some authors have concluded that their population numbered about 200,000 animals before whaling. Similarly, estimates of the global abundance of blue whales are uncertain. Since the cessation of whaling, the global population of blue whales has been estimated to range from 11,200 to 13,000 animals (Maser et al. 1981b). These estimates, however, are more than 20 years old.

Monnahan et al. (2014b) calculated a pre-whaling abundance of 2,210 (95 percent confidence interval [CI]: 1,823 to 3,721) for the eastern North Pacific population of blue whales. The current best available abundance estimate for the eastern North Pacific population of blue whales that occur off California, Oregon, and Washington is 2,138 (95 percent CI: 1,7774 to 2,584 (Fallis et al. 1983; Monnahan et al. 2014b). Blue whale density estimates vary annually and by season. The average density of blue whales off the coast of southern California between 2004 and 2013 was 0.07, 0.07, 3.01, and 0.56 individuals per 1,000 square kilometres (km^2) in the winter, spring, summer, and fall, respectively (Campbell et al. 2014). The overall annual average density of blue whales off the coast of southern California over this time period was 0.91 individuals per km^2 (Campbell et al. 2014). There was a documented increase in the blue whale population size between 1979 and 1994, but there has not been evidence to suggest an increase in the population since then (Barlow 1994; Barlow and Taylor 2001; Carretta et al. 2010b) (Monnahan et al. 2014a). In 2008, Cascadia Research conducted photographic identification surveys to make abundance estimates of blue whales along the U.S. West Coast. The results reflect an upward trend in abundance of blue whales along the U.S. West Coast, although their numbers are highly variable off California, most likely due to the variability of its use as a feeding area (Calambokidis et al. 2009b). Given the current abundance of blue whales compared to pre-whaling conditions, the cessation of whaling in the eastern North Pacific, and the minimal impact ship strikes are having on population growth/sustenance, Monnahan et al. (2014a) suggest the eastern North Pacific blue whale population is at carrying capacity and recovered[10]. Blue whales have been observed during aerial monitoring in Southern California (Navy 2013). A vast majority of blue whales in the SOCAL BRS action area are from the eastern North Pacific population (Monnahan et al. 2014b).

[10] *Monnahan et al. (2014) defined recovery as when the population is above it's maximum net productivity, or 60 percent of it's carrying capacity.*

The information available on the status and trend of blue whales do not allow us to reach any conclusions about the extinction risks facing blue whales as a species, or particular populations of blue whales. The possible exception is the eastern North Pacific blue whale population which many not have been subject to as much commercial whaling as other blue whale populations and which may be recovering to a stable population level since the cessation of commercial whaling in 1971 (Campbell et al. 2015; Monnahan et al. 2014b). With the limited data available on other blue whale populations, we do not know whether these whales exist at population sizes large enough to avoid demographic phenomena that are known to increase the extinction probability of species that exist as “small” populations (that is, “small” populations experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their population size to become a threat in and of itself), or if blue whales are threatened more by exogenous threats such as anthropogenic activities (primarily whaling and ship strikes) or natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate).

Diving and Social Behavior

Blue whales spend more than 94 percent of their time underwater (Lagerquist et al. 2000). Generally, blue whales dive five to 20 times at 12 to 20 second intervals before a deep dive of 3 to 30 minutes (Croll et al. 1999a; Leatherwood et al. 1976; Maser et al. 1981b; Yochem and Leatherwood 1985). Average foraging dives are 140 m (459 ft) deep and last for 7.8 minutes (Croll et al. 2001a). Non-foraging dives are shallower and shorter, averaging 68 m (223 ft) and 4.9 minutes (Croll et al. 2001a). However, dives of up to 300 m (984 ft) are known (Calambokidis et al. 2003). Nighttime dives are generally shallower (50 m [164 ft]).

Blue whales occur singly or in groups of two or three (Aguayo 1974; Mackintosh 1965; Nemoto 1964; Pike and Macaskie 1969; Ruud 1956; Slijper 1962). However, larger foraging aggregations, even with other species such as fin whales, are regularly reported (Corkeron et al. 1999; Fiedler et al. 1998; Schoenherr 1991; Shirihai 2002). Little is known of the mating behavior of blue whales. The primary and preferred diet of blue whales is krill (euphausiids).

Satellite tagging indicates that, for blue whales tagged off Southern California, movement is more linear and faster (3.7 km/hour) while traveling versus while foraging (1.7 km/hour) (Bailey et al. 2009). Residency times in what are likely prey patches averages 21 days and constituted 29 percent of an individual’s time overall, although foraging could apparently occur at any time of year for tagged individuals (Bailey et al. 2009). Broad scale movements also varied greatly, likely in response to oceanographic conditions influencing prey abundance and distribution (Bailey et al. 2009). Blue whales along Southern California were found to be traveling 85 percent of the time and milling 11 percent (Bacon et al. 2011). While feeding, blue whales show slowed and less obvious avoidance behavior then when not feeding (Sears et al. 1983 as cited in NMFS 2005a). In review of a 24-year blue whale sighting history, Sears et al. (Sears et al. 2013) documented a link between female blue whales sighted in the Gulf of California and the U.S. West Coast, although the authors suggest that only some of the U.S. West Coast blue whales migrate to the Gulf of California.

Vocalization and Hearing

Blue whales produce prolonged low-frequency vocalizations that include moans in the range from 12.5 to 400 Hz, with dominant frequencies from 16 to 25 Hz, and songs that span frequencies from 16 to 60 Hz that last up to 36 seconds repeated every one to two minutes (see McDonald et al. 1995). Berchok et al. (2006a) examined vocalizations of St. Lawrence blue whales and found mean peak frequencies ranging from 17.0 to 78.7 Hz. Reported source levels are 180 to 188 dB re: 1µPa, but may reach 195 dB re: 1µPa (Aburto et al. 1997b; Clark and Gagnon 2004; Ketten 1998; McDonald et al. 2001a). Samaran et al. (2010) estimated Antarctic blue whale calls in the Indian Ocean at 179 ± 5 dB re: $1\mu Pa_{rms}$ -1 m in the 17 to 30 Hz range and pygmy blue whale calls at 175± 1 dB re: 1µPa -1 m in the 17 to 50 Hz range.

As with other baleen whale vocalizations, blue whale vocalization function is unknown, although numerous hypotheses exist (maintaining spacing between individuals, recognition, socialization, navigation, contextual information transmission, and location of prey resources) (Edds-Walton 1997; Payne and Webb. 1971; Thompson et al. 1992). Intense bouts of long, patterned sounds are common from fall through spring in low latitudes, but these also occur less frequently while in summer high-latitude feeding areas. Short, rapid sequences of 30 to 90 Hz calls are associated with socialization and may be displays by males based upon call seasonality and structure. The low-frequency sounds produced by blue whales can, in theory, travel long distances, and it is possible that such long-distance communication occurs (Edds-Walton 1997; Payne and Webb. 1971). The long-range sounds may also be used for echolocation in orientation or navigation (Tyack 1999).

Cetaceans have an auditory anatomy that follows the basic mammalian pattern, with some modifications to adapt to the demands of hearing in the sea. The typical mammalian ear is divided into the outer ear, middle ear, and inner ear. The outer ear is separated from the inner ear by the tympanic membrane, or eardrum. In terrestrial mammals, the outer ear, eardrum, and middle ear function to transmit airborne sound to the inner ear, where the sound is detected in a fluid. Since cetaceans already live in a fluid medium, they do not require this matching, and thus do not have an air-filled external ear canal. The inner ear is where sound energy is converted into neural signals that are transmitted to the central nervous system via the auditory nerve. Acoustic energy causes the basilar membrane in the cochlea to vibrate. Sensory cells at different positions along the basilar membrane are excited by different frequencies of sound (Tyack 1999). Baleen whales have inner ears that appear to be specialized for low-frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing.

Blue whale vocalizations tend to be long (greater than 20 seconds), low-frequency (less than 100 Hz) signals (Thomson and Richardson 1995a), with a range of 12 to 400 Hz and dominant energy in the infrasonic range of 12 to 25 Hz (Ketten 1998; McDonald et al. 2001b; Mellinger and Clark 2003). Vocalizations are predominantly of two types – songs and calls. Blue whale calls have high acoustic energy, with reports of 186 to 188 dB re: 1μPa-m (Cummings and Thompson 1971b; McDonald et al. 2001b) and 195 dB re: 1μPa-m (Aburto et al. 1997a) source levels. Calls are short-duration sounds (2 to 5 seconds) that are transient and frequency-modulated, having a higher frequency range and shorter duration than song units and often sweeping down in frequency (80 to 30Hz), with seasonally variable occurrence.

Blue whale songs consist of repetitively patterned sounds produced over time spans of minutes to hours, or even days (Cummings and Thompson 1971b; McDonald et al. 2001b). The songs are divided into two components – pulsed/tonal units, which are continuous segments of sound, and phrases, which are repeated combinations of one to five units (Mellinger and Clark 2003; Payne and McVay 1971). A song is composed of many repeated phrases. Songs can be detected for hundreds, and even thousands of kms (Stafford et al. 1998), and have only been attributed to males (McDonald et al. 2001b; Oleson et al. 2007a). Worldwide, songs are showing a downward shift in frequency (Mcdonald et al. 2009). For example, a comparison of recordings from November 2003 and November 1964 and 1965 reveals a long-term shift in the frequency of blue whale calling near San Nicolas Island. In 2003, the spectral energy peak was 16 Hz compared to approximately 22.5 Hz in 1964 and 1965, illustrating a more than 30 percent shift in call frequency over four decades (McDonald et al. 2006). McDonald et al. (2009) observed a 31 percent downward frequency shift in blue whale calls off the coast of California, and also noted lower frequencies in seven of the world’s ten known blue whale songs originating in the Atlantic, Pacific, Southern, and Indian Oceans. Many possible explanations for the shifts exist, but none have emerged as the probable cause.

Although general characteristics of blue whale calls are shared in distinct regions (McDonald et al. 2001b; Mellinger and Clark 2003; Rankin et al. 2005; Thompson et al. 1996), some variability appears to exist among different geographic areas (Rivers 1997). Sounds in the North Atlantic have been confirmed to have different characteristics (i.e., frequency, duration, and repetition) than those recorded in other parts of the world (Berchok et al. 2006b; Mellinger and Clark 2003). Clear differences in call structure suggestive of separate populations for the western and eastern regions of the North Pacific have also been reported (Stafford et al. 2001); however, some overlap in calls from these geographically distinct regions have been observed, indicating that the whales may have the ability to mimic calls (Stafford and Moore 2005).

In Southern California, blues whales produce two predominant call types: Type B and D. B-calls are stereotypic of the blue whale population found in the eastern North Pacific (McDonald et al. 2006) and are produced exclusively by males and associated with mating behavior (Oleson et al. 2007a). These calls have long durations (20 seconds) and low frequencies (10 to 100 Hz); they are produced either as repetitive sequences (song) or as singular calls. The B call has a set of harmonic tonals, and may be paired with a pulsed type A call. Blue whale D calls are down-swept in frequency (100 to 40 Hz) with duration of several seconds. These calls are similar worldwide and are associated with feeding animals; they may be produced as call- counter call between multiple animals (Oleson et al. 2007b). In the Southern California region, D calls are produced in highest numbers during the late spring and early summer, and in diminished numbers during the fall, when A-B song dominates blue whale calling (Hildebrand et al. 2011; Hildebrand et al. 2012; Oleson et al. 2007c).

Calling rates of blue whales tend to vary based on feeding behavior. Stafford et al. (2005) recorded the highest calling rates when blue whale prey was closest to the surface during its vertical migration. Wiggins et al. (2005) reported the same trend of reduced vocalization during daytime foraging followed by an increase at dusk as prey moved up into the water column and dispersed. Blue whales make seasonal migrations to areas of high productivity to feed, and vocalize less at the feeding grounds than during migration (Burtenshaw et al. 2004). Oleson et al. (2007c) reported higher calling rates in shallow diving (less than 100 ft) whales, while deeper diving whales (greater than 165 ft) were likely feeding and calling less.

Direct studies of blue whale hearing have not been conducted, but it is assumed that blue whales can hear the same frequencies that they produce (low-frequency) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995c). Based on vocalizations and anatomy, blue whales are assumed to predominantly hear low-frequency sounds below 400 Hz (Croll et al. 2001b; Oleson et al. 2007c; Stafford and Moore 2005), although an audiogram of blue whale hearing thresholds suggests hearing may predominantly occur over a wider range of approximately 100 Hz to 10 kHz (Ketten 2014). In terms of functional hearing capability, blue whales belong to the low-frequency group, which have a hearing range of 7 Hz to 22 kHz (Southall et al. 2007a).

Nevertheless, recent studies indicate that blue whales can hear and respond to sounds in the mid-frequency range. Nineteen controlled exposure experiments were conducted on blue whales during the SOCAL BRS 2010 (Southall et al. 2011b) and 13 in the SOCAL BRS 2011 (Southall 2012a). Both controlled exposure experiments simulated exposure to U.S. Navy MFAS. Behavioral response was observed in some blue whales and consisted primarily of small changes in dive behavior and general avoidance of the sound source. Preliminary assessments showed behavior appearing to return to baseline shortly after the transmissions ended, however, it is possible that the changes observed were a direct response to the transmission or some other unknown or un-analyzed factors (Southall 2012a). During other controlled exposure experiments, blue whales responded to a mid-frequency sound source, with a source level between 160 to 210 dB re: 1µPa at 1 m and a received sound level up to 160 dB re: 1µPa, by exhibiting generalized avoidance responses and changes to dive behavior (Goldbogen et al. 2013c). However, reactions were temporary and were not consistent across individuals based on received sound levels alone. Results were likely the result of a complex interaction between sound exposure factors such as proximity to sound source and sound type (mid-frequency sonar simulation vs. pseudo-random sound), environmental conditions, and behavioral state. Surface feeding whales did not show a change in behavior during controlled exposure experiments, but deep feeding and non-feeding whales showed temporary reactions that often quickly abated after sound exposure. Distances of the sound source from the whales during controlled exposure experiments were sometimes less than a mile. Melcón et al. (2012) tested whether MFAS and other anthropogenic sounds in the mid-frequency band affected the "D-calls" produced by blue whales in the Southern California Bight. The likelihood of an animal calling decreased with the increased received level of mid-frequency sonar, beginning at a sound pressure level of approximately 110 to 120 dB re: 1µPa. It is not known whether the lower rates of calling actually indicated a reduction in feeding behavior or social contact since the study used data from remotely deployed, PAM buoys.

Critical Habitat

Blue whale critical habitat has not been designated.

4.2.2 Fin Whale

The fin whale is a cosmopolitan species of baleen whale (Gambell 1985b). Fin whales are the second-largest whale species by length. Fin whales are long-bodied and slender, with a prominent dorsal fin set about two-thirds of the way back on the body. The streamlined appearance can change during feeding when the pleated throat and chest area becomes distended by the influx of prey and seawater, giving the animal a tadpole-like appearance. The basic body color of the fin whale is dark gray dorsally and white ventrally, but the pigmentation pattern is complex. The lower jaw is gray or black on the left side and creamy white on the right side. This asymmetrical coloration extends to the baleen plates as well, and is reversed on the tongue. Individually distinctive features of pigmentation, along with dorsal fin shapes and body scars, have been used in photo-identification studies (Agler et al. 1990). Fin whales live 70 to 80 years (Kjeld 1982). Fin whales can be found in social groups of two to seven whales.

Distribution

Fin whales are distributed widely in every ocean except the Arctic Ocean. In the North Atlantic Ocean, fin whales occur in summer foraging areas from the coast of North America to the Arctic, around Greenland, Iceland, northern Norway, Jan Meyen, Spitzbergen, and the Barents Sea. In the western Atlantic, they winter from the edge of sea ice south to the U.S. Gulf of Mexico and the West Indies. In the eastern Atlantic, they winter from southern Norway, the Bay of Biscay, and Spain with some whales migrating into the Mediterranean Sea (Gambell 1985b).

In the Southern Hemisphere, fin whales are distributed broadly south of 50° South in the summer and migrate into the Atlantic, Indian, and Pacific Oceans in the winter, along the coast of South

America (as far north as Peru and Brazil), Africa, and the islands in Oceania north of Australia and New Zealand (Gambell 1985b).

Fin whales undertake migrations from low-latitude winter grounds to high-latitude summer grounds and extensive longitudinal movements both within and between years (Mizroch et al. 1999a). Fin whales are sparsely distributed during November through April, from 60° North, south to the northern edge of the tropics, where mating and calving may take place (Mizroch et al. 1999a). However, fin whales have been sighted as far as 60° North throughout winter (Mizroch et al. 1999b). A resident fin whale population may exist in the Gulf of California (Tershy et al. 1993).

Fin whales are observed year-round off central and southern California with peak numbers in the summer and fall (Barlow 1997a; Campbell et al. 2015; Dohl et al. 1983; Forney et al. 1995a). Peak numbers are seen during the summer off Oregon, and in summer and fall in the Gulf of Alaska and southeastern Bering Sea (Moore et al. 2000; Perry et al. 1999a). Fin whales are observed feeding in Hawaiian waters during mid-May, and their sounds have been recorded there during the autumn and winter (Balcomb 1987; Northrop et al. 1968b; Shallenberger 1981b; Thompson and Friedl 1982a). They have been recorded at Nihoa and other areas of the Northwest Hawaiian Islands in the winter and spring months (Meigs et al. 2013). Fin whales in the western Pacific winter in the Sea of Japan, the East China, Yellow, and Philippine seas (Gambell 1985a). November 2008 surveys by the Marine Mammal Research Consultants within the Southern California portion of the action area resulted in the sighting of 22 fin whales. U.S. Navy sponsored monitoring in the SOCAL Range Complex in recent years also recorded the presence of fin whales (Navy 2011; Navy 2012; Navy 2013). (Falcone and Schorr 2014) (2014) provide further evidence based on Southern California visual sighting records, photographic identification matches, and satellite tagging from 2006 to 2013 for a Southern California permanent or semi-permanent resident population of fin whales displaying seasonal distribution shifts within the region. Moore and Barlow (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." Fin whales have been observed during aerial monitoring in Southern California (Navy 2010; Navy 2012). Additionally, several fin whales were tagged during the SOCAL BRS (Southall et al. 2011a).

The distribution of fin whales in the Pacific during the summer includes the northern area of the Hawaii portion of the action area to 32° North off the coast of California (Barlow 1995; Forney et al. 1995b). Fin whales are relatively abundant in north Pacific offshore waters (Berzin and Vladimirov 1981; Mizroch et al. 2009). Acoustic signals that may be attributed to the fin whale have also been detected in the Transit Corridor portion of the action area (Northrop et al. 1968a; Watkins et al. 2000b). Fin whales have been recorded in the eastern tropical Pacific (Ferguson 2005) and are frequently sighted there during offshore ship surveys. Fin whales were detected acoustically and visually sighted year-round within the SOCAL Range Complex from 2008 to

2013 (Navy 2011; Navy 2012; Navy 2013). It is unclear if this represents a distinct fin whale sub-population with semi-permanent status in the region, or is reflective of frequent transit by fin whales in general through and within Southern California.

Locations of breeding and calving grounds for the fin whale are unknown, but it is known that the whales typically migrate seasonally to higher latitudes every year to feed and migrate to lower latitudes to breed (Kjeld et al. 2006; Macleod et al. 2006). The fin whale's ability to adapt to areas of high productivity controls migratory patterns (Canese et al. 2006; Reeves et al. 2002). Fin whales are one of the fastest cetaceans, capable of attaining speeds of 40.2 km (25 miles) per hour (Jefferson et al. 2008; Marini et al. 1996).

In the North Pacific Ocean, fin whales occur in summer foraging areas in the Chukchi Sea, the Sea of Okhotsk, around the Aleutian Islands, and the Gulf of Alaska; in the eastern Pacific, they occur south to California; in the western Pacific, they occur south to Japan. Fin whales in the eastern Pacific winter from California south; in the western Pacific, they winter from the Sea of Japan, the East China and Yellow Seas, and the Philippine Sea (Gambell 1985b). The overall distribution may be based on prey availability. Fin whales are larger and faster than humpback and right whales and are less concentrated in nearshore environments.

Population Structure

Fin whales have two recognized subspecies: *Balaoptera physalus physalus* occurs in the North Atlantic Ocean while *B. p. quoyi* (Fischer 1829) occurs in the Southern Ocean. A third possible subspecies occurs off South America (Gray 1865; Van Waerebeek and Engblom 2007) (Archer et al. 2013). Globally, fin whales are sub-divided into three major groups: Atlantic, Pacific, and Antarctic. Within these major areas, different organizations use different population structure.

In the North Pacific Ocean, the IWC recognizes two "stocks": (1) East China Sea and (2) rest of the North Pacific (Donovan 1991). However, Mizroch et al. (1984a) concluded that there were five possible "stocks" of fin whales within the North Pacific based on histological analyses and tagging experiments: (1) East and West Pacific that intermingle around the Aleutian Islands; (2) East China Sea; (3) British Columbia; (4) Southern-Central California to U.S. Gulf of Alaska; and (5) Gulf of California. Based on genetic analyses, Berube et al. (1998) concluded that fin whales in the Sea of Cortez represent an isolated population that has very little genetic exchange with other populations in the North Pacific Ocean (although the geographic distribution of this population and other populations can overlap seasonally). They also concluded that fin whales in the Gulf of St. Lawrence and U.S. Gulf of Maine are distinct from fin whales found off Spain and in the Mediterranean Sea.

Regardless of how different authors structure the fin whale population, mark-recapture studies have demonstrated that individual fin whales migrate between management units (Mitchell 1974a; Sigurjonsson et al. 1989), which suggests that these management units are not geographically isolated populations.

Mizroch et al. (1984a) identified five fin whale "feeding aggregations" in the Pacific Ocean: (1) an eastern group that move along the Aleutians, (2) a western group that move along the Aleutians (Berzin and Rovnin 1966; Nasu 1974); (3) an East China Sea group; (4) a group that moves north and south along the West Coast of North America between California and the U.S. Gulf of Alaska (Rice 1974); and (5) a group centered in the Sea of Cortez (Gulf of California).

Hatch (2004) reported that fin whale vocalizations among five regions of the eastern North Pacific were heterogeneous: the U.S. Gulf of Alaska, the northeast North Pacific (Washington and British Columbia), the southeast North Pacific (California and northern Baja California), the Gulf of California, and the eastern tropical Pacific.

Fin whales also appear to migrate to waters offshore of Washington, Oregon, and northern California to forage. Most fin whales that occur in the action area for this consultation appear to migrate between summer foraging areas and winter rearing areas along the Pacific Coast of the United States, although Moore et al. (1998) recorded fin whale vocalizations in waters off Washington and Oregon throughout the year, with concentrations between September and February, which demonstrates that fin whales are likely to occur in the action area throughout the year. Naval-sponsored PAM along Southern California found year-round vocalization detections from 2009 through 2012 (Navy 2013). Fin whales along Southern California were found to be traveling 87 percent of the time and milling five percent in groups that averaged 1.7 individuals (Bacon et al. 2011).

Natural Threats

Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987b) suggested annual natural mortality rates might range from 0.04 to 0.06 for northeast Atlantic fin whales. The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure and may be preventing some fin whale populations from recovering (Lambertsen 1983). Adult fin whales engage in flight responses (up to 40 km/h) to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Killer whale or shark attacks may also result in serious injury or death in very young and sick individuals (Perry et al. 1999a).

Anthropogenic Threats

Fin whales have undergone significant exploitation, but are currently protected under the IWC. Fin whales are still hunted in subsistence fisheries off West Greenland. In 2004, five males and six females were killed, and two other fin whales were struck and lost. In 2003, two males and four females were landed and two others were struck and lost (IWC 2005). Between 2003 and 2007, the IWC set a catch limit of up to 19 fin whales in this subsistence fishery. However, the scientific recommendation was to limit the number killed to four individuals until accurate populations could be produced (IWC 2005). The Japanese whalers planned to kill 50 whales per year starting in the 2007 to 2008 season and continuing for the next 12 years (IWC 2006; Nishiwaki et al. 2006).

Fin whales experience significant injury and mortality from fishing gear and ship strikes (Carretta et al. 2007; Douglas et al. 2008; Lien 1994; Perkins and Beamish 1979; Waring et al. 2007). Between 1969 and 1990, 14 fin whales were captured in coastal fisheries off Newfoundland and Labrador; of these seven are known to have died because of capture (Lien 1994; Perkins and Beamish 1979). In 1999, one fin whale was reported killed in the U.S. Gulf of Alaska pollock trawl fishery and one was killed the same year in the offshore drift gillnet fishery (Angliss and Outlaw 2005b; Carretta and Chivers. 2004). According to Waring et al. (2007), four fin whales in the western North Atlantic died or were seriously injured in fishing gear, while another five were killed or injured as a result of ship strikes between January 2000 and December 2004.

Jensen and Silber's (2004) review of the NMFS's ship strike database revealed fin whales as the most frequently confirmed victims of ship strikes (26 percent of the recorded ship strikes [n = 75/292 records]), with most collisions occurring off the east coast, followed by the West Coast of the U.S. and Alaska/Hawai'i. Between 1999 and 2005, there were 15 reports of fin whales strikes by vessels along the U.S. and Canadian Atlantic coasts (Cole et al. 2005; Nelson et al. 2007). Of these, 13 were confirmed, resulting in the deaths of 11 individuals. Five of seven fin whales stranded along Washington State and Oregon showed evidence of ship strike with incidence increasing since 2002 (Douglas et al. 2008). Similarly, 2.4 percent of living fin whales from the Mediterranean show ship strike injury and 16 percent of stranded individuals were killed by vessel collision (Panigada et al. 2006). There are also numerous reports of ship strikes off the Atlantic coasts of France and England (Jensen and Silber 2004).

Management measures aimed at reducing the risk of ships hitting right whales should also reduce the risk of collisions with fin whales. In the Bay of Fundy, recommendations for slower vessel speeds to avoid right whale ship strike appear to be largely ignored (Vanderlaan et al. 2008). However, new rules for seasonal (June through December) slowing of vessel traffic to 10 knots and changing shipping lanes by less than one nautical mile to avoid the greatest concentrations of right whales are predicted to be capable of reducing ship strike mortality by 27 percent in the Bay of Fundy region.

The organochlorines dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyltrichloroethane (DDT), and polychlorinated biphenyls (PCB) have been identified from fin whale blubber, but levels are lower than in toothed whales due to the lower level in the food chain that fin whales feed at (Aguilar and Borrell 1988; Borrell 1993; Borrell and Aguilar 1987; Henry and Best 1983; Marsili and Focardi 1996). Females contained lower burdens than males, likely due to mobilization of contaminants during pregnancy and lactation (Aguilar and Borrell 1988; Gauthier et al. 1997). Contaminant levels increase steadily with age until sexual maturity, at which time levels begin to drop in females and continue to increase in males (Aguilar and Borrell 1988).

Climate change also presents a threat to fin whales, particularly in the Mediterranean Sea, where fin whales appear to rely exclusively upon northern krill as a prey source. These krill occupy the southern extent of their range and increases in water temperature could result in their decline and that of fin whales in the Mediterranean Sea (Gambaiani et al. 2009).

Status and Trends

Although fin whale population structure remains unclear, various abundance estimates are available. Pre-exploitation fin whale abundance is estimated at 464,000 individuals worldwide; the estimate for 1991 was roughly 25 percent of this (Braham 1991b). Historically, worldwide populations were severely depleted by commercial whaling, with more than 700,000 whales harvested in the twentieth century (Cherfas 1989). The most recent abundance estimates for fin whales that we are aware of are 16,625 individuals in the North Pacific Ocean and 119,000 individuals worldwide (Braham 1991b). Fin whales of the north Pacific appear to be increasing in abundance although the trend is unclear or declining throughout the rest of their range (NMFS 2011).

Based on ecological theory and demographic patterns derived from several hundred imperilled species and populations, fin whales appear to exist at population sizes that are large enough to avoid demographic phenomena that are known to increase the extinction probability of species that exist as “small” populations (that is, “small” populations experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their population size to become a threat in and of itself). As a result, we assume that fin whales are likely to be threatened more by exogenous threats such as anthropogenic activities (primarily whaling, entanglement, and ship strikes) or natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate) than endogenous threats caused by the small size of their population.

Diving and Social Behavior

The amount of time fin whales spend at the surface varies. Some authors have reported that fin whales make 5 to 20 shallow dives, each of 13 to 20 seconds duration, followed by a deep dive of 1.5 to 15 minutes (Gambell 1985b; Lafortuna et al. 2003; Stone et al. 1992). Other authors have reported that the fin whale’s most common dives last two to six minutes (Hain et al. 1992; Watkins 1981b). The most recent data support average dives of 98 m and 6.3 minutes for foraging fin whales, while non-foraging dives are 59 m and 4.2 minutes (Croll et al. 2001a). However, Lafortuna et al. (1999) found that foraging fin whales have a higher blow rate than when traveling. Foraging dives in excess of 150 m (492 ft) are known (Panigada et al. 1999). In waters off the U.S. Atlantic Coast, individuals or duos represented about 75 percent of sightings during the Cetacean and Turtle Assessment Program (Hain et al. 1992).

Individuals or groups of less than five individuals represented about 90 percent of the observations. Barlow (2003) reported mean group sizes of 1.1 to 4.0 during surveys off California, Oregon, and Washington.

Vocalization and Hearing

Fin whales produce a variety of low-frequency sounds in the 10 Hz to 200 Hz range (Edds 1988; Thompson et al. 1992; Watkins 1981a; Watkins et al. 1987a). Typical vocalizations are long, patterned pulses of short duration (0.5 to 2 seconds) in the 18 Hz to 35 Hz range, but only males are known to produce these (Clark et al. 2002; Patterson and Hamilton 1964). Richardson et al. (1995c) reported the most common sound as a one second vocalization of about 20 Hz, occurring in short series during spring, summer, and fall, and in repeated stereotyped patterns in winter. Au (2000) reported moans of 14 Hz to 118 Hz, with a dominant frequency of 20 Hz, tonal vocalizations of 34 Hz 150 Hz, and songs of 17 Hz to 25 Hz (Cummings and Thompson 1994; Edds 1988; Watkins 1981a). Source levels for fin whale vocalizations are 140 to 200 dB re: 1μPa-m (see also Clark and Gagnon 2004; as compiled by Erbe 2002b). The source depth of calling fin whales has been reported to be about 50 m (Watkins et al. 1987a).

Although their function is still in doubt, low-frequency fin whale vocalizations travel over long distances and may aid in long-distance communication (Edds-Walton 1997; Payne and Webb. 1971). During the breeding season, fin whales produce pulses in a regular repeating pattern, which have been proposed to be mating displays similar to those of humpbacks (Croll et al. 2002). These vocal bouts last for a day or longer (Tyack 1999).

The inner ear is where sound energy is converted into neural signals that are transmitted to the central nervous system via the auditory nerve. Acoustic energy causes the basilar membrane in the cochlea to vibrate. Sensory cells at different positions along the basilar membrane are excited by different frequencies of sound (Tyack 1999). Baleen whales have inner ears that appear to be specialized for low-frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing. In a study using computer tomography scans of a calf fin whale skull, Cranford and Krysl (2015) found sensitivity to a broad range of frequencies between 10 Hz and 12 kHz and a maximum sensitivity to sounds in the 1 to 2 kHz range.

Direct studies of fin whale hearing have not been conducted, but it is assumed that fin whales can hear the same frequencies that they produce (low) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995c).

Fin whales produce a variety of low frequency (less than 1 kHz) sounds, but the most typically recorded is a 20 Hz pulse lasting about one second, and reaching source levels of 189 ± 4 dB re: 1μPam (Charif et al. 2002; Clark et al. 2002; Edds 1988; Richardson et al. 1995c; Sirovic et al. 2007; Watkins 1981a; Watkins et al. 1987a). These pulses frequently occur in long sequenced patterns, are down swept (e.g., 23 to 18 Hz), and can be repeated over the course of many hours

(Watkins et al. 1987a). In temperate waters, intense bouts of these patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clarke and Charif 1998). The seasonality and stereotypic nature of these vocal sequences suggest that they are male reproductive displays (Watkins 1981a; Watkins et al. 1987a); a notion further supported by recent data linking these vocalizations to male fin whales only (Croll et al. 2002). In Southern California, the 20 Hz pulses are the dominant fin whale call type associated both with call-counter-call between multiple animals and with singing (Navy 2010; Navy 2012). An additional fin whale sound, the 40 Hz call described by Watkins (1981a), was also frequently recorded, although these calls are not as common as the 20 Hz fin whale pulses. Seasonality of the 40 Hz calls differed from the 20 Hz calls, since 40 Hz calls were more prominent in the spring, as observed at other sites across the northeast Pacific (Sirovic et al. 2012). Source levels of Eastern Pacific fin whale 20-Hz calls has been reported as 189 +/- 5.8 dB re: 1 µPa at 1m (Weirathmueller et al. 2013). Although acoustic recordings of fin whales from many diverse regions show close adherence to the typical 20 Hz bandwidth and sequencing when performing these vocalizations, there have been slight differences in the pulse patterns, indicative of some geographic variation (Thompson et al. 1992; Watkins et al. 1987a).

Responses to conspecific sounds have been demonstrated in a number of mysticetes, and there is no reason to believe that fin whales do not communicate similarly (Edds-Walton 1997). The low-frequency sounds produced by fin whales have the potential to travel over long distances, and it is possible that long-distance communication occurs in fin whales (Edds-Walton 1997; Payne and Webb. 1971). Also, there is speculation that the sounds may function for long range echolocation of large-scale geographic targets such as seamounts, which might be used for orientation and navigation (Tyack 1999).

Although no studies have directly measured the sound sensitivity of fin whales, experts assume that fin whales are able to receive sound signals in roughly the same frequencies as the signals they produce. This suggests fin whales, like other baleen whales, are more likely to have their best hearing capacities at low frequencies, including frequencies lower than those of normal human hearing, rather than at mid- to high-frequencies (Ketten 1997). Several fin whales were tagged during the previous SOCAL BRS research activities and no obvious responses to a mid-frequency sound source were detected by the visual observers or in the initial phase tag analysis (Southall et al. 2011a). In terms of functional hearing capability fin whales belong to the low-frequency group, which have a hearing range of 7 Hz to 22 kHz (Southall et al. 2007c).

Critical Habitat

Fin whale critical habitat has not been designated.

4.2.3 Humpback Whale

Humpback whales (*Megaptera novaeangliae*) are distinguished from other whales in the same family (Balaenopteridae) by extraordinarily long flippers (up to 5 m or about 1/3 total body length), a more robust body, fewer throat grooves (14 to 35), more variable dorsal fin, and utilization of very long (up to 30 minutes), complex, repetitive vocalizations (songs) (Payne and McVay 1971) during courtship. Their grayish-black baleen plates, approximately 270 to 440 on each side of the jaw, are intermediate in length (6,570 cm) to those of other baleen whales. Humpbacks in different geographical areas vary somewhat in body length, but maximum recorded size is 18 m (Winn and Reichley 1985a).

The whales are generally dark on the back, but the flippers, sides and ventral surface of the body and flukes may have substantial areas of natural white pigmentation plus acquired scars (white or black). The Applicant distinguishes individual humpbacks by the apparently unique black and white patterns on the underside of the flukes as well as other individually variable features (Glockner and Venus 1983; Katona and Whitehead 1981; Kaufman and Osmond 1987).

The lifespan of humpback whales is estimated to be 80 to 100 years. Sexual maturity is reached at five to 11 years of age. The gestation period of humpback whales is 11 months, and calves are nursed for 12 months. The average calving interval is two to three years. Birthing occurs in low latitudes during winter months.

Distribution

Humpback whales are widely distributed in the Atlantic, Indian (Arabian Sea), Pacific, and Southern Oceans. Individuals generally migrate seasonally between warmer, tropical and sub-tropical waters in winter months (where they reproduce and give birth to calves, although feeding occasionally occurs) and cooler, temperate and sub-Arctic waters in summer months (where they feed). In their summer foraging areas and winter calving areas, they tend to occupy shallower, coastal waters; though during seasonal migrations they disperse widely in deep, pelagic waters and tend to avoid shallower coastal waters (Winn and Reichley 1985c).

In the eastern and central North Pacific Ocean, the summer range of humpback whales includes coastal and inland waters from Point Conception, California, north to the U.S. Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk (Tomlin 1967, Nemoto 1957, Johnson and Wolman 1984 as cited in NMFS 1991a). These whales migrate to calving grounds near Hawaii, southern Japan, the Mariana Islands, and Mexico during the winter months.

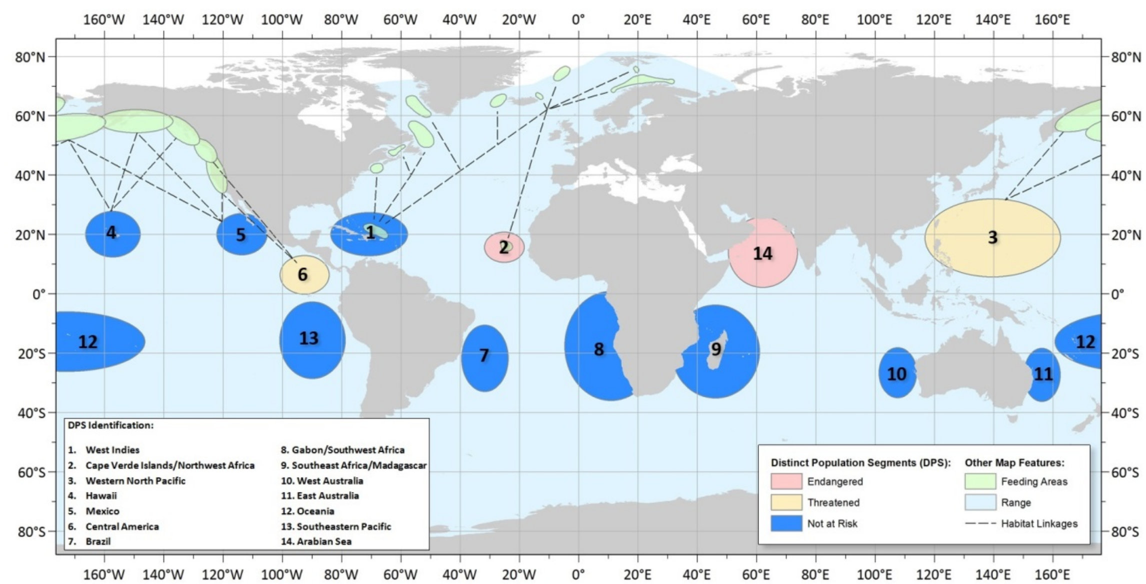

Figure 2. Worldwide distribution of the 14 identified humpback distinct population segments.

Population Structure

Humpback whale abundance pre-exploitation cannot be known, but various estimates have been proposed:

- Global (though mostly representative of the Southern Ocean): at least 150,000 whales in the early 1900s (Winn and Reichley 1985c)
- North Atlantic: estimates range from 40,000 to 250,000 (Smith and Pike 2009)
- North Pacific: 15,000 humpback whales prior to 1905 (Rice 1978a)

Currently, there are over 60,000 humpback whales worldwide, occurring primarily in the North Atlantic, North Pacific, and Southern Hemisphere. Though abundance estimates are not available for all populations or stocks worldwide, estimates are available for some major groups:

- North Atlantic: total population between 7,698 and 11,570 (Palsbøll et al. 1997a; Smith et al. 1999; Stevick et al. 2003), though all are considered to be under estimates
- North Pacific: total population is estimated to be 20,800 (Barlow et al. 2011a), though this is likely an underestimate
- Southern Hemisphere: total population estimated by IWC in 1997/98 was 42,000

Though all populations of humpback whales are depressed relative to pre-exploitation levels, population growth appears to be positive. Growth rates for populations worldwide vary between 3.1 to 10.0 percent (Allen and Angliss 2014; Angliss and Outlaw 2005a; Barlow 1997b; Barlow et al. 2011a; Calambokidis et al. 2008b; Hendrix et al. 2012; Katona and Beard 1990; Punt 2010; Saracco et al. 2013; Stevick et al. 2003).

Though the ESA-listed entity is the worldwide population of humpback whales, some evidence suggests there may be multiple distinct populations within the North Pacific Ocean. Descriptions of the population structure of humpback whales differ depending on whether an author focuses on where humpback whales winter or where they feed. During winter months in northern or southern hemispheres, adult humpback whales migrate to specific areas in warmer, tropical waters to reproduce and give birth to calves. During summer months, humpback whales migrate to specific areas in northern temperate or sub-arctic waters to forage. In summer months, humpback whales from different “reproductive areas” will congregate to feed; in the winter months, whales will migrate from different foraging areas to a single wintering area. In either case, humpback whales appear to form “open” populations; that is, populations that are connected through the movement of individual animals.

Based on genetic and photo-identification studies, Hill and DeMaster (1998) recognized four stocks, likely corresponding to populations of humpback whales in the North Pacific Ocean: two in the eastern North Pacific, one in the central North Pacific, and one in the western Pacific (Hill and DeMaster 1998). However, gene flow between them may exist. Humpback whales summer in coastal and inland waters from Point Conception, California, north to the U.S. Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk (Johnson and Wolman 1984; Nemoto 1957; Tomilin 1967). These whales migrate to Hawaii, southern Japan, the Mariana Islands, and Mexico during winter. However, more northerly penetrations in Arctic waters occur on occasion (Hashagen et al. 2009). The central North Pacific population winters in the waters around Hawaii while the eastern North Pacific population (also called the California-Oregon-Washington stock) winters along Central America and Mexico. However, Calambokidis et al. (1997a) identified individuals from several populations wintering (and potentially breeding) in the areas of other populations, highlighting the potential fluidity of population structure. Herman (1979b) presented extensive evidence that humpback whales associated with the main Hawaiian Islands immigrated there only in the past 200 years. Winn and Reichley (1985a) identified genetic exchange between the humpback whales that winter off Hawaii and Mexico (with further mixing on feeding areas in Alaska) and suggested that humpback whales that winter in Hawaii may have emigrated from Mexican wintering areas. A “population” of humpback whales winters in the South China Sea east through the Philippines, Ryukyu Retto, Ogasawara Gunto, Mariana Islands, and Marshall Islands, with occurrence in the Mariana Islands, at Guam, Rota, and Saipan from January through March (Darling and Cerchio 1993; Eldredge 1991; Eldredge 2003; Fulling et al. 2011; Rice 1998). During summer, whales from this population migrate to the Kuril Islands, Bering Sea, Aleutian Islands, Kodiak, Southeast Alaska, and British Columbia to feed (Angliss and Outlaw 2008; Calambokidis 1997; Calambokidis et al. 2001).

Humpback whales primarily feed along the shelf break and continental slope (Green et al. 1992; Tynan et al. 2005). Separate feeding groups of humpback whales are thought to inhabit western U.S. and Canadian waters, with the boundary between them located roughly at the U.S./Canadian border. The southern feeding ground ranges between 32° and 48° North, with limited interchange with areas north of Washington State (Calambokidis et al. 2004; Calambokidis et al. 1996).

Natural Threats

Natural sources and rates of mortality of humpback whales are not well known. Based upon prevalence of tooth marks, attacks by killer whales appear to be highest among humpback whales migrating between Mexico and California, although populations throughout the Pacific Ocean appear to be targeted to some degree (Steiger et al. 2008). Juveniles appear to be the primary age group targeted. Humpback whales engage in grouping behavior, flailing tails, and rolling extensively to fight off attacks. Calves remain protected near mothers or within a group and lone calves have been known to be protected by presumably unrelated adults when confronted with attack (Ford and Reeves 2008).

Parasites and biotoxins from red-tide blooms are other potential causes of mortality (Perry et al. 1999a). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in humpback whales and may be preventing some populations from recovering (Lambertsen 1992). Studies of 14 humpback whales that stranded along Cape Cod between November 1987 and January 1988 indicate they apparently died from a toxin produced by dinoflagellates during this period.

Anthropogenic Threats

Three human activities are known to threaten humpback whales: whaling, commercial fishing, and shipping. Historically, whaling represented the greatest threat to every population of whales and was ultimately responsible for listing several species as endangered.

Humpback whales are also killed or injured during interactions with commercial fishing gear. Like fin whales, humpback whales have been entangled by fishing gear off Newfoundland and Labrador, Canada. A total of 595 humpback whales were reported captured in coastal fisheries in those two provinces between 1969 and 1990, of which 94 died (Lien 1994; Perkins and Beamish 1979). Along the Atlantic coast of the U.S. and the Maritime Provinces of Canada, there were 160 reports of humpback whales being entangled in fishing gear between 1999 and 2005 (Cole et al. 2005; Nelson et al. 2007). Of these, 95 entangled humpback whales were confirmed, with 11 whales sustaining injuries and nine dying of their wounds. Observers have not been assigned to a number of fisheries known to interact with the Central and Western North Pacific stocks of humpback whale. In addition, the Canadian observation program is also limited and uncertain (Angliss and Allen 2009).

More humpback whales are killed in collisions with ships than any other whale species except fin whales (Jensen and Silber 2003). Along the Pacific coast, a humpback whale is known to be killed about every other year by ship strikes (Barlow et al. 1997b). Of 123 humpback whales that stranded along the Atlantic coast of the U.S. between 1975 and 1996, 10 (8.1 percent) showed evidence of collisions with ships (Laist et al. 2001). Between 1999 and 2005, there were 18 reports of humpback whales being struck by vessels along the Atlantic coast of the U.S. and the Maritime Provinces of Canada (Cole et al. 2005; Nelson et al. 2007). Of these reports, 13 were confirmed as ship strikes and in seven cases, ship strike was determined to be the cause of death. In the Bay of Fundy, recommendations for slower vessel speeds to avoid right whale ship strike appear to be largely ignored (Vanderlaan et al. 2008). However, new rules for seasonal (June through December) slowing of vessel traffic to 10 knots and changing shipping lanes by less than one nautical mile to avoid the greatest concentrations of right whales are expected to reduce the chance of humpback whales being hit by ships by 9 percent.

Organochlorines, including PCB and DDT, have been identified from humpback whale blubber (Gauthier et al. 1997). Higher PCB levels have been observed in Atlantic waters versus Pacific waters along the United States and levels tend to increase with individual age (Elfes et al. 2010). Although humpback whales in the Gulf of Maine and off Southern California tend to have the highest PCB concentrations, overall levels are on par with other baleen whales, which are generally lower than odontocete cetaceans (Elfes et al. 2010). As with blue whales, these contaminants are transferred to young through the placenta, leaving newborns with contaminant loads equal to that of mothers before bioaccumulating additional contaminants during life and passing the additional burden to the next generation (Metcalfe et al. 2004). Contaminant levels are relatively high in humpback whales as compared to blue whales. Humpback whales feed higher on the food chain, where prey carry higher contaminant loads than the krill that blue whales feed on.

Status and Trends

The humpback whale is endangered because of past commercial whaling. Historical commercial harvests in the North Atlantic, North Pacific, and Southern Hemisphere are as follows:

- North Atlantic: approximately 31,000 whales killed since the 1600s (Smith and Reeves 2010)
- North Pacific: nearly 28,000 whales killed between 1905 and 1965 (Perry et al. 1999a)
- Southern Hemisphere: more than 200,000 whales killed in the 20th century (Findlay 2001)

Whaling for subsistence purposes does still occur for humpback whales, though at a reduced level compared to historical levels. Since 1985, there have been 98 humpback whale “catches” for subsistence purposes; of those catches, 59 were hunted by Denmark in Greenland and 38 were hunted by St. Vincent and the Grenadines in the West Indies (IWC 2015).

Winn and Reichley (1985b) argued that the global humpback whale population consisted of at least 150,000 whales in the early 1900s, mostly in the Southern Ocean. In 1987, the global population of humpback whales was estimated at about 10,000 (NMFS 1987). Although this estimate is outdated, it appears that humpback whale numbers are increasing.

It is estimated that 15,000 humpback whales resided in the North Pacific in 1905 (Rice 1978b). However, from 1905 to 1965, nearly 28,000 humpback whales were harvested in whaling operations, reducing the number of all North Pacific humpback whale to roughly 1,000 (Perry et al. 1999a). The overall abundance of humpback whales in the north Pacific was recently estimated at 21,808 individuals (coefficient of variation = 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. 2011b). Data indicates the north Pacific population has been increasing at a rate of between 5.5 percent and 6.0 percent per year, therefore approximately doubling every ten years (Calambokidis et al. 2008a). The current (year 2008) best estimate of abundance for the California, Oregon, and Washington stock is 1,918 (coefficient of variation = 0.03), with an estimated mimimum population size estimate of 1,876 individuals (Carretta et al. 2014). Based on ship surveys conducted in the summer and fall from 1991 to 2005, it is estimated that 36 humpback whales (coefficient of variation = 0.51) occur off Southern California in the waters south of Point Conception (Barlow and Forney 2007). Humpback whale density estimates vary annually and by season. The average density of humpback whales off Southern California between 2004 and 2013 was 1.07, 1.92, 1.03, and 0.82 individuals per 1,000 km^2 in the winter, spring, summer, and fall, respectively (Campbell et al. 2014). The overall annual average density of humpback whales off Southern California over this time period was 1.17 individuals per km^2 (Campbell et al. 2014). The current (year 2006) best estimate of abundance for the Central North Pacific stock has been estimated at 10,103 individuals on wintering grounds throughout the main Hawaiian Islands (Allen and Angliss 2013), with an estimated minimum population size of 5,833 individuals (Carretta et al. 2014).

Though whaling does continue, the number of whales killed has been significantly reduced. The species' large population size and increasing trends indicate that it is resilient to current threats., and, of the 14 proposed DPSs, two are proposed to be "downlisted" to threatened and ten are proposed to be delisted (80 FR 22304, April 21, 2015).

Diving and Social Behavior

Maximum diving depths are approximately 170 m (558 ft), with a dive of 240 m (787 ft) recorded off Bermuda (Hamilton et al. 1997). Dives can last for up to 21 minutes, although feeding dives ranged from 2.1 to 5.1 minutes in the north Atlantic (Dolphin 1987b). In southeast Alaska, average dive times were 2.8 minutes for feeding whales, 3.0 minutes for non-feeding whales, and 4.3 minutes for resting whales (Dolphin 1987b). Because most humpback prey is likely found within 300 m (984 ft) of the surface, most humpback dives are probably relatively shallow. In Alaska, capelin are the primary prey of humpback and are found primarily between 92 and 120 m (302 to 394 ft); depths to which humpbacks apparently dive for foraging (Witteveen et al. 2008).

Humpback whale feeding occurs in high latitudes during summer months. They exhibit a wide range of foraging behaviors and feed on a range of prey types, including small schooling fishes, krill, and other large zooplankton. In a review of humpback whale social behavior, Clapham (1996a) reported that they form small, unstable social groups during the breeding season and form small groups that occasionally aggregate on concentrations of food during the feeding season. The breeding season can best be described as a floating lek or male dominance polygyny (Clapham 1996a).

During the feeding season, humpback whales form small groups that occasionally aggregate on concentrations of food that may be stable for long-periods of times. Humpbacks use a wide variety of behaviors to feed on various small, schooling prey including krill and fish (Hain et al. 1982; Hain et al. 1995; Jurasz and Jurasz 1979; Weinrich et al. 1992b). There is good evidence of some territoriality on feeding and calving areas (Clapham 1994; Clapham 1996b; Tyack 1981). Humpback whales are generally believed to fast while migrating and on breeding grounds, but some individuals apparently feed while in low-latitude waters normally believed to be used exclusively for reproduction and calf-rearing (Danilewicz et al. 2009; Pinto De Sa Alves et al. 2009). Some individuals, such as juveniles, may not undertake migrations at all (Findlay and Best 1995).

Humpback whales feed on pelagic schooling euphausiids and small fish including capelin, herring and mackerel. Like other large mysticetes, they are a "lunge feeder" taking advantage of dense prey patches and engulfing as much food as possible in a single gulp. They also blow nets, or curtains, of bubbles around or below prey patches to concentrate the prey in one area, then lunge with open mouths through the middle. Dives appear to be closely correlated with the depths of prey patches, which vary from location to location. In the north Pacific (southeast Alaska), most dives were of fairly short duration (less than four minutes) with the deepest dive to 148 m (486 ft) (Dolphin 1987b), while whales observed feeding on Stellwagen Bank in the North Atlantic dove to less than 40 m (131 ft) (Hain et al. 1995). Hamilton et al. (1997) tracked one possibly feeding whale near Bermuda to 240 m (787 ft) depth.

Vocalization and Hearing

Humpback whale vocalization is much better understood than is hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls (Dunlop et al. 2008). Males sing complex sounds while in low-latitude breeding areas in a frequency range of 20 Hz to 4 kHz with estimated source levels from 144 to 174 dB (Au et al. 2006; Au et al. 2000b; Frazer and Mercado III 2000; Richardson et al. 1995c; Winn et al. 1970). Males also produce sounds associated with aggression, which are generally characterized as frequencies between 50 Hz to 10 kHz and having most energy below 3 kHz (Silber 1986; Tyack 1983). Such sounds can be heard up to 9 km away (Tyack 1983). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson et al. 1995c; Tyack 1983). While in northern feeding areas, both sexes vocalize in grunts (25 Hz to 1.9 kHz), pulses (25 to 89 Hz), and songs (ranging from 30 Hz to 8 kHz but dominant frequencies of 120 Hz to 4 kHz) which can be very loud (175 to 192 dB re: 1μPa at 1 m) (Au et al. 2000b; Erbe 2002a;

Payne 1985; Richardson et al. 1995c; Thompson et al. 1986). However, humpbacks tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson et al. 1995c). NMFS classifies humpback whales in the low-frequency cetacean (i.e., baleen whale) functional hearing group. As a group, it is estimated that baleen whales can hear frequencies between 0.007 and 30 kHz (NOAA 2013). Houser et al. (2001) produced a mathematical model of humpback whale hearing sensitivity based on the anatomy of the humpback whale ear. Based on the model, they concluded that humpback whales would be sensitive to sound in frequencies ranging from 0.7 to 10 kHz, with a maximum sensitivity between 2 to 6 kHz.

Humpback whales are known to produce three classes of vocalizations: (1) "songs" in the late fall, winter, and spring by solitary males; (2) social sounds made by calves (Zoidis et al. 2008) or within groups on the wintering (calving) grounds; and (3) social sounds made on the feeding grounds (Thomson and Richardson 1995a). The best-known types of sounds produced by humpback whales are songs, which are thought to be reproductive displays used on breeding grounds only by adult males (Clark and Clapham 2004; Gabriele and Frankel. 2002; Helweg et al. 1992; Schevill et al. 1964; Smith et al. 2008). Singing is most common on breeding grounds during the winter and spring months, but is occasionally heard in other regions and seasons (Clark and Clapham 2004; Gabriele and Frankel. 2002; McSweeney et al. 1989). Au et al. (Au et al. 2000a) noted that humpbacks off Hawaii tended to sing louder at night compared to the day. There is geographical variation in humpback whale song, with different populations singing a basic form of a song that is unique to their own group. However, the song evolves over the course of a breeding season, but remains nearly unchanged from the end of one season to the start of the next (Payne et al. 1983). The song is an elaborate series of patterned vocalizations that are hierarchical in nature, with a series of songs ('song sessions') sometimes lasting for hours (Payne and McVay 1971). Components of the song range from below 20 Hz up to 4 kHz, with source levels measured between 151 and 189 dB re: 1μPa-m and high-frequency harmonics extending beyond 24 kHz (Au et al. 2006; Winn et al. 1970).

Social calls range from 20 Hz to 10 kHz, with dominant frequencies below 3 kHz (D'Vincent et al. 1985; Dunlop et al. 2008; Silber 1986; Simao and Moreira 2005). Female vocalizations appear to be simple; Simão and Moreira (2005) noted little complexity.

"Feeding" calls, unlike song and social sounds are a highly stereotyped series of narrow-band trumpeting calls. These calls are 20 Hz to 2 kHz, less than 1 second in duration, and have source levels of 162 to 192 dB re: 1μPa-m (D'Vincent et al. 1985; Thompson et al. 1986). The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent et al. 1985) (D'Vincent et al. 1985; Thompson et al. 1986). The acoustics and dive profiles associated with humpback whale feeding behavior in the northwest Atlantic has been documented with DTAGs[11] (Stimpert et al. 2007). Underwater lunge behavior was associated with nocturnal feeding at depth and with multiple bouts of broadband click trains that were acoustically different from toothed whale echolocation: Stimpert et al. (Stimpert et al. 2007) termed these sounds "mega-clicks" which showed relatively low received levels at the DTAGs (143 to 154 dB re: 1μPa), with the majority of acoustic energy below 2 kHz.

Humpback whale audiograms using a mathematical model based on the internal structure of the ear estimate sensitivity is from 700 Hz to 10 kHz, with maximum relative sensitivity between 2 kHz and 6 kHz (Ketten and Mountain 2014). Previously mentioned research by Au et al. (2001, 2006) off Hawaii indicated the presence of high-frequency harmonics in vocalizations up to and beyond 24 kHz. While recognizing this was the upper limit of the recording equipment, it does not demonstrate that humpbacks can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental in the humpback whale song. The ability of humpbacks to hear frequencies around 3 kHz may have been demonstrated in a playback study. Maybaum (1990) reported that humpback whales showed a mild response to a handheld sonar marine mammal detection and location device with frequency of 3.3 kHz at 219 dB re: 1μPa-m or frequency sweep of 3.1 kHz to 3.6 kHz. In addition, the system had some low frequency components (below 1 kHz) which may have been an artifact of the acoustic equipment. This possible artifact may have affected the response of the whales to both the control and sonar playback conditions.

In terms of functional hearing capability humpback whales belong to low-frequency cetaceans which have a hearing range of 7 Hz to 22 kHz (Southall et al. 2007c).

Humpback whales are the most abundant ESA-listed species observed during U.S. Navy visual surveys in the winter months. To date, humpback whales have been documented as the species which has received the highest sound pressure levels from U.S. Navy MFAS training (i.e., at least 183 dB re: 1μPa) based upon an analysis which utilized shipboard Marine Mammal Observer sightings on February 18, 2011 (Farak et al 2011), combined with Pacific Missile Range Facility (PMRF) range hydrophone data (Martin Manzano-Roth 2012). Analysis of PMRF range hydrophone data for purpose of estimating received levels on marine mammals has also been done in conjunction with satellite tagged animals (Baird et al. 2014) and aerial focal follows (Mobley et al. 2013). Passive acoustic monitoring of PMRF hydrophones during U.S. Navy training for the month of February from 2011 to 2013 has shown that acoustically localized

[11] *DTAG is a novel archival tag, developed to monitor the behavior of marine mammals, and their response to sound, continuously throughout the dive cycle. The tag contains a large array of solid-state memory and records continuously from a built-in hydrophone and suite of sensors. The sensors sample the orientation of the animal in three dimensions with sufficient speed and resolution to capture individual fluke strokes. Audio and sensor recording is synchronous so the relative timing of sounds and motion can be determined precisely (Johnson & Tyack 2003).*

minke whales are reduced during periods involving MFAS training activity when compared to other periods of time (Martin et al 2014). PAM monitoring for beaked whale foraging dives at PMRF has also shown reduced foraging dive rates during periods of MFAS training with estimated receive levels on the group dive members (mean levels of 109 dB re: 1µPa) in February of 2012 (Manzano-Roth et al. 2013). Acoustic analysis has also shown that marine mammals near the sea surface can be exposed to higher estimated receive levels due to ducted propagation, that typically exists at PMRF. Analysis of behaviors observed during one focal follow taken during aerial surveys, in conjunction with estimated received levels using PMRF passive acoustic data products, are reported as a case study of a single focal follow on a humpback whale in the vicinity of MFAS (Mobley et al. 2013).

Critical Habitat

Humpback whale critical habitat has not been designated.

4.2.4 Sei Whale

Sei whales are members of the baleen whale family and are considered one of the "great whales" or rorquals. Two subspecies of sei whales are recognized, *B. b. borealis* in the Northern Hemisphere and *B. b. schlegellii* in the Southern Hemisphere. These large animals can reach lengths of 12 to 18 m (40 to 60 ft) and weigh 45,000 kg (100,000 lbs). Females may be slightly longer than males. Sei whales have a long, sleek body that is dark bluish-gray to black in color and pale underneath.

Sei whales become sexually mature at six to 12 years of age when they reach about 13 m (45 ft) in length, and generally mate and give birth during the winter in lower latitudes. Females breed every two to three years, with a gestation period of 11 to 13 months. Females give birth to a single calf that is about 4.6 m (15 ft) long and weighs about 680 kg (1,500 lbs). Calves are usually nursed for six to nine months before being weaned on the preferred feeding grounds. Sei whales have an estimated lifespan of 50 to 70 years.

Distribution

The sei whale occurs in all oceans of the world except the Arctic. The migratory pattern of this species is thought to encompass long distances from high-latitude feeding areas in summer to low-latitude breeding areas in winter; however, the location of winter areas remains largely unknown (Perry et al. 1999a). Sei whales are often associated with deeper waters and areas along continental shelf edges (Hain et al. 1985). This general offshore pattern is disrupted during occasional incursions into shallower inshore waters (Waring et al. 2004b). The species appears to lack a well-defined social structure and individuals are usually found alone or in small groups of up to six whales (Perry et al. 1999a). When on feeding grounds, larger groupings have been observed (Gambell 1985c).

In the North Pacific Ocean, sei whales occur from the Bering Sea south to California (on the east) and the coasts of Japan and Korea (on the west). During the winter, sei whales are found from 20° to 23° North (Gambell 1985c; Masaki 1977). Sasaki et al. (2013) demonstrated that sei whale in the North Pacific are strongly correlated with sea surface temperatures between 13.1 and 16.8º C.

Population Structure

The population structure of sei whales is not well defined, but presumed to be discrete by ocean basin (north and south), except for sei whales in the Southern Ocean, which may form a ubiquitous population or several discrete ones.

Mark-recapture, catch distribution, and morphological research indicate more than one population may exist in the North Pacific – one between 155° and 175° West, and another east of 155° West (Masaki 1976; Masaki 1977). Sei whales have been reported primarily south of the Aleutian Islands, in Shelikof Strait and waters surrounding Kodiak Island, in the U.S. Gulf of Alaska, and inside waters of southeast Alaska and south to California to the east and Japan and Korea to the west (Leatherwood et al. 1982; Nasu 1974). Sightings have also occurred in Hawaiian waters. In U.S. Navy-funded surveys 2007 through 2012, there were three confirmed sighting of sei whales for a total of five individuals—all made from vessels (HDR 2012). Two sightings were documented northeast of Oahu in 2007 (Smultea et al. 2007), while the third was encountered near Perret Seamount west of the Island of Hawaii in 2010 (HDR 2012). Bottom depths for the sei whale sightings were from 3,100 to 4,500 m (10,171 to 14,764 ft). Sightings were made during Beaufort sea state two to four. Smultea et al. (2010) noted that the lack of sightings of sei whales in the Hawaiian Islands may be due to misidentification and/or poor sighting conditions. Sei whales have been occasionally reported from the Bering Sea and in low numbers on the central Bering Sea shelf (Hill and DeMaster 1998). Whaling data suggest that sei whales do not venture north of about 55° North (Gregr et al. 2000). Harwood (1987) evaluated Japanese sighting data and concluded that sei whales rarely occur in the Bering Sea. Harwood (1987) reported that 75 to 85 percent of the North Pacific population resides east of 180°. Considering the many British Columbia whaling catches in the early to mid-1900s, sei whales have clearly utilized this area in the past (Gregr et al. 2000; Pike and Macaskie 1969). Masaki (1977) reported sei whales concentrating in the northern and western Bering Sea from July through September, although other researchers question these observations because no other surveys have reported sei whales in the northern and western Bering Sea.

Sei whales appear to prefer to forage in regions of steep bathymetric relief, such as continental shelf breaks, canyons, or basins situated between banks and ledges (Best and Lockyer 2002; Gregr and Trites 2001; Kenney and Winn 1987), where local hydrographic features appear to help concentrate zooplankton, especially copepods. In their foraging areas, sei whales appear to associate with oceanic frontal systems (Horwood 1987b). In the north Pacific, sei whales are found feeding particularly along the cold eastern currents (Perry et al. 1999a). Masaki (1977) presented sightings data on sei whales in the North Pacific from the mid-1960s to the early 1970s. Over that time interval sei whales did not appear to occur in waters of Washington State and southern British Columbia in May or June, their densities increased in those waters in July and August (1.9 to 2.4 and 0.7 to 0.9 whales per 161 km [100 miles] of distance for July and August, respectively), then declined again in September. More recently, sei whales have become known for an irruptive migratory habit in which they appear in an area then disappear for time periods that can extend to decades. Sei whales are distributed in offshore waters in Southern California. There are records of sightings in California waters as early as May and June, but primarily are encountered there 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). On March 18, 2011 off Maui, the Hawaiian Islands Entanglement Response Network found a sub-adult sei whale entangled in rope and fishing gear. An attempt to disentangle the whale was unsuccessful although a telemetry buoy attached to the entangled gear was reported to be tracking the whale over 21 days as it moved north and over 463 km (250 nmi) from the Hawaiian Islands.

Natural Threats

Andrews (1916) suggested that killer whales attacked sei whales less frequently than fin and blue whales in the same areas. Sei whales engage in a flight responses to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Endoparasitic helminths (worms) are commonly found in sei whales and can result in pathogenic effects when infestations occur in the liver and kidneys (Rice 1977).

Anthropogenic Threats

Human activities known to threaten sei whales include whaling, commercial fishing, and maritime vessel traffic. Historically, whaling represented the greatest threat to every population of sei whales and was ultimately responsible for listing sei whales as an endangered species. Sei whales are thought to not be widely hunted, although harvest for scientific whaling or illegal harvesting may occur in some areas.

Sei whales, because of their offshore distribution and relative scarcity in U.S. Atlantic and Pacific waters, probably have a lower incidence of entrapment and entanglement than fin whales. Data on entanglement and entrapment in non-U.S. waters are not reported systematically. Heyning and Lewis (1990) made a crude estimate of about 73 rorquals killed/year in the southern California offshore drift gillnet fishery during the 1980s. Some of these may have been fin whales instead of sei whales. Some balaenopterids, particularly fin whales, may also be taken in the drift gillnet fisheries for sharks and swordfish along the Pacific coast of Baja California, Mexico (Barlow et al. 1997b). Heyning and Lewis (1990) suggested that most whales killed by offshore fishing gear do not drift far enough to strand on beaches or to be detected floating in the nearshore corridor where most whale-watching and other types of boat traffic occur. Thus, the small amount of documentation may not mean that entanglement in fishing gear is an insignificant cause of mortality. Observer coverage in the Pacific offshore fisheries has been too low for any confident assessment of species-specific entanglement rates (Barlow et al. 1997b).

The offshore drift gillnet fishery is the only fishery that is likely to take sei whales from this stock, but no fishery mortalities or serious injuries to sei whales have been observed. Sei whales, like other large whales, may break through or carry away fishing gear. Whales carrying gear may die later, become debilitated or seriously injured, or have normal functions impaired, but with no evidence recorded.

Sei whales are occasionally killed in collisions with vessels. Of three sei whales that stranded along the U.S. Atlantic coast between 1975 and 1996, two showed evidence of collisions (Laist et al. 2001). Between 1999 and 2005, there were three reports of sei whales being struck by vessels along the U.S. Atlantic coast and Canada's Maritime Provinces (Cole et al. 2005; Nelson et al. 2007). Two of these ship strikes were reported as having resulted in death. One sei whale was killed in a collision with a vessel off the coast of Washington in 2003 (Waring et al. 2009). New rules for seasonal (June through December) slowing of vessel traffic in the Bay of Fundy to 10 knots and changing shipping lanes by less than one nautical mile to avoid the greatest concentrations of right whales are predicted to reduce sei whale ship strike mortality by 17 percent.

Sei whales are known to accumulate DDT, DDE, and PCBs (Borrell 1993; Borrell and Aguilar 1987; Henry and Best 1983). Males carry larger burdens than females, as gestation and lactation transfer these toxins from mother to offspring.

Status and Trends

Ohsumi and Fukuda (1975) estimated that sei whales in the North Pacific numbered about 49,000 whales in 1963, had been reduced to 37,000 to 38,000 whales by 1967, and reduced again to 20,600 to 23,700 whales by 1973. From 1910 to 1975, approximately 74,215 sei whales were caught in the entire North Pacific Ocean (Harwood and Hembree. 1987; Perry et al. 1999a). From the early 1900s, Japanese whaling operations consisted of a large proportion of sei whales: 300 to 600 sei whales were killed per year from 1911 to 1955. The sei whale catch peaked in 1959, when 1,340 sei whales were killed. In 1971, after a decade of high sei whale catch numbers, sei whales were scarce in Japanese waters. Japanese and Soviet catches of sei whales in the North Pacific and Bering Sea increased from 260 whales in 1962 to over 4,500 in 1968 to 1969, after which the sei whale population declined rapidly (Mizroch et al. 1984a). When commercial whaling for sei whales ended in 1974, the population in the North Pacific had been reduced to 7,260 to 12,620 animals (Tillman 1977). Between 1991 and 2001, during aerial surveys, there were two confirmed sightings of sei whales along the U.S. Pacific coast. The most recent abundance estimates for sei whales that we are aware of range from 7,260 to 12,620 in the North Pacific Ocean (Tillman et al. 1997) and 25,000 individuals worldwide (Braham 1991b).

Diving and Social Behavior

Generally, sei whales make 5 to 20 shallow dives of 20 to 30 second duration followed by a deep dive of up to 15 minutes (Gambell 1985c). The depths of sei whale dives have not been studied;

however the composition of their diet suggests that they do not perform dives in excess of 300 meters. Sei whales are usually found in small groups of up to six individuals, but they commonly form larger groupings when they are on feeding grounds (Gambell 1985c).

Sei whales are primarily planktivorous, feeding mainly on euphausiids and copepods, although they are also known to consume fish (Waring et al. 2007). In the Northern Hemisphere, sei whales consume small schooling fish such as anchovies, sardines, and mackerel when locally abundant (Mizroch et al. 1984a; Rice 1977). Sei whales in the North Pacific feed on euphausiids and copepods, which make up about 95 percent of their diets (Calkins 1986). The dominant food for sei whales off California during June through August is northern anchovy, while in September and October whales feed primarily on krill (Rice 1977). The balance of their diet consists of squid and schooling fish, including smelt, sand lance, Arctic cod, rockfish, pollock, capelin, and Atka mackerel (Nemoto and Kawamura 1977). In the Southern Ocean, analysis of stomach contents indicates sei whales consume *Calanus* spp. and small-sized euphasiids with prey composition showing latitudinal trends (Kawamura 1974). Evidence indicates that sei whales in the Southern Hemisphere reduce direct interspecific competition with blue and fin whales by consuming a wider variety of prey and by arriving later to feeding grounds (Kirkwood 1992). Rice (1977) suggested that the diverse diet of sei whales may allow them greater opportunity to take advantage of variable prey resources, but may also increase their potential for competition with commercial fisheries.

Little is known about the actual social system of these animals. Groups of two to five individuals are typically observed, but sometimes thousands may gather if food is abundant. However, these large aggregations may not be dependent on food supply alone, as they often occur during times of migration. Norwegian workers call the times of great sei whale abundance "invasion years." During mating season, males and females may form a social unit, but strong data on this issue are lacking.

Vocalization and Hearing

Data on sei whale vocal behavior is limited, but includes records off the Antarctic Peninsula of broadband sounds in the 100 Hz to 600 Hz range with 1.5 second duration and tonal and upsweep calls in the 200 Hz to 600 Hz range of 1 to 3 second durations (McDonald et al. 2005). Differences may exist in vocalizations between ocean basins (Rankin et al. 2009). Vocalizations from the North Atlantic consisted of paired sequences (0.5 to 0.8 seconds, separated by 0.4 to 1.0 seconds) of 10 to 20 short (4 msec) FM sweeps between 1.5 to 3.5 kHz (Richardson et al. 1995c).

Recordings made in the presence of sei whales have shown that they produce sounds ranging from short, mid-frequency pulse sequences (Knowlton et al. 1991; Thompson et al. 1979) to low frequency broadband calls characteristic of mysticetes (Baumgartner et al. 2008; McDonald et al. 2005; Rankin and Barlow 2007). Off the coast of Nova Scotia, Canada, Knowlton et al. (1991)

recorded two-phased calls lasting about 0.5 to 0.8 seconds and ranging in frequency from 1.5 kHz to 3.5 kHz in the presence of sei whales—data similar to that reported by Thompson et al. (1979a). These mid-frequency calls are distinctly different from low-frequency tonal and frequency swept calls recorded in later studies. For example, calls recorded in the Antarctic averaged 0.45 ± 0.3 s in duration at 433 ± 192 Hz, with a maximum source level of 156 ± 3.6 dB re: 1μPa-m (McDonald et al. 2005). During winter months off Hawaii, Rankin and Barlow (2007) recorded down swept calls by sei whales that exhibited two distinct low frequency ranges of 100 Hz to 44 Hz and 39 Hz to 21 Hz, with the former range usually shorter in duration. Similar sei whale calls were also found near the U.S. Gulf of Maine in the northwest Atlantic, ranging from 82.3 Hz to 34.0 Hz and averaging 1.38 seconds in duration (Baumgartner et al. 2008). These calls were primarily single occurrences, but some double or triple calls were noted as well. It is thought that the difference in call frequency may be functional, with the mid-frequency type serving a reproductive purpose and the low frequency calls aiding in feeding/social communication (McDonald et al. 2005). Sei whales have also been shown to reduce their calling rates near the U.S. Gulf of Maine at night, presumably when feeding, and increase them during the day, likely for social activity (Baumgartner and Fratantoni 2008). Off the Mariana Islands, 32 sei whale calls were recorded, 25 of which were backed up by sightings (Norris et al. 2012). The peak mean frequency of these calls ranged from 890.6 Hz to 1,046.9 Hz with a mean duration of 3.5 to 0.2 seconds.

While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing. In terms of functional hearing capability, sei whales belong to low-frequency cetaceans which have a hearing range of 7 Hz to 22 kHz (Southall et al. 2007b). There are no tests or modeling estimates of specific sei whale hearing ranges.

Critical Habitat

Sei whale critical habitat has not been designated.

4.2.5 Sperm Whale

Sperm whales are the largest of the odontocetes (toothed whales) and the most sexually dimorphic cetaceans, with males considerably larger than females. Adult females may grow to lengths of 11 m (36 ft) and weigh 13,607 kg (15 tons). Adult males, however, reach about 16 m (52 ft) and may weigh as much as 40,823 kg (45 tons).

The sperm whale is distinguished by its extremely large head, which takes up to 25 to 35 percent of its total body length. It is the only living cetacean that has a single blowhole asymmetrically situated on the left side of the head near the tip. Sperm whales have the largest brain of any animal (on average 7.8 kg [17 lb] in mature males). However, compared to their large body size, the brain is not exceptional in size. Sperm whales are mostly dark gray, but oftentimes the interior of the mouth is bright white, and some whales have white patches on the belly. Their flippers are paddle-shaped and small compared to the size of the body, and their flukes are very triangular in shape. They have small dorsal fins that are low, thick, and usually rounded.

Distribution

Sperm whales are distributed in all of the world's oceans, from equatorial to polar waters, and are highly migratory. Mature males range between 70º North in the North Atlantic and 70º South in the Southern Ocean (Perry et al. 1999a; Reeves and Whitehead 1997b), whereas mature females and immature individuals of both sexes are seldom found higher than 50º North or South (Reeves and Whitehead 1997b). In winter, sperm whales migrate closer to equatorial waters (Kasuya and Miyashita 1988; Waring 1993) where adult males join them to breed.

Population Structure

There is no clear understanding of the global population structure of sperm whales (Dufault et al. 1999). Recent ocean-wide genetic studies indicate low, but statistically significant, genetic diversity and no clear geographic structure, but strong differentiation between social groups (Lyrholm and Gyllensten 1998; Lyrholm et al. 1996; Lyrholm et al. 1999). The IWC currently recognizes four sperm whale stocks: North Atlantic, North Pacific, northern Indian Ocean, and Southern Hemisphere (Dufault et al. 1999; Reeves and Whitehead 1997b). The NMFS recognizes six stocks under the MMPA: three in the Atlantic/Gulf of Mexico and three in the Pacific (Alaska, California-Oregon-Washington, and Hawai′i; (Perry et al. 1999b; Waring et al. 2004b)). Genetic studies indicate that movements of both sexes through expanses of ocean basins are common, and that males, but not females, often breed in different ocean basins than the ones in which they were born (Whitehead 2003). Sperm whale populations appear to be structured socially, at the level of the clan, rather than geographically (Whitehead 2003; Whitehead 2008).

Sperm whales are found throughout the North Pacific and are distributed broadly in tropical and temperate waters to the Bering Sea as far north as Cape Navarin in summer, and occur south of 40^{o} North in winter (Gosho et al. 1984; Miyashita et al. 1995 as cited in Carretta et al. 2005; Rice 1974). Sperm whales are found year-round in Californian waters (Barlow 1995; Dohl 1983; Forney et al. 1995c; Shallenberger 1981a). In an U.S. Navy-funded survey in May 2011, a pod of 20 sperm whales with at least two calves was seen within the SOCAL Range Complex, approximately 48.3 km (30 miles) from San Diego.

Sperm whales are seen in every season except winter (December and February) in Washington and Oregon (Green et al. 1992). In surveys of waters off Oregon and Washington conducted by Green et al. (1992), no sperm whales were encountered in waters less than 200 m deep, 12 percent of the sperm whales were encountered in waters 200 to 2000 m deep (the continental slope), and the remaining 88 percent of the sperm whales were encountered in waters greater than 2,000 m deep. Sperm whales were reported from the Olympic Coast Slope transects (west of the Olympic Coast National Marine Sanctuary), but not from surveys conducted over the National Marine Sanctuary or the area immediately west of Cape Flattery (Forney 2007). In May 2011, a pod of 20 sperm whales including two calves was sighted during aerial surveys approximately 44 km (24 nmi) west of San Diego in waters 200 to 300 m (656 to 984 ft) deep (Navy 2011).

Summer/fall surveys in the eastern tropical Pacific (Wade and Gerrodette 1993) show that although sperm whales are widely distributed in the tropics, their relative abundance tapers off markedly towards the middle of the tropical Pacific and northward towards the tip of Baja California (Carretta et al. 2006). Sperm whales occupying the California Current region are genetically distinct from those in the eastern tropical Pacific and Hawaiian waters (Mesnick et al. 2011). The discreteness of the latter two areas remains uncertain (Mesnick et al. 2011).

Off California, sperm whales are present in offshore waters year-round, with peak abundance from April to mid-June and again from late August through November (Barlow 1997a; Dohl et al. 1981; Dohl et al. 1983; Gosho et al. 1984). The majority of sightings off central and northern California were in waters deeper than 1,800 m (5,900 ft), but near the continental shelf edge (Dohl et al. 1983). U.S. Navy surveys have found sperm whales in the action area (Navy 2012).

Natural Threats

Sperm whales are known to be occasionally predated upon by killer whales (Jefferson et al. 1991; Pitman et al. 2001) by pilot whales (Arnbom et al. 1987; Palacios and Mate. 1996; Rice 1989a; Weller et al. 1996; Whitehead et al. 1997) and large sharks (Best et al. 1984a) and harassed by pilot whales (Arnbom et al. 1987; Palacios and Mate. 1996; Rice 1989a; Weller et al. 1996; Whitehead et al. 1997). Strandings are also relatively common events, with one to dozens of individuals generally beaching themselves and dying during any single event. Although several hypotheses, such as navigation errors, illness, and anthropogenic stressors, have been proposed (Goold et al. 2002; Wright 2005), direct widespread causes remain unclear. Calcivirus and papillomavirus are known pathogens of this species (Lambertsen et al. 1987; Smith and Latham 1978).

Anthropogenic Threats

Sperm whales historically faced severe depletion from commercial whaling operations. From 1800 to 1900, the IWC estimated that nearly 250,000 sperm whales were killed by whalers, with another 700,000 from 1910 to 1982 (IWC Statistics 1959 through 1983). However, other estimates have included 436,000 individuals killed between 1800 and 1987 (Carretta et al. 2005). However, all of these estimates are likely underestimates due to illegal killings and inaccurate reporting by Soviet whaling fleets between 1947 and 1973. In the Southern Hemisphere, these whalers killed an estimated 100,000 whales that they did not report to the IWC (Yablokov et al. 1998b), with smaller harvests in the Northern Hemisphere, primarily the North Pacific, that extirpated sperm whales from large areas (Yablokov 2000). Additionally, Soviet whalers disproportionately killed adult females in any reproductive condition (pregnant or lactating) as well as immature sperm whales of either gender.

Hill and Demaster (1999) concluded that about 258,000 sperm whales were harvested in the North Pacific between 1947 and 1987. Although the IWC protected sperm whales from commercial harvest in 1981, Japanese whalers continued to hunt sperm whales in the North

Pacific until 1988 (Reeves and Whitehead 1997a). Following a moratorium on whaling by the IWC, significant whaling pressures on sperm whales were eliminated. However, sperm whales are known to have become entangled in commercial fishing gear and 17 individuals are known to have been struck by vessels (Jensen and Silber 2004). Whale-watching vessels are known to influence sperm whale behavior (Richter et al. 2006).

Based on reports from 2000 to 2010, a total of two sperm whales were entangled in fishing gear off California, both of which were reported within the Southern California Bight (Saez et al. 2013). Available data from NMFS indicate that in waters off California between 1991 and 2010, there was one ship strike involving a sperm whale (NMFS Southwest Region Stranding Database 2011).

Interactions between sperm whales and longline fisheries in the U.S. Gulf of Alaska have been reported since 1995 and are increasing in frequency (Hill and DeMaster 1998; Hill et al. 1999; Rice 1989a). Between 2002 and 2006, there were three observed serious injuries (considered mortalities) to sperm whales in the U.S. Gulf of Alaska from the sablefish longline fishery (Angliss and Outlaw 2008). Sperm whales have also been observed in Gulf of Alaska feeding off longline gear (for sablefish and halibut) at 38 of the surveyed stations (Angliss and Outlaw 2008). Recent findings suggest sperm whales in Alaska may have learned that fishing vessel propeller cavitations (as gear is retrieved) are an indicator that longline gear with fish is present as a predation opportunity (Thode et al. 2007).

Contaminants have been identified in sperm whales, but vary widely in concentration based upon life history and geographic location, with northern hemisphere individuals generally carrying higher burdens (Evans et al. 2004). Contaminants include dieldrin, chlordane, DDT, DDE, PCBs, hexachlorobenzene, and hexachlorocyclohexane in a variety of body tissues (Aguilar 1983; Evans et al. 2004), as well as several heavy metals (Law et al. 1996). However, unlike other marine mammals, females appear to bioaccumulate toxins at greater levels than males, which may be related to possible dietary differences between females who remain at relatively low latitudes compared to more migratory males (Aguilar 1983; Wise et al. 2009). Chromium levels from sperm whales skin samples worldwide have varied from undetectable to 122.6 μg Cr/g tissue, with the mean (8.8 μg Cr/g tissue) resembling levels found in human lung tissue with chromium-induced cancer (Wise et al. 2009). Older or larger individuals did not appear to accumulate chromium at higher levels.

Status and Trends

Although population structure of sperm whales is unknown, several studies and estimates of abundance are available. Sperm whale populations probably are undergoing the dynamics of small population sizes, which is a threat in and of itself. In particular, the loss of sperm whales to directed Soviet whaling likely inhibits recovery due to the loss of adult females and their calves, leaving sizeable gaps in demographic and age structuring (Whitehead and Mesnick 2003).

The most comprehensive abundance estimate for sperm whales we are aware of is from Whitehead (2002a), who estimated that there are approximately 76,803 sperm whales in the eastern tropical Pacific, eastern North Pacific, Hawaii, and western North Pacific, and a worldwide population of 360,000 individuals. The tropical Pacific is home to approximately 26,053 sperm whales and the western North Pacific has approximately 29,674 (Whitehead 2002a). There was a dramatic decline in the number of females around the Galapagos Islands during 1985 to 1999 versus 1978 to 1992 levels, likely due to migration to nearshore waters of South and Central America (Whitehead and Mesnick 2003).

Sperm whale abundance varied off California between 1979/80 and 1991 (Barlow 1994) and between 1991 and 2008 (Barlow and Forney 2007). The estimate from 2008 is the lowest to date, in sharp contrast to the highest abundance estimates obtained from 2001 and 2005 surveys. There is no reason to believe that the population has declined; the most recent survey estimate likely reflects interannual variability in the action area.

Hill and DeMaster (1999) concluded that about 258,000 sperm whales were harvested in the North Pacific between 1947 to 1987. Although the IWC protected sperm whales from commercial harvest in 1981, Japanese whalers continued to hunt sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997b). In 2000, the Japanese Whaling Association announced plans to kill ten sperm whales in the Pacific Ocean for research. Although consequences of these deaths are unclear, the paucity of population data, uncertainty regarding recovery from whaling, and re-establishment of active programs for whale harvesting pose risks for the recovery and survival of this species. Sperm whales are also hunted for subsistence purposes by whalers from Lamalera, Indonesia, where a traditional whaling industry has been reported to kill up to 56 sperm whales per year.

Diving and Social Behavior

Sperm whales are probably the deepest and longest diving mammalian species, with dives to 3 km (1.6 nmi) down and durations in excess of two hours (Clarke 1976; Watkins 1985; Watkins et al. 1993). However, dives are generally shorter (25 to 45 minutes) and shallower (400 to 1,000 m). Dives are separated by eight to 11 minute rests at the surface (Gordon 1987; Watwood et al. 2006) (Jochens et al. 2006b; Papastavrou et al. 1989a). Sperm whales typically travel about 3 km (1.6 nmi) horizontally and 0.5 km (0.3 nmi) vertically during a foraging dive (Whitehead 2003). Differences in night and day diving patterns are not known for this species, but, like most diving air-breathers for which there are data (rorquals, fur seals, and chinstrap penguins), sperm whales probably make relatively shallow dives at night when prey are closer to the surface.

Unlike other cetaceans, there is a preponderance of dive information for this species, most likely because it is the deepest diver of all cetacean species and therefore generates a lot of interest. Sperm whales feed on large and medium-sized squid, octopus, rays and sharks, on or near the ocean floor (Clarke 1986; Whitehead 2002c). Some evidence suggests that they do not always dive to the bottom of the sea floor (likely if food is elsewhere in the water column), but that they do generally feed at the bottom of the dive. Davis et al. (2007) report that dive-depths (100 to 500 m [328 to 1,640 ft]) of sperm whales in the Gulf of California overlapped with depth distributions (200 to 400 m) of jumbo squid, based on data from satellite-linked dive recorders placed on both species, particularly during daytime hours. Their research also showed that sperm whales foraged throughout a 24-hour period, and that they rarely dove to the sea floor bottom (greater than 1000 m). The most consistent sperm whale dive type is U-shaped, during which the whale makes a rapid descent to the bottom of the dive, forages at various velocities while at depth (likely while chasing prey) and then ascends rapidly to the surface. There is some evidence that male sperm whales, feeding at higher latitudes during summer months, may forage at several depths including less than 200 m, and utilize different strategies depending on position in the water column (Teloni et al. 2007).

Movement patterns of Pacific female and immature male groups appear to follow prey distribution and, although not random, movements are difficult to anticipate and are likely associated with feeding success, perception of the environment, and memory of optimal foraging areas (Whitehead 2008). However, no sperm whale in the Pacific has been known to travel to points over 5,000 km (2,700 nmi) apart and only rarely have been known to move over 4,000 km (2,160 nmi) within a time frame of several years. This means that although sperm whales do not appear to cross from eastern to western sides of the Pacific (or vice-versa), significant mixing occurs that can maintain genetic exchange. Movements of several hundred miles are common, (i.e. between the Galapagos Islands and the Pacific coastal Americas). Movements appear to be group or clan specific, with some groups traveling straighter courses than others over the course of several days. However, general transit speed averages about 4 km/h. Sperm whales in the Caribbean region appear to be much more restricted in their movements, with individuals repeatedly sighted within less than 160 km (86 nmi) of previous sightings. Gaskin (1973) proposed a northward population shift of sperm whales off New Zealand in the austral autumn based on reduction of available food species and probable temperature tolerances of calves.

Sperm whales have a strong preference for waters deeper than 1,000 m (Reeves and Whitehead 1997b; Watkins and Schevill 1977), although Berzin (1971) reported that they are restricted to waters deeper than 300 m. While deep water is their typical habitat, sperm whales are rarely found in waters less than 300 m in depth (Clarke 1956; Rice 1989a). Sperm whales have been observed near Long Island, New York, in water between 40 and 55 m deep (Scott and Sadove 1997).

Sperm whales are frequently found in locations of high productivity due to upwelling or steep underwater topography, such as continental slopes, seamounts, or canyon features (Jaquet 1996; Jaquet and Whitehead 1996). Cold-core eddy features are also attractive to sperm whales in the Gulf of Mexico, likely because of the large numbers of squid that are drawn to the high concentrations of plankton associated with these features (Biggs et al. 2000; Davis et al. 2000;

Davis et al. 2002). Surface waters with sharp horizontal thermal gradients, such as along the Gulf Stream in the Atlantic, may also be temporary feeding areas for sperm whales (Griffin 1999; Jaquet and Whitehead 1996; Waring et al. 1993). Sperm whales over George's Bank were associated with surface temperatures of 23.2 to 24.9° C (Waring et al. 2004b).

Local information is inconsistent regarding sperm whale tendencies. Gregr and Trites (2001) reported that female sperm whales off British Columbia were relatively unaffected by the surrounding oceanography. However, Tynan et al. (2005) reported increased sperm whales densities with strong turbulence associated topographic features along the continental slope near Heceta Bank. Two noteworthy strandings in the region include an infamous incident (well publicized by the media) of attempts to dispose of a decomposed sperm whale carcass on an Oregon beach by using explosives. In addition, a mass stranding of 47 individuals in Oregon occurred during June 1979 (Norman et al. 2004; Rice et al. 1986).

Stable, long-term associations among females form the core of sperm whale societies (Christal et al. 1998). Up to about a dozen females usually live in such groups, accompanied by their female and young male offspring. Young individuals are subject to alloparental care by members of either sex and may be suckled by non-maternal individuals (Gero et al. 2009). Group sizes may be smaller overall in the Caribbean Sea (six to 12 individuals) versus the Pacific (25 to 30 individuals) (Jaquet and Gendron 2009). Males start leaving these family groups at about 6 years of age, after which they live in "bachelor schools," but this may occur more than a decade later (Pinela et al. 2009). The cohesion among males within a bachelor school declines with age. During their breeding prime and old age, male sperm whales are essentially solitary (Christal and Whitehead 1997).

Vocalization and Hearing

Sound production and reception by sperm whales are better understood than in most cetaceans. Sperm whales produce broad-band clicks in the frequency range of 100 Hz to 20 kHz that can be extremely loud for a biological source (200 to 236 dB re: 1μPa), although lower source level energy has been suggested at around 171 dB re: 1μPa (Goold and Jones 1995; Madsen et al. 2003; Weilgart and Whitehead 1997b; Weilgart et al. 1993). Most of the energy in sperm whale clicks is concentrated at around 2 kHz to 4 kHz and 10 kHz to 16 kHz (Goold and Jones 1995; NMFS 2006; Weilgart et al. 1993). The highly asymmetric head anatomy of sperm whales is likely an adaptation to produce the unique clicks recorded from these animals (Cranford 1992; Norris and Harvey. 1972). These long, repeated clicks are associated with feeding and echolocation (Goold and Jones 1995; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997b). However, clicks are also used in short patterns (codas) during social behavior and intra-group interactions (Weilgart et al. 1993). They may also aid in intra-specific communication. Another class of sound, "squeals", are produced with frequencies of 100 Hz to 20 kHz (e.g., Weir et al. 2007).

Our understanding of sperm whale hearing stems largely from the sounds they produce. The only direct measurement of hearing was from a young stranded individual from which auditory evoked potentials were recorded (Carder and Ridgway 1990). From this whale, responses support a hearing range of 2.5 kHz to 60 kHz. However, behavioral responses of adult, free-ranging individuals also provide insight into hearing range; sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins 1985; Watkins and Schevill 1975a). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995). Because they spend large amounts of time at depth and use low-frequency sound, sperm whales are likely to be susceptible to low frequency sound in the ocean (Croll et al. 1999c).

Recordings of sperm whale vocalizations reveal that they produce a variety of sounds, such as clicks, gunshots, chirrups, creaks, short trumpets, pips, squeals and clangs (Goold 1999). Sperm whales typically produce short-duration repetitive broadband clicks with frequencies below 100 Hz to greater than 30 kHz (Thomson and Richardson 1995b; Watkins 1977) and dominant frequencies between 1 kHz to 6 kHz and 10 kHz to 16 kHz. The source levels can reach 236 dB re: 1μPa-m (Møhl et al. 2003). The clicks of neonate sperm whales are very different from typical clicks of adults in that they are of low directionality, long duration, and low-frequency (between 300 Hz and 1.7 kHz) with estimated source levels between 140 to 162 dB re: 1μPa-m (Madsen et al. 2003). Clicks are heard most frequently when sperm whales are engaged in diving and foraging behavior (Miller et al. 2004; Whitehead and Weilgart 1991). Creaks (rapid sets of clicks) are heard most frequently when sperm whales are foraging and engaged in the deepest portion of their dives, with inter-click intervals and source levels being altered during these behaviors (Laplanche et al. 2005; Miller et al. 2004).

When sperm whales are socializing, they tend to repeat series of group-distinctive clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill 1977). Codas are shared between individuals in a social unit and are considered to be primarily for intragroup communication (Rendell and Whitehead 2004; Weilgart and Whitehead 1997a). Recent research in the South Pacific suggests that in breeding areas the majority of codas are produced by mature females (Marcoux et al. 2006). Coda repertoires have also been found to vary geographically and are categorized as dialects, similar to those of killer whales (Pavan et al. 2000; Weilgart and Whitehead 1997a). For example, significant differences in coda repertoire have been observed between sperm whales in the Caribbean and those in the Pacific (Weilgart and Whitehead 1997a). Three coda types used by male sperm whales have recently been described from data collected over multiple years: these include codas associated with dive cycles, socializing, and alarm (Frantzis and Alexiadou 2008).

Direct measures of sperm whale hearing have been conducted on a stranded neonate using the auditory brainstem response technique: the whale showed responses to pulses ranging from 2.5 kHz to 60 kHz and highest sensitivity to frequencies between 5 kHz to 20 kHz (Ridgway and

Carder 2001). Other hearing information consists of indirect data. For example, the anatomy of the sperm whale's inner and middle ear indicates an ability to best hear high-frequency to ultrasonic hearing (Ketten 1992a). The sperm whale may also possess better low-frequency hearing than other odontocetes, although not as low as many baleen whales (Ketten 1992a). Reactions to anthropogenic sounds can provide indirect evidence of hearing capability, and several studies have made note of changes seen in sperm whale behavior in conjunction with these sounds. For example, sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echo-sounders and submarine sonar (Watkins et al. 1985; Watkins and Schevill 1975a). In the Caribbean, Watkins et al. (1985) observed that sperm whales exposed to 3.25 kHz to 8.4 kHz pulses (presumed to be from submarine sonar) interrupted their activities and left the area. Similar reactions were observed from artificial sound generated by banging on a boat hull (Watkins et al. 1985). Andre et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signal did not ultimately exhibit any general avoidance reactions: when resting at the surface in a compact group, sperm whales initially reacted strongly, and then ignored the signal completely. Thode et al. (2007) observed that the acoustic signal from the cavitation of a fishing vessel's propeller (110 dB re: 1μPa^2 between 250 Hz and 1.0 kHz) interrupted sperm whale acoustic activity and resulted in the animals converging on the vessel. The full range of functional hearing for the sperm whale is estimated to occur between approximately 150 Hz and 160 kHz, placing them among the group of cetaceans that can hear mid-frequency sounds (Southall et al. 2007b).

Sperm whales have been observed by marine mammal observers aboard U.S. Navy surface ships during training events and detected on the PMRF naval range hydrophones; however, MFAS was not active so no behavioral response data exists during naval training events. However, a sperm whale was tagged for a controlled exposure experiment during the initial phase of the proposed study, SOCAL BRS 2010. The sperm whale did not appear to demonstrate obvious behavioral changes in dive pattern or production of clicks (Southall et al. 2011c).

Critical Habitat

Sperm whale critical habitat has not been designated.

4.2.6 Guadalupe Fur Seal

Guadalupe fur seals are medium sized, sexually dimorphic otariids that are generally asocial with their conspecifics and other species (Belcher and T.E. Lee 2002; Reeves et al. 2002). Except for adult males, members of this species resemble California sea lions and northern fur seals. Distinguishing characteristics of the Guadalupe fur seal include the digits on their hind flippers (all of similar length), large, long foreflippers, unique vocalizations, and a characteristic behavior of floating vertically with their heads down in the water and their hind flippers exposed for cooling (Reeves et al. 2002).

Distribution

Guadalupe fur seals' historic range included the U.S. Gulf of Farallones, California to the Revillagigedo Islands, Mexico (Belcher and T.E. Lee 2002; Rick et al. 2009). Currently, they breed mainly on Guadalupe Island, Mexico, 155 miles off of the Pacific Coast of Baja California. A smaller breeding colony, discovered in 1997, appears to have been established at Isla Benito del Este, Baja California, Mexico (Belcher and T.E. Lee 2002). All Guadalupe fur seals represent a single population.

There are reports of individuals being sighted in the California Channel Islands, Farallone Islands, Monterey Bay, and other areas of coastal California and Mexico (Belcher and T.E. Lee 2002; Carretta et al. 2002; Reeves et al. 2002). A single female gave birth to a pup on the Channel Islands in 1997. No Guadalupe fur seals have been sighted during 2009 through 2013 U.S. Navy-funded surveys in the action area.

Population Structure

All Guadalupe fur seals represent a single population.

Natural Threats

Although currently protected from commercial harvest, natural genetic factors are seen as a significant threat to the continued survival of this species. Because few individuals remained after commercial hunting, relatively low genetic diversity means that remaining individuals tend to be more susceptible to disease and inbreeding effects over subsequent generations (Bernardi et al. 1998; Weber et al. 2004). Sharks are known to prey upon Guadalupe fur seals, although mortality level is unknown (Gallo-Reynosa 1992).

Anthropogenic Threats

Due to small population size, this species is highly susceptible to extinction risk by relatively small mortalities. Guadalupe fur seals have been found stranded with fish hooks and other evidence of fishing gear interaction along the California coast (Hanni et al. 1997).

Status and Trends

Guadalupe fur seals were hunted to near extinction by the late 1800s, with pre-harvest population estimates of 20,000 to 100,000 individuals. By 1897, the Guadalupe fur seal was believed to be extinct until a small population was found on Guadalupe Island in 1926. The most recent estimate is 7,408 animals in 1993 (Carretta et al. 2014), with a population growth rate of 13.7 percent per year (Carretta et al. 2002). The number of individuals on the San Benito Islands appear to be increasing rapidly, with over 2,000 individuals counted in 2008 and is undergoing an exponential increase in population sizes, likely due to immigration from Guadalupe Island (Aurioles-Gamboa et al. 2010). The estimated minimum population size for Guadalupe sur seals in Mexico is 3,028 individuals based on actual counts of hauled out seals (Carretta et al. 2014). This population took a hit during the 2015 Unusual Mortality Event, which was concurrent with the 2013 to 2015 California sea lion Unusual Mortality Event. The official causes of death are yet undetermined. Guadalupe fur seal are stranding alive and dead and are mostly weaned pups and juveniles (1 to 2 years old). Findings from the majority of stranded animals include malnutrition with secondary bacterial and parasitic infections.

Diving and Social Behavior

The mean dive depth of Guadalupe fur seal lactating females is 17 m (55 ft), with a mean dive duration of 2.6 minutes. Mean surface interval between dives was two minutes. Dives were organized as outings lasting 2.5 hours. Foraging occurred during the night and transit during the day, with a maximum of 168 dives per day. Generally diving occurred at night, between eight in the evening and five in the morning (Croll et al. 1999b). Little is known about Guadalupe fur seal behavior during non-breeding season. They appear to spend long periods foraging at shallow depths during this time, but little information is known on their distribution at sea (Belcher and T.E. Lee 2002). Guadalupe fur seals are solitary, non-social animals.

Vocalization and Hearing

Pinnipeds produce sounds both in air and water that range in frequency from approximately 100 Hz to several tens of kHz and it is believed that these sounds serve social functions such as mother-pup recognition and reproduction. Source levels for pinniped vocalizations range from approximately 95 to 190 dB re: 1μPa (Richardson et al. 1995a).

Underwater hearing in otariid seals is adapted to low frequency sound and less auditory bandwidth than phocid seals. Hearing in otariid seals has been tested in two species present in the action area: California sea lion (Kastak and Schusterman 1998) and northern fur seal (Babushina et al. 1991; Moore and Schusterman 1987). Based on these studies, Guadalupe fur seals would be expected to hear sounds within the ranges of 50 Hz to 75 kHz in air and 50 Hz to 50 kHz in water. Schusterman et al. (2000) reviewed available evidence on the potential for pinnipeds to echolocate and indicated that pinnipeds have not developed specialized sound production or reception systems required for echolocation. Instead, it appears pinnipeds have developed alternative sensory systems (e.g., visual, tactile) to effectively forage, navigate and avoid predators underwater.

Critical Habitat

NMFS has not designated critical habitat for Guadalupe fur seals.

5 ENVIRONMENTAL BASELINE

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this opinion includes the effects of several activities that affect the survival and recovery of ESA-listed species in the action area. For this opinion, the action area consists of the Southern California bight in the U.S. off the southwestern coast of California (see Section 2.2 and Figure 1 of this opinion).

5.1 Climate Change

The average global surface temperature rose by 0.85º C from 1880 to 2012, and it continues to rise at an accelerating pace (IPCC 2014); the 10 warmest years on record since 1880 have occurred since 1998, with 2014 being the warmest (NCDC 2015). Since 2000, the Arctic (latitudes between 60 and 90º North) has been warming at more than twice the rate of lower latitudes (Jeffries et al. 2014) due to "Arctic amplification", a characteristic of the global climate system influenced by changes in sea ice extent, atmospheric and oceanic heat transports, cloud cover, black carbon, and many other factors (Serreze and Barry 2011).

Direct effects of climate change include increases in atmospheric temperatures, decreases in sea ice, and changes in sea surface temperatures, patterns of precipitation, and sea level. Indirect effects of climate change have, are, and will continue to impact marine species in the following ways (IPCC 2014):

- Shifting abundances
- Distribution
- Migration patterns
- Timing of seasonal activities

Climate change is likely to have its most pronounced effects on species whose populations are already in tenuous positions (Isaac 2009). Therefore, we expect the extinction risk of ESA-listed species to rise with global warming. Cetaceans with restricted distributions linked to water temperature may be particularly exposed to range restriction (Isaac 2009; Learmonth et al. 2006). MacLeod (2009) estimated that, based on expected shifts in water temperature, 88 percent of cetaceans will be affected by climate change, 47 percent will be negatively affected, and 21 percent will be put at risk of extinction. Of greatest concern are cetaceans with ranges limited to non-tropical waters, and preferences for shelf habitats (MacLeod 2009).

Oceanographic Features and Climatic Variability

Climatic change and change may be affecting ESA-listed species through change in habitat and prey availability. However, these effects are not well understood. Possible effects of climatic variability for marine species include the alteration of community composition and structure, changes to migration patterns or community structure, changes to species abundance, increased susceptibility to disease and contaminants, alterations to prey composition and altered timing of breeding (Kintisch 2006; Learmonth et al. 2006; MacLeod et al. 2005; McMahon and Hays 2006; Robinson et al. 2005). Naturally occurring climatic patterns, such as the Pacific Decadal Oscillation and the El Niño and La Niña events, are identified as major causes of changing marine productivity worldwide and may also therefore influence ESA-listed species' prey abundance (Beamish et al. 1999; Benson and Trites 2002; Francis et al. 1998; Hare et al. 1999; Mantua et al. 1997). Gaps in information and the complexity of climatic interactions complicate the ability to predict the effects of climate change and variability may have to these species (Kintisch 2006; Simmonds and Isaac 2007).

5.2 Natural Sources of Stress and Mortality

5.2.1 Blue Whales

Little is known about natural mortality of blue whales. In the North Atlantic, ice entrapment is known to injure and kill some blue whales (Beamish 1979; Sergeant 1982) and individuals have been observed to bear scars thought to be from contact with ice (Sears et al. 1987). Killer whales have been observed to attack blue whales (Tarpy 1979), and blue whales in the Gulf of California bear scars that are consistent with killer whale attacks (Sears et al. 1990). However, it is uncertain how these attacks can impact populations (Reeves 1998).

5.2.2 Fin Whales

Sources and rates of natural mortality are largely unknown in fin whales. Ice entrapment is known to injure and kill some whales in the Atlantic (Sergeant et al. 1970). Disease presumably plays a role in natural mortality as well (Lambertsen 1986). Urinary tract diseases caused by parasites has been suggested to be the primary cause of natural mortality in North Atlantic fin whales (Lambertsen 1986a). Killer whale attacks may result in serious injury or death in young or sick fin whales (Perry et al. 1999a). Rates of natural mortality in fin whales generally are thought to range between four and six percent (Aguilar and Lockyer 1987a).

5.2.3 Sei Whales

Important natural mortality factors are largely unknown in sei whales. However, diseases have been observed in this species. The sei whale is often heavily infected with endoparasitic helminth worms (Rice 1977). In addition, in the 1980's, roughly seven percent of sei whales off California were observed to have an unknown disease that causes them to shed their baleen plates which impairs their feeding ability (Mizroch et al. 1984b). However, it is unknown how these diseases affect sei whale populations.

5.2.4 Humpback Whales

The causes of natural mortality in humpback whales are largely unknown although parasites may play a significant role (Lambertsen 1986). Humpback whales are known to be parasitized by the nematode, *Crassicauda boopis*, which is a significant cause of death in the closely related fin whale (Lambertsen 1986). Killer whale attacks have also been documented on humpback whales (Dolphin 1987a), but it is unclear what impacts this has on population trends for this species. Lethal strandings attributed to harmful algal blooms have also been documented (Geraci et al. 1989) and lethal entrapment in ice has also been observed (Mitchell 1979).

5.2.5 Sperm Whales

Although it is unclear how they affect sperm whale populations, predation on calves from killer whales (Arnbom et al. 1987) and possibly large sharks (Best et al. 1984b) has been documented. Recently, bone necrosis has been observed in sperm whales, possibly caused by the formation of nitrogen bubbles following deep dives and subsequent ascents (Moore and Early 2004) which could potentially contribute to mortality. However, the effects of necrosis on the fitness of individuals or populations are unknown.

5.2.6 Guadalupe Fur Seals

Although currently protected from commercial harvest, natural genetic factors are seen as a significant threat to the continued survival of this species. Relatively low genetic diversity as a result of overharvesting has resulted in remaining individuals being more susceptible to disease and inbreeding effects (Bernardi et al. 1998; Weber et al. 2004). Sharks are known to prey upon Guadalupe fur seals but the effects to the population is unknown (Gallo-Reynosa 1992).

5.3 Anthropogenic Stressors

5.3.1 Commercial Harvest

Although commercial harvesting no longer targets any listed species in the proposed action area, prior exploitation may have altered the population structure and social cohesion of the species such that effects on abundance and recruitment can continue for years after harvesting has ceased.

Blue Whales

While the pre-whaling worldwide abundance of blue whales may have been as high as 200,000 individuals (Maser et al. 1981a; U.S. Department of Commerce 1983), current estimates range from 3,300 (Wade and Gerrodette. 1993) to as low as 1,400 (Barlow et al. 1997a). The IUCN estimated an approximate 50 percent decline in blue whales worldwide over the last 75 years when commercial whaling was widely practiced (Reeves et al. 2003). Rice (1974) suggested that the pre-1924 North Pacific blue whale population size was around 6,000. Approximately 9,500 whales of this population were reported killed between 1910 and 1965 (Ohsumi and Wada. 1972). An estimated 360,644 southern hemisphere blue whales have been killed by whalers from

1904 to 2000 (Clapham and Baker 2002; Yablokov et al. 1998a). In addition, an unknown number of blue whales were taken illegally by the Soviet Union after gaining protection from commercial whaling in 1966 (Yablokov et al. 1998a). At least 11,000 blue whales were killed in the North Atlantic in the 19th to mid-20th centuries (Sigurjónsson and Gunnlaugsson 1990).

Fin Whales

Coinciding with the advent of modern whaling practices, the IUCN estimated an approximate 50 percent decline in fin whales worldwide over the last 75 years, with most of this decline occurring in the Southern Hemisphere (Reeves et al. 2003). Prior to commercial harvest, there may have been up to 45,000 fin whales in the North Pacific. By the early 1970s, commercial whaling may have reduced this population to between 13,620 and 18,630 (Ohsumi and Wada 1974). Commercial whaling for fin whales ended in the North Pacific in 1976. There were 703,693 fin whales killed in the Antarctic from 1904 to 1975 (IWC 1990).

In the North Atlantic, there may have been as many as 30,000 to 50,000 fin whales before commercial exploitation (Sergeant 1977). However, Roman and Palumbi (2003) estimated that, based on genetic analysis, the historical population size for North Atlantic fin whales may have been as high as 360,000. Over 48,000 fin whales were caught between 1860 and 1970 in the Atlantic (Braham 1991a). Fin whales are still hunted in Greenland and subject to catch limits under the IWC's Aboriginal Subsistence Whaling Scheme. From 1996 to 2007, subsistence catches are reported to be 126 animals from the North Atlantic (IWC 2007). The best current abundance estimate available for the western North Atlantic fin whale stock is 2,269 (Waring et al. 2008).

Sei Whales

The stocks of sei whales have been heavily depleted before gaining protection from commercial harvest in the 1970s and 1980s (Reeves et al. 2003). After the blue and fin whales became scarce due to overharvesting, sei whales were heavily exploited (Reeves et al. 2003). The IUCN estimated an approximate 50 percent decline in sei whales worldwide over the last 75 years when commercial whaling was widely practiced (Reeves et al. 2003). Most of this decline occurred in the Southern Hemisphere (Reeves et al. 2003). In the North Pacific, 72,215 sei whales were reported to have been killed by commercial whalers between 1910 and 1975 (Horwood 1987a). There were 14,295 sei whales reported to have been killed in the North Atlantic between 1885 and 1984 (Horwood 1987a). A total of 152,233 sei whales were killed in the Southern Hemisphere between 1910 and 1979 (Horwood 1987a). The extent to which stocks have recovered since then is unknown. Relatively little recent research has been conducted on this species (Reeves et al. 2003).

Humpback Whales

Commercial whaling heavily depleted worldwide humpback whale numbers, but most populations have increased since whaling was banned in 1966 (Reilly 2008). For Humpback whales in the Pacific Ocean, whaling operations took nearly 30,000 whales from 1900 to 1965 with an unknown number harvested prior to 1900 (Perry et al. 1999a). In 1965, the IWC banned the commercial hunting of humpback whales in the Pacific.

In the western North Atlantic, 522 humpback whales were harvested off Greenland from 1886 to 1976 (Kapel 1979) and 1,397 animals were harvested off of eastern Canada from 1903 to 1970 (Mitchell 1974b). At least 1,579 humpback whales were killed in the eastern North Atlantic and Arctic from 1868 to 1955, with other un-documented harvestings also occurring (Perry et al. 1999a). This stock was given protected status in the North Atlantic in 1955, with an allowance for subsistence harvesting (Brown 1976). Reported subsistence harvests of this stock have been of one or two animals in most years since 1986 (IWC 2007).

In the Southern Hemisphere, some 208,359 humpback whales were recorded to have been killed between 1904 to 2002 (Clapham and Baker 2002; Yablokov et al. 1998a). Soviet whalers killed more than 48,000 humpback whales after World War II with nearly 13,000 animals harvested in the 1959 to 1960 season alone (Clapham and Baker 2002). The population of whales that inhabited the coastal waters of New Zealand collapsed in 1960 (Clapham and Baker 2002). Although rare, some animals have been recently observed in these waters (Clapham and Baker 2002).

Sperm Whales

Sperm whales were subject to commercial whaling in all parts the world. Whitehead (2002b) suggested that the pre-exploitation worldwide population of sperm whales was approximately 1,100,000. This number had been reduced to approximately 360,000 by the 1990’s (Taylor 2008; Whitehead 2002b). The IWC gave sperm whales complete protection from commercial whaling in 1986 (IWC 1982). Japan still takes a small number of sperm whales each year under an exemption for scientific research and Norway and Iceland have formally objected to the IWC ban on commercial whaling and therefore may resume whaling of sperm whales under IWC rules.

In the North Pacific, sperm whale hunting began in the early 1800s (Best 1983). After the introduction of modern whaling technology, the peak annual catches by modern whaling before the war were less than 2,000, but soon climbed to over 16,000 by 1968 (Ohsumi 1980). Between 1910 and 1976, approximately 269,000 sperm whales were taken in the North Pacific (Ohsumi 1980). However, deliberate misreporting of Japanese catch data has been suggested (Kasuya 1998). Under reporting by Soviet whalers is also known to have occurred (Yablokov 1994). An estimated 180,000 animals are now believed to have been killed by Soviet whalers between 1949 and 1971 (Brownell et al. 1998) before the IWC implemented it’s international observer policy to curtail misreporting of whale catch data. This figure is approximately 60 percent higher than official reports (Brownell et al. 1998).

No reliable records exist for the number of sperm whales killed in the North Atlantic before the 1900s, but estimates are in the hundreds of thousands (see NMFS 2006). Better records exist for catches after the advent of modern whaling. An extrapolation of all catch data in the North

Atlantic after 1905 resulted in an estimated figure of 38,235 whales killed since 1905 (IWC 1981).

Guadalupe Fur Seals

Guadalupe fur seals were hunted to near extinction by the 1890s (Townsend 1931). The species was believed to be extinct until two adult males were captured on Guadalupe Island in 1928 (Townsend 1931). The population size prior to commercial exploitation is unknown, but estimates range from 20,000 to 100,000 animals (Fleischer 1987; Hubbs 1956).

5.3.2 U.S. Navy Activities

SOCAL Range Complex

The U.S. Navy has been conducting training and other activities in SOCAL for over 70 years. Current activities include anti-submarine warfare exercises, anti-air warfare exercises, anti-surface warfare exercises, and amphibious warfare exercises, coordinated training events and research, development and evaluation activities. The U.S. Navy estimates that it currently conducts about eight major training exercises, seven integrated exercises, and numerous unit-level training and maintenance exercises in the Southern California Range Complex each year (U.S. Navy 2008).

Although the U.S. Navy did not estimate the number of times different listed species might be exposed to mid-frequency active sonar during these training activities, NMFS estimated about 14,000 instances in which endangered or threatened marine mammals would be exposed to U.S. Navy training activities during the cold season and another 3,600 exposure events during the warm season. The largest number of exposure events (about 70 percent or about 9,900 exposure events during the cold season and about 1,891 exposure events during the warm season) would involve blue whales, with 2,100 exposure events involving sperm whales (about 15 percent of the exposure events), and 1,900 exposure events involving fin whales (about 13.7 percent of the exposures).

Of this total number of exposure events involving MFAS, the U.S. Navy estimated that yearly totals for behavioral harassment events would be 480 for blue whales, 135 for fin whales, 120 for sperm whales, and 772 for Guadalupe fur seals. Because blue whales are not likely to hear MFAS, it is assumed that blue whales would be more likely to be harassed by vessel traffic rather than the active sonar itself.

The U.S. Navy also estimated that three blue whales would have been behaviorally harassed each year as a result of underwater detonations associated with training activities in Southern California and another two blue whales would have experienced temporary losses in hearing sensitivity as a result of being exposed to those detonations. Two fin whales and an additional fin whale would also have experienced temporary losses in hearing sensitivity as a result of being exposed to these detonations. Two sperm whales would have been behaviorally harassed each year and an additional two sperm whales would have experienced temporary losses in hearing sensitivity as a result of being exposed to these detonations. Two Guadalupe fur seals would have been behaviorally harassed and an additional two seals would have experienced temporary losses in hearing sensitivity as a result of being exposed to these detonations.

5.3.3 Pollution

Pesticides and Contaminants

Exposure to pollution and contaminants has the potential to cause adverse health effects in marine species. In the eastern Pacific, marine ecosystems receive pollutants from a variety of local, regional, and international sources and their levels and sources are therefore difficult to identify and monitor (Grant and Ross 2002). Marine pollutants come from multiple municipal, industrial and household as well as from atmospheric transport (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata 1993).

The accumulation of persistent pollutants through trophic transfer may cause mortality and sub-lethal effects in long-lived higher trophic level animals (Waring et al. 2008), including immune system abnormalities, endocrine disruption and reproductive effects (Krahn et al. 2007). Recent efforts have led to improvements in regional water quality and monitored pesticide levels have declined, although the more persistent chemicals are still detected and are expected to endure for years (Grant and Ross 2002; Mearns 2001).

Hydrocarbons

Exposure to hydrocarbons released into the environment via oil spills and other discharges pose risks to marine species. Marine mammals are generally able to metabolize and excrete limited amounts of hydrocarbons, but exposure to large amounts of hydrocarbons and chronic exposure over time pose greater risks (Grant and Ross 2002). Acute exposure of marine mammals to petroleum products causes changes in behavior and may directly injure animals (Geraci 1990). Cetaceans have a thickened epidermis that greatly reduces the likelihood of petroleum toxicity from skin contact with oils (Geraci 1990), but may inhale these compounds at the water’s surface and ingest them while feeding (Matkin and Saulitis 1997). Hydrocarbons also have the potential to impact prey populations, and therefore may affect listed species indirectly by reducing food availability.

Marine Debris

Types of marine debris include plastics, glass, metal, polystyrene foam, rubber, and derelict fishing gear from human marine activities or transported into the marine environment from land. The sources of this debris include littering, dumping and industrial loss and discharge from land. Marine debris can damage important marine habitat, such as rookeries and haulout sites of pinnipeds by making them inhospitable to the species that rely on them. Marine animals can also become entangled in marine debris, or ingest it, which may lead to injury or death.

The bottom-feeding habits of sperm whales suggest that they could ingest marine debris (Lambertsen 1997). One of 32 sperm whales examined for pathology in Iceland had a lethal disease thought to have been caused by the complete obstruction of the gut with plastic marine debris (Lambertsen 1997). Given the limited knowledge about the impacts of marine debris on baleen whales, it is difficult to determine the extent of the threats that marine debris poses to these species.

Sound

Sound generated by human activity has the potential to affect listed species. This includes sound generated by commercial and recreational vessels, aircraft, commercial sonar, military activities, seismic exploration, in-water construction activities and other human activities. These activities all occur within the action area to varying degrees throughout the year. Marine mammals generate and rely on sound to navigate, hunt and communicate with other individuals. As a result, anthropogenic sound can interfere with these important activities. The effects of sound on marine mammals can range from behavioral effects to physical damage (Richardson et al. 1995a).

Commercial shipping traffic is a major source of low frequency anthropogenic sound in (NRC 2003). Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo ships that includes significant levels above 2 kHz, which may interfere with important biological functions of cetaceans (Holt 2008). Commercial sonar systems are used on recreational and commercial vessels and may affect marine mammals (NRC 2003). Although, little information is available on potential effects of multiple commercial sonars to marine mammals, the distribution of these sounds would be small because of their short durations and the fact that the high frequencies of the signals attenuate quickly in seawater (Richardson et al. 1995a).

Seismic surveys using towed airguns also occur within the action area and are the primary exploration technique for oil and gas deposits and for fault structure and other geological hazards. Airguns generate intense low-frequency sound pressure waves capable of penetrating the seafloor and are fired repetitively at intervals of 10 to 20 seconds for extended periods (NRC 2003). Most of the energy from the guns is directed vertically downward, but significant sound emission also extends horizontally. Peak sound pressure levels from airguns usually reach 235 to 240 dB at dominant frequencies of 5 to 300 Hz (NRC 2003). Most of the sound energy is at frequencies below 500 Hz. In the U.S., all seismic projects for oil and gas exploration and most research activities involving the use of airguns with the potential to take marine mammals are covered by incidental take authorizations under the MMPA.

Fishing Activities

Entrapment and entanglement in fishing gear is a frequently documented source of human-caused mortality in marine mammals (see Dietrich et al. 2007). Guadalupe fur seals have been found stranded with fish hooks and other evidence of fishing gear interaction along the California coast (Hanni et al. 1997). These entanglements also make animals more vulnerable to additional dangers (e.g., predation and ship strikes) by restricting agility and swimming speed.

There is concern that many marine mammals that die from entanglement in commercial fishing gear tend to sink rather than strand ashore thus making it difficult to accurately determine the extent of such mortalities.

Marine mammals probably consume at least as much fish as is harvested by humans (Kenney et al. 1985). Therefore, competition with humans for prey is a potential concern for whales. The sperm whale's principle prey is large squid (Clarke 1996; Clarke et al. 1980; Clarke and Macleod. 1980), but they will also eat large sharks, skates, and fishes (Clarke 1977; Clarke 1980; Rice 1989b). Reductions in fish populations, whether natural or human-caused, may affect listed whale populations and their recovery.

Sei whales consume a diverse set of prey which may allow them a greater opportunity to take advantage of variable resources (Waring et al. 2008). However, this attribute may also increase their potential for competition with commercial fisheries (Rice 1977). Similarly, humpback and fin whales are known to feed on several species of fish that are harvested by humans and fishery-caused reductions in prey resources could also have an influence on these species (Waring et al. 2008). However, the extent of competition between humans and whales is not known.

Krill species are their principle prey of blue whales and are not commercially exploited on a large scale in the Northern Hemisphere. However, reduced zooplankton abundance due to habitat degradation is a potential indirect threat to these species.

5.3.4 Ship Strikes and Other Vessel Interactions

Ships have the potential to affect marine mammals through strikes and from sound and visual disturbance by their physical presence. Responses to vessel interactions include disturbance of vital behaviors and social groups, separation of mothers and young and abandonment of resting areas (Bejder et al. 1999; Boren et al. 2001; Colburn 1999; Constantine 2001; Cope et al. 1999; Kovacs and Innes. 1990; Kruse 1991; Mann et al. 2000; Nowacek et al. 2001; Samuels et al. 2000; Samuels and Gifford. 1998; Wells and Scott 1997). Whale watching, a profitable and rapidly growing business with more than 9 million participants in 80 countries and territories, may increase these types of disturbance and negatively affect listed species (Hoyt 2001).

Ship strikes are considered a serious and widespread threat to marine mammals. This threat is increasing as commercial shipping lanes cross important breeding and feeding habitats and as whale populations recover and populate new areas or areas where they were previously extirpated (Swingle et al. 1993; Wiley et al. 1995). As ships continue to become faster and more widespread, an increase in ship interactions with marine mammals is to be expected. For whales, studies show that the probability of fatal injuries from ship strikes increases as vessels operate at speeds above 14 knots (Laist et al. 2001).

However, ships moving at relatively slow speeds may be a threat as well. On Oct. 19, 2009 a ship mapping the seafloor off California for NOAA reported a "a shudder underneath the[ir] ship" (NMFS unpublished data). A whale was spotted soon thereafter and was observed to be bleeding profusely. A dead 20 m (65.6 ft) long blue whale was found washed up on Ft. Bragg beach in northern California soon thereafter and was the apparent victim of a ship strike (Unpublished report from Fugro Pelacos, Inc. to NMFS). The vessel that struck the whale was only traveling at approximately 10.2 km per hour (5.5 knots) (NMFS unpublished data).

Twenty-one confirmed mortalities of large whales resulted from 42 confirmed ship strikes in the North Atlantic between the years of 2000 to 2004 alone (Cole et al. 2006). Fin whales are the most frequently struck whale, although right whales, humpback whales and sperm whales are also commonly struck (Laist et al. 2001). In some locations, one-third of all fin whale and North Atlantic right whale strandings appear to involve ship strikes (Laist et al. 2001).

5.3.5 Scientific Research

Marine mammals in the action area have been the subject of scientific research activities, as authorized by NMFS permits. Research in the action area has included biopsy sampling, close vessel and aircraft approaches, the collection of sloughed skin, tagging, active acoustic experiments and anatomical data gathering using ultrasound devices. No mortalities are authorized for any animal of any age. There are 14 active permits authorizing research in the Pacific Ocean on one or more of the marine species listed to be taken by the proposed action. The following is a list of some currently authorized scientific research permits that have been issued for tagging or introducing sound into the marine environment that have similarities to those in the proposed action:

- Permit No. 14118 (Woods Hole Oceanographic Institute) involves medium to long-term satellite, acoustic, and multi-sensor tagging studies on large and small cetaceans in North Pacific waters via a novel, noninvasive peduncle belt attachment mechanism. This permit has not been used since it was issued in May 2012 and extends through April 2017.
- Permit No. 14245 (NMFS National Marine Mammal Laboratory) involves research on all cetacean species in the Pacific Ocean off of Alaska and the U.S. West Coast to capture animals, collect samples, conduct monitoring surveys, and enhance general knowledge on marine mammal ecology. A wide range of data collection techniques will be used. This permit extends through May 2017.
- Permit No. 14534 (Southall Environmental Associates, Inc.) involves behavioral response studies of marine mammals in the Pacific Ocean using controlled sound exposure. This permit extends through June 2016 and will be replaced by the current consultation and proposed permit. As shown in Table 4 below, we have post-collection reporting from the first four years of 14534-permitted activities that had actual take numbers for ESA-listed species that were much lower than the expected take that was proposed in the original application.

Table 3. Comparison of actual and expected takes of ESA-listed species from the first four years of behavioral response study activities under Permit No. 14534.

Species-Year	Category 1		Category 2		Category 3		Category 4		Category 5	
	Exp	Act	Exp	Act	Exp	Act	Exp	Act	Exp	Act
Blue-1	20	19	80	18	228	0	40	34	4	0
Blue-2	20	13	80	17	228	17	40	8	4	0
Blue-3	20	2	80	0	228	0	40	1	4	0
Blue-4	20	3	80	10	228	29	40	3	4	0
Total Blue	80	37	320	45	912	46	160	46	16	0
Fin-1	20	5	80	2	342	0	60	3	6	0
Fin-2	20	0	80	1	342	8	60	0	6	0
Fin-3	20	3	80	0	342	0	60	2	6	0
Fin-4	20	6	80	8	342	65	60	11	6	0
Total Fin	80	14	320	11	1368	73	240	16	24	0
Humpback-1	-	-	-	-	-	-	-	-	2	0
Humpback-2	20	2	80	0	114	0	60	0	2	0
Humpback-3	20	2	80	0	114	0	60	1	2	0
Humpback-4	20	0	80	0	114	0	60	0	2	0
Total Humpback	60	4	240	0	342	0	180	1	6	0
Sei-1	-	-	-	-	-	-	-	-	6	0
Sei-2	-	-	-	-	-	-	-	-	6	0
Sei-3	-	-	-	-	-	-	-	-	6	0
Sei-4	-	-	-	-	-	-	-	-	6	0
Total Sei	0	0	0	0	0	0	0	0	24	0
Sperm-1	20	2	40	0	86	0	100	0	10	0
Sperm-2	20	2	40	0	86	0	100	0	10	0
Sperm-3	20	0	40	0	86	0	100	0	10	0
Sperm-4	20	0	40	0	86	1	100	0	10	0
Total Sperm	80	4	160	0	344	1	400	0	40	0
Guadalupe*-1	-	-	-	-	-	-	-	-	5	0
Guadalupe*-2	-	-	-	-	-	-	-	-	5	0
Guadalupe*-3	-	-	-	-	-	-	-	-	5	0
Guadalupe*-4	-	-	-	-	-	-	-	-	5	0
Total Guadalupe*	0	0	0	0	0	0	0	0	20	0

*Guadalupe Fur Seal, Exp = Expected, Act = Actual
Category 1 = Tag, Playback, Category 2 = Tag, No Playback, Category 3 = No Tag, No Playback
Category 4 = No Tag, Playback, Category 5 = Unintentional Harassment from Acoustic Exposure

- Permit No. 14809 (Duke University) involves ecological and bioacoustic research on cetaceans in the Central Pacific using tagging and behavioral research methodologies. This permit extends through March 2019.
- Permit No. 15271 (Moss Landing Marine Labs) includes research on U.S. West Coast (to 15 nmi) to investigate movements, foraging, and behavioral changes of large whales in the eastern North Pacific . This permit extends through March 2017.
- Permit No. 15330 (Cascadia Research Collective) involves surveys to study population size, population structure, habitat use, movements, behavior and ecology of cetaceans in the Pacific Ocean . This permit extends through August 2016.
- Permit No. 15569 (Center for Whale Research) involves characterizing the population size, structure, forging ecology, and movement patterns of Southern Resident Killer Whales and congener ecotypes in the Eastern North Pacific Ocean. This permit extends through June 2017.
- Permit No. 16111 (Cascadia Research Collective) involves tagging, biopsy, and photographic identification of marine mammals in the eastern North Pacific to examine abundance, movements, population structure, and human impacts. This permit extends through July 2017.
- Permit No. 16239 (HDR) aims to further their understanding of marine mammals sharing waters with U.S. Naval training, offshore energy development, and construction using of aerial and vessel surveys, behavioral focal follows, and PAM monitoring techniques. This permit extends through September 2018.
- Permit No. 16388 (Woods Hole Oceaonographic Institution) involves research on diving behavior and foraging ecology of baleen whales. This permit extends through April 2018.
- Permit No. 17266 (U.S. Navy) involves research on marine mammals within the Hawaii-Southern California Training and Testing Area. This permit extends through December 2018.
- Permit No. 17312 (Scripps Institution of Oceanography) involves research on marine mammal use of sound and response to anthropogenic impacts. This permit extends through September 2018.
- Permit No. 17845 (Keiki Kohola Project) involves research on habitat use and behavioral dynamics of maternal-female, calf and juvenile humpback whales in feeding and breeding regions. This permit extends through January 2019.
- Permit No. 18887 (U.S. Navy) involves research on marine mammals within the Northwest Training and Testing Area. This permit extends through November 2020.
- Permit No. 19091 (NMFS Southwest Fisheries Science Center) involves research on pinniped, cetacean, and sea turtles in the Pacific Ocean primarily along the U.S. West

Coast and in Hawaii, although could range into international waters as well. This permit extends through November 2020.

No authorized studies on these animals in the past are reported to have caused mortalities.

6 Effects of the Action on Species and Designated Critical Habitat

Section 7 regulations define "effects of the action" as the direct and indirect effects of an action on the species or designated critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but are reasonably certain to occur. This effects analyses section is organized following the stressor, exposure, response, risk assessment framework.

As was stated in Section 3, this opinion includes both a jeopardy analysis and an adverse modification analysis.

The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The distruction or adverse modification analysis considers the impacts on the conservation value of designated critical habitat.

For this consultation, we are particularly concerned about behavioral disruptions that may result in animals that fail to feed or breed successfully or fail to complete their life history because these responses are likely to have population-level consequences. The proposed permit would authorize non-lethal "takes" by harassment of listed species during activities. The ESA does not define harassment nor has NMFS defined the term pursuant to the ESA through regulation. However, the MMPA defines harassment as, "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal population in the wild or has the potential to disturb a marine mammal or marine mammal population in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [16 U.S.C. 1362(18)(A)]." The latter portion of this definition (that is, " ... causing disruption of behavioral patterns including ... migration, breathing, nursing, breeding, feeding, or sheltering") is almost identical to the USFWS's regulatory definition of "harass" pursuant to the ESA.

6.1 Stressors Associated with the Proposed Action

The potential stressors we expect to result from the activities to be authorized under the proposed permit are:

- Vessel sound
- Vessel discharge
- Vessel approach and focal follows
- Vessel strike
- Tagging
- Active acoustics (MFAS), recorded playback activities, and prey mapping surveys

Below we discuss each stressor's potential to affect ESA-listed species.

6.1.1 Stressors Not Likely to Adversely Affect ESA-listed Species

Based on a review of available information, we determined which of the possible stressors would be likely to occur, but would be discountable or insignificant.

6.1.1.1 Vessel Sound

Sound created by vessels (propeller cavitation and engine) and recorded playbacks of vessel sound are expected to have insignificant effects on ESA-listed whales and seals. Though sound originating from vessel propulsion will propagate into the marine environment, the amount would be insignificant. Brief interruptions in communication via masking would be possible, though unlikely, given the habits of whales and seals to move away from vessels, because of engine sound, the physical presence of the vessel, or both. We expect that vessel sound playbacks are similar to other vessel sound that would typically occur in the action area. Therefore, we conclude this stressor is insignificant, and it is not discussed further in this opinion.

6.1.1.2 Vessel Discharge

Vessel discharge in the form of leakages of fuel or oil is possible, though effects of any spills are expected to have insignificant effects on ESA-listed whales and seals. Given the experience of the Applicant and boat operators in conducting these types of surveys in the action area, we expect it is unlikely that spills or discharges will occur. If discharges do occur, the amounts of leakage would be small, would disperse into the water, and would not affect ESA-listed whales or seals directly, or pose hazards to their food sources. Therefore, we conclude this stressor is insignificant, and it is not discussed further in this opinion.

6.1.1.3 Vessel Strike

The possibility of vessel strike is extremely unlikely. Boat operators and the Applicant will be actively searching for whales while performing the proposed actions; therefore, we expect whales not targeted for tagging will be avoided. Though the proposed actions require close vessel approaches to whales targeted for tagging activities, the boat operators will be moving in deliberate ways to approach closely, but not physically contact, target whales. We also expect that it would be extremely unlikely for seals to be struck by the research vessels, given the previous experience of the Applicant, boat operators and the Applicant in the action area combined with the already low vessel strike rate for Guadalupe fur seals. Therefore, we conclude this stressor is discountable, and it will not be discussed further in this opinion.

6.1.1.4 Summary of Stressors Not Likely to Adversely Affect ESA-listed Species

In conclusion, based on review of available information, we determined that one stressor, vessel strike, is unlikely to occur. We consider this stressor to be discountable. We determined two stressors, vessel sound and vessel discharge, will have insignificant effects on ESA-listed whales and seals.

6.1.2 Stressors Likely to Adversely Affect ESA-listed Species

The following sections analyze the remaining stressors likely to adversely affect ESA-listed species in the action area:

- Vessel approach and focal follows
- Tagging
- Active acoustics (MFAS), recorded playback activities, and prey mapping surveys

The exposure analysis below will discuss each of these stressors and their expected effects to ESA-listed species.

6.2 Exposure and Response Analysis

Our analysis evaluates the available evidence to determine the likelihood of ESA-listed species or designated critical habitat being exposed to the above-mentioned stressors. Our analysis assumed that these stressors pose no risk to ESA-listed species or designated critical habitat if these stressors do not co-occur, in space or time, with (1) individuals of endangered or threatened species or critical habitat that have been designated for endangered or threatened species; (2) species that are food for endangered or threatened species; (3) species that prey on or compete with endangered or threatened species.

6.2.1 Exposure Analysis

Our exposure analyses identifies the co-occurrence of ESA-listed species with the action’s effects in space and time and the nature of that co-occurrence. When possible, this exposure analyses identifies the number, age or life stage, and gender of the individuals that are likely to be exposed to the action’s effects and the population(s) or subpopulation(s) (or other sub-divisions of “populations,” including demes, runs, or races) those individuals represent.

We considered the following categories:

- Disturbance of threatened and endangered species from presence and movements of surface vessels that would be used during the proposed study activities.
- Risks from tagging activities.
- Acoustic sources such as MFAS and playbacks associated with the proposed activities.

In this opinion, we relied on the NMFS Permits Division exposure estimates of the number of ESA-listed species occurring in the SOCAL BRS action area that might interact with activities associated with potential stressors listed above.

The harassment would be both intentional and unintentional, and result from close approaches and playbacks of natural and artificial sounds. A limited number (as specified in Table 1 in Appendix 1 of the permit) of "target" animals from each ESA-listed species would be intentionally closely approached for purposes of attaching scientific instruments. Photo-identification, and "focal follow" behavioral observations. A limited number (as specified in Table 1 in Appendix 1 of the permit) of "non-target" animals may be unintentionally approached due to their proximity or association with the target animals would be unintentionally exposed to sound playbacks, which would result in the unintentional exposure of a limited number of non-target animals due to their proximity to the target animal or sound source. These procedures may result in short-term behavioral responses such as alterations in swimming speed and dive patterns, or avoidance of the vessel or vicinity of playbacks. ESA-listed species may temporarily cease whatever activity they were engaged in at the time of exposure to the research. In the location and at the time of year the research would take place, the subject species would be engaged in social interactions, feeding, breeding activities, and traveling, depending on the species.

The only research activity that would involve physical contact with the whales would be attachment of scientific instruments, which could result in minor injury. The Applicant would attach digital archival recording devices (i.e., tags) using suction cups. The dimensions and functions of the tag are described in the permit application. Because the tags are mounted on suction cups, the duration of attachment, and thus the effect of the tag on the animal, is typically several hours. The suction tags, by design, gradually lose suction and dislodge. In addition, whales can, and have, dislodged the tags by rolling, diving, or other swimming maneuvers. Suction cup tags may cause minor injuries in the form of bruises at the site of the tag. The whales exhibit short-term behavioral responses to both the act of tag attachment (when the tag touches their skin) as well as the presence of the tag. Observed behavioral responses to tag attachments have included sudden changes in swimming speed or direction or short-term changes in dive patterns.

The Permits Division proposes to issue Permit No. 19116 to the Applicant authorizing take (by harassment) of ESA-listed whales and fur seals for five years. Table 1 (in Section 2 of this opinion) shows the amount of annual take that the Permits Division proposed to authorize. Under the proposed action, exposure to proposed activities would occur each year for five years until the permit's expiration. The Applicant calculated take numbers of marine mammals based on their previous work in the action area. Because the Applicant does not know when and where all research activities will occur within the action area, it is difficult to estimate takes based on species' densities; therefore, we defer to the Permits Division concerning the number of takes requested and we assume all takes may occur. All takes are in response to vessel approaches, tagging, or active acoustics (i.e., MFAS) and recorded playback activities.

The proposed actions may expose ESA-listed species to disturbance from boat based survey and tagging activities. Playback experiments also have the potential to disturb ESA-listed species. These activities have the potential to harass, wound, injure, or kill ESA-listed individuals. In addition, these animals may undergo changes in behavior in response to disturbances from the proposed activities. Table 5 identifies the combined proposed takes to ESA-listed species.

Table 4. The Applicant's combined proposed "takes" to ESA-listed species from the proposed activities over the duration of the proposed permit (five years).

Species	Number of Takes Allowed under the Proposed Permit	
	Annual	Total over Five Years
Blue Whale	352	1,760
Fin Whale	488	2,440
Humpback Whale	304	1,520
Sei Whale	6	30
Sperm Whale	65	325
Guadalupe Fur Seal	5	25

Proposed takes were separated into five categories in the Applicant's package:

The information regarding proposed take calculations is based on the Applicant's previous research. NMFS's ESA Interagency Cooperation Division reviewed and agrees with the approach presented by the Applicant. Take category one estimated the maximum number of animals taken by close approaches, tagging, focal follow, and playback. This category includes only those animals that successfully go through the entire sequence of tagging, focal follow, and playback stimulus. The target ESA-listed species for this category are: blue, fine, humpback, and sperm whales. Ideally, the researchers are trying to add a new individual per each tagging effort for a total of 20 tags per species per year, with the understanding that actual takes per species will likely be well below 20 involved in the entire sequence.

Take category two estimated the total number of animals taken by close approach, photo-identification, tag attachment, and focal follow but no playback. This will provide a baseline and serve as a control experiment to compare those exposed to playback experiments. Although the objective in this category is to tag the same number (20) as in category 1, this number is increased by 40 so that a group of individuals may be tagged simultaneously. Because of the possibility of a tag releasing prematurely or the inability to recognize an individual through natural markings, the same individual animal may be repeatedly tagged up to three times a day over several days within a year.

Table 5. The Applicant's "take category two" estimated maximum number of takes by tagging with no playback.

Species	Research Objectives Requiring Tag Takes (No Playbacks)	Number of Tag Takes (Tagging Goal, No Playbacks)
Blue whale	1 (20 + 40), 2 (20)	80
Fin whale	1 (20 + 40), 2 (20)	80
Humpback whale	1 (20 + 40), 2 (20)	80
Sperm whale	1 (20), 2 (20)	40

Take category three estimated the total number of animals taken by close approaches, photo-identification, and focal follow but no tagging or playback (Table 7). In Table 7, the number of "close approach takes" are determined by the number of tag takes (column B) and divided by the estimated tagging success rate (column C) to get the maximum number of tagging attempts needed (column D). The maximum number of tagging attempts is then multiplied by the sub-group size to get the number of "close approach takes (column F). This category depends on the estimated success rate for tagging and the number includes animals that are approached but may be already tagged or when tagging is not attempted. It is necessary to close approach to identify individuals. Typically one group is followed for much of a day, but it is possible that the same group could be approached several times on the same day or on different days.

Table 6. The Applicant's "take category three" estimated total takes.

Species	B. Number of takes (Tagging goal, No Playback)	C. Estimated Tagging Success Rate	D. Maximum Number of Tagging Attempts (B/C)	E. Sub-Group Size	F. Close Approach Takes (D x E)
Blue whale	80	0.7	114	2	228
Fin whale	80	0.7	114	3	342
Humpback whale	80	0.7	114	1	114
Sperm whale	40	0.7	57	2	114

Take category four estimates the number of animals taken by intentional playbacks but are not tagged (Table 8). In other words, many species targeted for tagging and playback are social and will be in groups, which some individuals will be tagged and others will not. The latter-mentioned untagged individuals is what this category is estimating. Although unlikely, it is possible that the same individual may be exposed to several playbacks.

Table 7. The Applicant's "take category four" estimated total takes.

Species	B. Group Size	C. Goal Number of Playbacks	D. Number of Non-Tag Playback Takes when Animal in Group is Tagged (B-1)*C	E. Max Number Playbacks to Non-Tagged Animals	F. Max Number of Playbacks where No Animal is Tagged	G. Grand Total of Non-Tagged Playback Takes (D+F)
Blue whale	2	20	20	0	0	20
Fin whale	3	20	40	0	0	40
Humpback whale	1	20	40	0	0	40
Sperm whale	5	20	80	0	0	80

Take category five estimates the takes from unintentional exposure of animals to playbacks (Table 9). These estimates were produced using data from the initial phase of the SOCAL BRS study. If the animal is not a target animal that can be monitored and enters the shutdown zone, the playback will be stopped. The estimate is based on an estimate of the number of animals that might occur without being detected within the take harassment zone during all of the yearly-planned playbacks, therefore category five is dependent on the number of playbacks expected per year, species group size, density category approximation for a species, and an estimate of the likelihood of sighting the group before it comes within the zone of predicted take. An alternative estimate was also made that is double the estimated group size to cover for the scenario of a group of unseen, untargeted and untagged animals surfacing within the harassment take zone. The larger of the two estimates was used for that group to use the most conservative estimate.

The proposed research is intended to specifically help determine and/or assess contexts and levels of exposure causing behavioral disturbance in the target species. A major goal of the proposed research is to help inform acoustic criteria (such as Southall et al., 2007; NMFS, 2013) that describe/predict changes in behavior considered to constitute harassment. The Applicant proposes to follow current NMFS practice and report all marine mammals sighted within a range from the source vessel during playbacks where the animal received level is predicted to be 160 dB re: 1µPa in a tally of animals that might be used to estimate potential unintentional harassment takes (NMFS, 2005; 2013). In order to cover the possibility of unintentional

Table 8. The Applicant's "take category five" estimated total takes.

Species	Maximum Possible Number of Playbacks (A)	Assumed Mean Group Size (B)	SOCAL Highest Seasonal Density density/km^2 (D)	Assumed Value for Probability Being Present in SOCAL (E)	Probability of Detection within 1 km (F)	Estimated Incidental Takes	Group Size x 2	Greater of Calculation and Group Size Estimate (Rounded Up)
Blue whale	100	2	0.001442459	0.05	0.9	1	4	4
Fin whale	100	3	0.002672097	0.05	0.9	01.5	6	6
Sei whale	100	3	0.000110352	0.0005	0.9	0.015	6	6
Humpback whale	100	1	0.001679804	0.005	0.9	0.05	2	2
Sperm whale	100	5	0.000850412	0.0005	0.9	0.025	10	10
Guadalupe fur seal	100	2 (at sea)	0.006488001	0.005	0.5	0.5	4	5

exposure during playback, the applicant is requesting potential takes by harassment of marine mammal species that may be present in the research area. The details of where an animal would be exposed to 160 dB sound pressure level (SPL) or above depends upon its depth, range and how sound is propagating through the ocean. In order to make a general estimate that takes source level and general features of sound propagation into account, the applicant will use an estimate based upon spherical spreading loss (Urick 1983). This assumes that sound spreads evenly in a homogeneous medium. Sound propagation is well-known to be much more complex where the ocean is not homogenous, but the sonar equation will still give a reasonable estimate of the volume of water ensonified for the short ranges out to the 160 dB SPL level for the relatively low-level playbacks to be conducted in this research program, including intentionally quiet sources in order to determine the ranges over which responses may occur for quieter sources at shorter range. Considering that the Applicant is unlikely to achieve the upper bound of 100 total playbacks annually, the estimates of unintentional harassment takes for the non-target species are likely significant over-estimates, including when taking into account the low number of unintentional harassment takes associated with initial testing and calibration of sources in the study area outside of CEEs.

The following sections discuss exposure for each stressor, which is likely to adversely affect ESA-listed species, in greater detail.

6.2.1.1 Vessel Approach and Focal Follows

The procedure for close vessel approaches and focal follows was described in the Proposed Action section. Also previously described were the minimization measures the applicant will use in order to minimize disturbance to animals including slowly approaching animals and terminating an approach if signs of disturbance are observed (e.g., changes in behavior, stress vocalizations, abrupt shifts in direction of movement).

The proposed close approaches, photography, tracking, focal follows, passive recording, tagging activities and skin collections can cause disturbance to ESA-listed species. Animals of both sexes and of all age groups are proposed to be tracked, and approaches of as close as 3 m may be made after visual contact is established. The proposed tracking activities also involve the use of sonar which also has the potential to disturb listed species from the sounds emitted. During focal follows whales are proposed to be video-recorded and photographed.

The presence of vessels has the potential to induce behavioral and physiological changes in individuals being targeted, although the animals' reactions are generally short term and low impact. The degree to which individuals are disturbed is highly variable. Whales may respond differently depending upon what behavior the individual or pod is engaged in before the vessel approaches (Hooker et al. 2001a; Wursig et al. 1998) and the degree to which they have become accustomed to vessel traffic (Lusseau 2004; Richter et al. 2006); reactions may also vary by species or individuals within a species (Gauthier and Sears 1999). Overall, reactions range from little to no observable change in behavior to momentary changes in swimming speed, pattern, orientation; diving; time spent submerged; foraging; and respiratory patterns. Responses may also include aerial displays like tail flicks and lobtailing and may possibly influence distribution (Baker et al. 1983a; Bauer and Herman 1986; Clapham et al. 1993; Jahoda et al. 2003; Watkins et al. 1981b). In a few cases, longer lasting responses have been documented. For example, (Jahoda et al. 2003) found effects of more than a few minutes, with fin whales failing to return to baseline behaviors after one hour of observation in some cases. Baker et al. (1988) reported that changes in whale behavior corresponded to vessel speed, size, and distance from the whale, as well as the number of vessels operating in the proximity. Based on experiments conducted by Clapham and Mattila (1993a), experienced, trained personnel approaching whales slowly would result in fewer whales exhibiting responses that might indicate stress.

Numerous studies have documented varied responses of humpback whales to vessel approaches, ranging from no response to approach to evasion (Goodyear 1993a; Salden 1993). In response to vessel approach, Felix (2001) found that 27 of 86 individuals approached resulted in avoidance of the vessel (50 were indifferent and nine approached vessels), including long dive, change in heading, tail splashes, altered swimming speed or breathing frequency, and group structure disruption. Approaching vessels may instigate aerial behavior, such as fluke slapping and breaching, behavior suggested to be a switch in communication from vocal to surface active signaling (Baker et al. 1983a; Baker et al. 1983b; Holt et al. 2009). Hall (1982) did not find social or feeding behavior to be disturbed by vessel traffic or close approaches. However, there is the possibility that humpback whales may habituate to vessel sound if given sufficient time and exposure (Clapham and Mattila 1993a; Watkins 1986). Goodyear (1983) did not observe changes in behavior due to vessel approaches in most cases, although an increase in speed did occur on one occasion when a whale was approached within 10 m. Cantor et al. (2010) generally found resting or socializing whales to switch to traveling upon approach of their research vessels. (Watkins 1981d); Watkins et al. (1981b) found that humpback whales appeared to react to vessel approach by increasing swim speed, exhibiting a startle reaction, and moving away from the vessel with strong fluke motions. Several authors found that humpbacks spent less time at the surface and altered their direction of travel in response to approaching vessels (Baker and Herman 1989; Baker et al. 1983a; Bauer 1986; Bauer and Herman 1986; Green and Green 1990). Increased time underwater and decreased swim speed persisted for up to 20 minutes after vessels left the area. (Watkins and Goebel 1984) found humpbacks to be very difficult to approach. (Norris 1994) documented changes in humpback song structure in response to passing vessels, with unit and phrase durations reduced versus control periods.

In Alaskan waters, increased dive durations have been observed along with a shift in orientation away from the path of moving boats, often at ranges up to three to 4 km (Baker and Herman 1989; Baker et al. 1983a). Some approaches in Alaskan waters closer than 100 m initiated evasive behavior (Hall 1982). Watkins (1986) found little response to approaches outside of 100 m away, although humpbacks regularly reacted to outboard vessels on a collision course even from long distance.

Information on contextual responses is also relatively abundant for humpback whales. Responses by humpback whales likely depend upon a given individual's prior experience and current situation (Clapham and Mattila 1993a). The use of smaller, outboard-powered vessels (presumably louder) elicited more frequent and stronger responses to biopsy attempts than larger, inboard-powered vessels; sex was not a factor in response frequency or intensity (Cantor et al. 2010). Sudden changes in vessel speed and direction have been identified as contributors to humpback whale behavioral responses from vessel maneuvering (Watkins 1981d). The more active the group, the more easily it was disturbed; however, (Cantor et al. 2010) found structuring in the response rate of various individuals in mating groups, with male response becoming progressively less frequent with increasing degree of dominance in the mating group. Mother-calf pairs were the most easily disturbed group, followed by all adult groups, adult sub-adult mixes, and all sub-adult groups (Felix 2001). Several authors found feeding animals to be least responsive, although data from these studies was contradictory when evaluating responses while resting or on breeding grounds (Cantor et al. 2010; Krieger and Wing 1984b; Weinrich et al. 1991; Weinrich et al. 1992b). On several occasions, research trips conducted by (Krieger and Wing 1984a); Krieger and Wing (1984b) had to actively avoid collisions with humpbacks, although whales presumably were aware of the vessel's presence. Single or paired individuals may respond more than larger groups (Bauer and Herman 1986). Wursig et al. (1998) found milling or resting cetaceans to be more sensitive.

Repeated exposure can have a cumulative effect that is greater than the sum of individual exposures, eliciting responses that are more significant for individuals and populations, although (Cantor et al. 2010) did not find a difference in response based upon re-exposure. However, humpback whales have vacated areas where relatively high boat traffic and human activity occurs (Herman 1979a). Major declines and distributional shifts in Glacier Bay, Alaska were correlated with a rapid and significant increase in vessel traffic from 1976 to 1978, whereas humpback whales in other nearby areas with less traffic did not undergo such changes (Bauer and Herman 1986). Matkin and Matkin (1981) did not find a correlation between humpback whale behavior and recreational vessels.

Other large whale species have also been investigated for their responses to close vessel approaches. Pettis et al. (1999) found gray whales tended to disperse in the presence of boats and aggregate in their absence. When directly approached, individuals were more likely to change heading, do a fluke-down dive, or slip under water, whereas indirect approaches tended to result in fluke or flipper swishes and head raises. Calf presence did not appear to impact response, although calves tended to respond with bubble release from the blowholes, change their heading, or roll, whereas adults were more likely to dive or slip underwater. Gray whales vacated a wintering (breeding, non-feeding) lagoon apparently in response to increased commercial vessel traffic but reoccupied it after vessel traffic decreased (Reeves 1977). Fin whales were found to accelerate their speed upon vessel approach (Watkins 1981d). Fin whales were particularly evasive in a study published by Ray et al. (1978), exhibiting high-speed swimming, frequent changes in heading, separation of groups, and irregular breathing patterns. As with humpback whales, fin whales have been found to respond by rapid course change, accelerated dive, and speed increases to vessel sound, particularly throttle changes, such as reversing.

Close vessel approach could result in unintentional harassment of non-target ESA-listed whales and seals if these animals are in close proximity to the target animal and therefore, close to the research vessel. We would expect these animals to at most, react in a similar manner to the research vessel as those animals that are being targeted. That is, we would expect non-target animals that may be unintentionally harassed under the proposed permit to exhibit either no visible reaction or short-term low-level to moderate behavioral responses. We do not expect fitness consequences for individual whales that may be unintentionally harassed.

Pinnipeds have exhibited behavioral responses when disturbed by vessel approaches and activities. Pinnipeds may respond to vessel approaches by becoming more alert, moving, and flushing into the water (Jansen et al. 2010). The vessel type, size, and bearing are factors in the strength of the response by the animal. Greater levels of disturbance have occurred when vessels have stopped or move erratically near seal haul-outs (Henry and Hammill 2001; Johnson and Acevedo-Gutierrez 2007). The sensitivity of seals to disturbance may depend on breeding or molting status as well as previous experience. Repeated disturbance by small boats may increase levels of tolerance, but females with pups have been found to have increased vigilance (Jansen et al. 2010; Suryan and Harvey 1999). These vessel approaches may elicit energetic costs when flushed into cold water from ice or other haul-outs, particularly during period of pupping, nursing, and molting (Jansen et al. 2010; Young et al. 2014). Studies have shown that long-term disturbance events have resulted in population consequences and site abandonment for some harbor seal (*Phoca vitulina*) populations (Becker et al. 2011; Bejder et al. 2006). We would not expect non-target animals that may be unintentionally harassed under the proposed permit to exhibit either no visible reaction or short-term low-level to moderate behavioral responses. We do not expect fitness consequences for individual seals that may be unintentionally harassed as the vessel approaches are not expected to be chronic and repeated disruptions.

6.2.1.2 Tagging

Up to 300 sperm, 500 blue, 500 humpback and 500 fin whales are proposed to be tagged over the duration of the permit. All tags are proposed to be attached by using a hand-held 6 to 8 m carbon fiber pole from 5 to 7 m vessels, known as RHIBs. These activities have the potential to injure listed species as well as harass them via the process of approaching and tagging as well as from the effects that the tags themselves have on the target animals while attached. Sloughed skin samples are collected when the suction cup is removed from a whales skin surface.

Target animals are proposed to be fitted with DTAGs to measure received sound exposure, animal vocalizations, behavior and physiology. The tags are designed to be attached to an animal for relatively short periods of time. The tags are attached via suction cups made from medical grade silicone. Suction cups are disinfected prior to attachment to avoid possible infection or disease transfer. The dimensions of the tags are approximately 20 cm x 10 cm x 4 cm for the tag in its fairing housing.

Bio-Probes (B-Probes or Acousonde 3B) are also proposed to be attached to target animals. The B-Probes record calibrated acoustic pressure, temperature, depth, two-axis acceleration, and body orientation of the tagged animals. These tags are approximately 33 cm long and 6 cm in diameter. They are equipped with a flotation device and VHF transmitter to allow for recovery after detachment from the whale. Attachment of the B-Probes will be via suction cups similar to those proposed for the DTAG.

Tags similar to the proposed DTAGs and B-Probes have been used successfully in numerous past studies on both toothed and baleen whales and other marine mammals (see Burgess et al., 1998; Johnson et al., 2004; Tyack et al., 2006; Watwood et al., 2006) as well as the same tagging instruments were used in the initial phase of this ongoing study conducted under a previous permit. The investigators note that in their experience with these types of tags on large whales, the behavior of tagged animals has not been observed to be significantly affected.

Although suction cup tagging is not as invasive as implantable tagging, whales have also demonstrated behavioral reactions to tag attachment. Goodyear (1989a; 1989c) observed a quickened dive, high back arch, tail swish (31 percent) or no reaction (69 percent) to suction cup attachment, although one breach was observed in roughly 100 taggings. In response to suction cup tagging, (Baird et al. 2000) observed only low (e.g., tail arch or rapid dive) to medium (e.g., tail flick) level reactions. No long term or strong reactions were recorded (Baird et al. 2000). Regardless, pre-tagging behavior was observed in all cases within minutes. No damage to skin was found (Goodyear 1989a; 1989c). Baumgartner and Mate (2003) reported that strong reactions of North Atlantic right whales to suction-cup tagging were uncommon, and that 71% of the 42 whales closely approached for suction-cup tagging showed no observable reaction. Of the remaining whales, reactions included lifting of the head or flukes, rolling, back-arching, or performing head lunges. No differences in dive patterns were found after two dives post-tagging. Goodyear (1989a; 1989c) noted that humpbacks monitored several days after being suction-cup tagged did not appear to exhibit altered behavior.

Walker et al. (2012) reviewed the effects of different marking and tagging techniques on marine mammals. In their review, they found that cetacean behavioral responses to suction-cup tagging could include changes in frequency of leaps and group speed, flinching, tail slapping, rapid swimming, and rapid surfacing attempts. In the studies they reviewed, only short-term behavioral responses were observed. No long term fitness consequences were documented from suction-cup tagging in the studies the authors reviewed.

6.2.1.3 Active Acoustics and Recorded Playback Activities

Two hundred blue, 300 fin, 300 humpback, and 500 hundred sperm whales are proposed to be directly taken by targeted playback exposures. Other ESA-listed animals that are not target species, such as Guadalupe fur seals, may also be exposed to playback sounds. The synthetic mid-frequency sounds simulating sonar or pseudorandom sounds would be between 1.5 and 5 kHz and are proposed to be 0.5 to 5 seconds in length, transmitted every 20 to 60 seconds. Simulated sonar playbacks are expected to affect ESA-listed marine mammals because these sounds are within their assumed hearing ranges. Simulated killer whale vocalizations may be transmitted over a larger bandwidth (1 to 20 kHz) for up to 30 minutes. Simulated killer whale vocalization playback sounds are also expected to affect ESA-listed marine mammals.

Anthropogenic sounds can disturb or harm marine mammals in several ways. For example, whales have been observed to abandon feeding and mating grounds (Bryant et al. 1984; Morton and Symonds 2002; Weller et al. 2002), deviate from migration routes (Richardson et al. 1995b), and change vocalizations because of manmade sound (Miller et al. 2000). Sonar exposures have been directly correlated with mass stranding events (Cox et al. 2006). Acoustic exposures can also result in induced hearing loss in marine mammals (Finneran et al. 2002). In addition to direct physiological effects, sound exposures can impair marine mammals' hearing abilities through "masking" or result in other adverse behavioral responses. During the MFAS sonar experiments in SOCAL 2013, behavioral responses ranged from no observable response to temporary avoidance (Southall 2014). Although the proposed experiments would be targeted specifically to blue, fin, humpback, and sperm whales; sei whales and Guadalupe fur seals occur in the action area and could be exposed.

6.2.2 Response Analysis

Response analyses determine how listed resources are likely to respond after being exposed to an action's effects on the environment or directly on listed animals themselves. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal, physiological or behavioral responses that might reduce the fitness of individuals. The proposed activities have the potential to produce disturbances that may affect ESA-listed marine mammals.

Responses by animals to human disturbance are similar to their responses to potential predators (Beale and Monaghan 2004; Frid 2003; Frid and Dill 2002; Gill and Sutherland 2001; Harrington and Veitch 1992; Lima 1998b; Romero 2004). These responses include interruptions of essential behavior and physiological processes such as feeding, mating, nursing, resting, digestion etc. This can result in stress, injury and increased susceptibility to disease and predation (Frid and Dill 2002; Romero 2004; Walker et al. 2006).

Risks to ESA-listed individuals are measured in terms of changes to an individual's "fitness." Fitness is defined as the individual's growth, survival, annual reproductive success and lifetime reproductive success. When listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (Anderson 2000; Brandon 1978; Mills and Beatty 1979; Stearns 1992). As a result, if the assessment indicates that listed plants or animals are not likely to experience reductions in their fitness, we conclude our assessment. If possible reductions in individuals' fitness are likely to occur, the assessment considers the risk posed to populations to which those individuals belong, and then to the species those populations represent.

6.2.2.1 Vessel Approach and Focal Follows

All of the proposed activities require that investigators closely approach ESA-listed whales by boat. Tagging requires direct physical contact with target individuals. These activities have the potential to injure listed whales and seals. Indirect effects are also expected to ESA-listed animals that are exposed to boat, sonar and playback experiments. These animals may undergo changes in behavior in response to disturbances from these proposed activities.

There is mounting evidence that wild animals respond to human disturbance in the same way that they respond to predators (Beale and Monaghan 2004; Frid 2003; Frid and Dill 2002; Gill et al. 2001; Harrington and Veitch 1992; Lima 1998a; Romero 2004). These responses manifest themselves as stress responses (in which an animal perceives human activity as a potential threat and undergoes physiological changes to prepare for a flight or fight response or more serious physiological changes with chronic exposure to stressors), interruptions of essential behavioral or physiological events, alteration of an animal's time budget, or some combinations of these responses (Frid and Dill 2002; Romero 2004; Sapolsky et al. 2000; Walker et al. 2005). These responses have been associated with abandonment of sites (Sutherland and Crockford 1993), reduced reproductive success (Giese 1996; Mullner et al. 2004), and the death of individual animals (Bearzi 2000; Daan 1996; Feare 1976). Stress is an adaptive response and does not normally place an animal at risk. However, distress involves a stress response resulting in a biological consequence to the individual. The mammalian stress response involves the hypothalamic-pituitary-adrenal (HPA) axis being stimulated by a stressor, causing a cascade of physiological responses, such as the release of the stress hormones adrenaline (epinephrine), glucocorticosteroids, and others (Busch and Hayward 2009; Gulland et al. 1999; St. Aubin and Geraci 1988; St. Aubin et al. 1996; Thomson and Geraci 1986). These hormones subsequently can cause short-term weight loss, the liberation of glucose into the blood stream, impairment of the immune and nervous systems, elevated heart rate, body temperature, blood pressure, and alertness, and other responses (Busch and Hayward 2009; Cattet et al. 2003; Dickens et al. 2010; Dierauf and Gulland 2001b; Dierauf and Gulland 2001c; Elftman et al. 2007; Fonfara et al. 2007; Kaufman and Kaufman 1994; Mancia et al. 2008; Noda et al. 2007; Thomson and Geraci 1986). In some species, stress can also increase an individual's susceptibility to gastrointestinal parasitism (Greer et al. 2005). In highly-stressful circumstances, or in species prone to strong "fight-or-flight" responses, more extreme consequences can result, including muscle damage and death (Cowan and Curry 1998; Cowan and Curry 2002; Cowan and Curry 2008; Herraez et al. 2007). The most widely-recognized indicator of vertebrate stress, cortisol, normally takes hours to days to return to baseline levels following a significantly stressful event, but other hormones of the HPA axis may persist for weeks (Dierauf and Gulland 2001a). Mammalian stress levels can vary by age, sex, season, and health status (Gardiner and Hall 1997; Hunt et al. 2006; Keay et al. 2006; Romero and Kannada 2008; St. Aubin et al. 1996). Smaller mammals tend to react more strongly to stress than larger mammals (Peters 1983); a trend reflected in data from Gauthier and Sears (1999) where smaller whale species tended to react more frequently to biopsy than larger whales. Stress is lower in immature right whales than adults and mammals with poor diets or undergoing dietary change tend to have higher fecal cortisol levels (Hunt et al. 2006; Keay et al. 2006).

Studies have suggested that stress can adversely impact female reproduction through alterations in the estrus cycle (Herrenkohl and Politch 1979; Moberg 1991; Mourlon et al. 2011; Rivier 1991). Komesaroff et al. (1998) found that estrus may inhibit the stress response to some extent, although several studies suggest estrus and particularly the follicular stage may be susceptible to stress-induced disruption (see (Rivier 1991) and (Moberg 1991) for reviews). Most of these studies were conducted with single or multiple highly invasive and frequent stress methodologies or chronic stress; we do not expect stressors associated with the proposed research to be nearly as stressful. Under less invasive and acutely stressful methods (but more invasive than those proposed by the applicant), Omsjoe et al. (2009) found no impacts to the percentage of individuals with offspring the following year following chase, capture, and restraint of reindeer (ungulates in general tend to be prone to strong, potentially lethal stress responses). Overall, we do not expect reproduction to be impaired primarily due to the lack extreme stressors utilized by studies to induce adverse reproductive impacts and the acute nature of the stressors involved.

Marine mammals exhibit a variety of responses to disturbances from boat based human activities such as the proposed close approaches. These include short-term changes in swimming and feeding behaviors, as well as diving and staying submerged for longer periods of time (Baker and Herman. 1987; Best et al. 2005; Brown et al. 1991; Clapham and Mattila 1993b; Jahoda et al. 1997; Malme et al. 1984; Patenaude et al. 2002; Richardson et al. 1985; Watkins et al. 1981a). Pinnipeds such as Guadalupe fur seals react to such disturbances by exhibiting an escape response (Richardson et al. 1995a). These responses create additional energy expenditures that result in animals incurring an energy debt that must be compensated for by increased foraging. This can further interrupt normal behavior. Individually and collectively, these disturbances can adversely affect already imperiled individuals and populations.

Marine mammals can display great tolerance to boat traffic (Richardson et al. 1995a). Although some startle reactions have been observed in sperm whales upon close approaches (Whitehead et al. 1990), reactions to boat activities are usually minor when small vessels operate non-aggressively such as is proposed for the activities considered here (Papastavrou et al. 1989b). Similarly, a study involving the close approaches of research vessels to humpback whales showed that responses were minimal when approaches were slow (Clapham and Mattila 1993b). These behavioral changes, if they even occurred, were short lived (Clapham and Mattila 1993b). Watkins (1986) found that several species of baleen whales simply ignored weak vessel sounds altogether. Because any reactions to close approaches are expected to be minor and temporary, and because investigators will employ mitigation measures such as ceasing tagging attempts after three unsuccessful close approaches and conducting such approaches slowly, deliberately, and for as short a time as necessary, any reduction of fitness to any animal is unlikely to occur as a result of these activities. While Guadalupe fur seals may exhibit an escape reaction in response to these disturbances, the severity of these reactions is variable (Calkins and Pitcher 1982). A major concern for pinnipeds responding to vessel disturbance is trampling and pup abandonment from evacuating rookeries and haulouts (see Johnson 1977). These severity of these reactions is variable and can range from permanent evacuation of haulout areas to no reaction at all (Calkins and Pitcher 1982). The proposed activities are oceanic in nature and will not affect animals at haulouts or at rookeries so these responses are unlikely. Any disturbances that would result from the proposed activities would be to swimming Guadalupe fur seals and should be brief and not have long-term consequences to any animal.

The proposed echosounders for prey mapping are of the type routinely used for fisheries surveys by NMFS and other agencies and investigators. These sonar systems are used widely on recreational and commercial vessels. They use high operating frequencies, low power, narrow beam patterns, and short pulse lengths (NRC 2003). Frequencies for the model proposed to be used range between 38 and 120 kHz, and are well above the expected upper limit of hearing of baleen whales (see Southall et al. 2007a).

While it is possible that sperm whales could hear these sounds, there is no evidence that short pulses at this frequency adversely affect this species. In fact, sperm whales have been observed to show no reaction when exposed to transponders that produced 7 msec pings at 36 kHz at a level of 180 dB (Watkins and Tyack 1991). These sound pulses were much longer than those expected for the proposed echosounders. In addition, the areas that would be affected would likely be very small due the high attenuation of the low power and high frequency sounds used. Therefore, any that the proposed use of this sonar may pose to ESA-listed species are minimized.

Based on the information presented above, we would expect most whales exposed to close vessel approaches and focal follows under the proposed permit to exhibit either no visible reaction or short-term low-level to moderate behavioral responses. Although close approaches conducted under the proposed permit might still be stressful for some individuals, and might temporarily interrupt behaviors such as foraging, evidence from investigators and in the literature suggests that responses would be short-lived. Actions will be terminated if target animals are observed to display unusual behavior, aggravation or distress. In addition, no mortality or physical injury to any animal is expected as a result of these proposed activities. Therefore, based on the proposed action, mitigation measures and the fact that these species are not likely to significantly alter their behavior or physiology as a result of these disturbances, no reduction in the fitness of any listed animal is expected from vessel disturbance from the proposed activities.

6.2.2.2 Tagging

Suction-cup tags have been deployed multiple times in the past on blue, humpback, fin and sperm whales as well as other species for the attachment of various instruments. The suction-cup attachment method is non-invasive and the duration of the attachment is limited. The tagging protocol involves careful observation of potential behavioral reactions to the approach of the tagging vessel and to the actual tag attachment. Attempts to tag will be terminated if the animal shows any adverse reactions or after the third failed attachment attempt. Observations will be made and recorded of the target animal's behavior during approaches and tag attachment, as well as after the tags have detached.

Few studies have investigated the effects of tagging on cetaceans and the available data are often limited to visual assessments of behavior (Walker and Boveng 1995). To further complicate matters, reactions to tagging are difficult to differentiate from reactions to the close vessel approaches necessary to ensure proper tag placement. Evidence available on the short-term effects of tagging whales indicates that responses vary from little or no observable change in behavior to momentary changes such as skin twitching, startle reactions, altered swimming, diving, rolling, head lifts, high back arching and tail swishing (Goodyear 1981; Goodyear 1989b; Goodyear 1993b; Hooker et al. 2001b; Mate et al. 1998; Mate et al. 1997; Watkins 1981c; Watkins et al. 1984). Rarely, aerial displays like breaching are also noted (Goodyear 1989b). Behavioral responses are usually short-term (Mate et al. 2007), and possibly dependent on the animal's behavioral state at the time of tagging (Hooker et al. 2001b). Observed reactions to tagging include disturbances in foraging and diving behavior soon after the tag attachment (see Jochens et al. 2006a).

Davis et al. (2007) tagged sperm whales with barbed attachments and observed reactions of tail strokes and shallow dives but researchers noted no unusual behaviors or aggression to the tagging vessel. Sperm whales tagged with suction cups (similar to those proposed) exhibited a high rate of breaching (Palka and Johnson. 2007). Jochens et al. (2003) analyzed the behavior of suction cup sperm whales during foraging dives. The behavior during the first dive differed significantly from subsequent dives and the researchers attributed the difference to the tag operation.

Although there is evidence of minor short-term effects on tagged whales, no research has been done to assess long-term impacts of these activities. However, Goodyear (1989b) observed that humpback whales did not appear to exhibit altered behavior monitored several days after being suction-cup tagged. In addition, Mate et al. (2007) observed that tagged whales re-sighted up to three years later did not appear to be affected or to behave differently than untagged whales.

Although these tags would create drag, the proportion of this tag to a whale's size and weight is such that any drag effects would be insignificant. Tags are not expected to significantly alter the long-term behavior of any animal. In addition, investigators must exercise caution when approaching animals and immediately terminate activities if the animals appear to be adversely affected by the activities.

The proposed tagging activities are not likely to result in injuries to any ESA-listed animal. Tag attachment is expected to only change a whale's short-term behavior and these disruptions are not expected to lead to the reduction in fitness of any individual animal. Any effects of the proposed tagging activities are therefore minimized.

Based on the available information presented above, we expect responses to consist of brief, low-level to moderate behavioral responses. These are likely to include increased swimming speed, diving, change in direction, lobtail, forceful exhalation, submergence, tail and flipper movements, agonistic behavior, twitches, back arches, and defecation. However, we expect that individuals would return to baseline behavior within a few minutes.

6.2.2.3 Active Acoustics and Recorded Playback Activities

Activities involving active acoustics and playback of audio recordings could cause several biological responses in the ESA-listed animals exposed to these stressors including auditory injury, behavioral and stress responses, and masking of acoustic signals or sources. These potential outcomes are discussed in detail below.

Auditory Injury

Playbacks are designed to avoid sound levels that could cause hearing damage. The maximum received level of 180 dB would be used for playback signals which should avoid any potential for injury to marine mammals (after Southall et al. 2007a). Exposures of target animals to playbacks would be limited to the shortest duration required to elicit identifiable behavioral reactions. The playback subjects will be followed after exposure to monitor for their return to baseline behavior and playback protocols will be modified if there is any evidence of longer term changes. A margin of error for safety will be added to account for the possibility that the acoustic models used to predict received level at the animal are not always correct. This margin of error will be determined and validated by comparing estimated levels to received levels measured during the course of the playback experiments.

If there is any sign of prolonged responses that might pose a risk of injury, playbacks will be suspended. No animal will be taken more than two times in one day by intentional exposure to playbacks. A playback episode must be discontinued if an animal exhibits a strong adverse reaction to the playback activity or the vessels. Given the control over the single sound source, the precautions taken by the Applicant and mitigation procedures in the permit, injuries from the proposed playback experiments are not expected.

Behavioral and Stress Responses

The responses of marine mammals to anthropogenic sound and killer whale playback experiments are variable. For target and non-target listed whales and Guadalupe fur seals, responses to playback experiments could incur a physiological cost by disrupting normal behavior and result in additional energy expenditure. Sperm whale clicking and behavior has been observed to be disrupted by sonar sound. Sperm whales have been observed to frequently stop echolocations in the presence of these sounds (Watkins and Schevill 1975b). Watkins and Schevill (1975) showed that sperm whales interrupted click production in response to pinger sounds (6 to 13 kHz). Sperm whales have also been observed to react to military sonar by dispersing from social aggregations, moving away from the sound source, remaining relatively silent and becoming difficult to approach (Watkins et al. 1987b).

Other studies identify instances in which sperm whales did not appear to respond to anthropogenic sounds (Madsen and Mohl 2000b). Andre et al. (1997) exposed sperm whales to a variety of sounds to determine what sounds may be used to scare whales out of the path of vessels and observed sperm whales to have startle reactions to 10 kHz pulses at 180 dB source levels, but not to the other sources played to them. Another study indicated that sperm whales continued to call when exposed to pulses from a distant seismic vessel at levels of up to 146 dB (Madsen et al. 2002). Similarly, the distribution or behavior of sperm whales was not observed to change at various distances from an active seismic program (McCall Howard 1999). The results from these studies suggest that some sperm whales tolerate seismic surveys and that any behavioral responses that do occur are temporary.

The possible responses of listed baleen whales to anthropogenic sounds similar to those being proposed for playback experiments are less well known. Blue whales have been observed to continue vocalizing at the same rate as before exposure to airgun pulses, suggesting that behavior was undisturbed by the sound (McDonald et al. 1993). However, meta-analysis of combined study data from all years by Stone (2003) indicated that baleen whales altered their course more often, and were headed away from the vessel more frequently during periods of acoustic and seismic activities.

Humpback whales responded to sonar in the 3.1 to 3.6 kHz range by swimming away from the sound source or by increasing their speed (Maybaum 1993). However, the frequency and duration of their dives and the rate of underwater vocalizations did not change. In a controlled exposure experiment involving low frequency active sonar sound, humpback whales responded with longer songs when the playback sounds were louder (Fristrup et al. 2003).

There are numerous studies on the responses of pinnipeds to playback experiments sounds. These responses include diving to avoid detection and are stronger when pinnipeds are exposed to playback calls from killer whales (Deeke 2006; Deeke et al. 2002). This occurs presumably because the sounds are unfamiliar, or are perceived as a threat (Deeke et al. 2002).

The behavioral responses to anthropogenic sound are variable. Although marine mammals elicit a variety of responses to anthropogenic sounds at the frequencies and levels proposed for this action, these responses are short lived and do not appear to affect the long-term health of any individual animal. In addition, the proposed mitigation measures listed above further ensure that any response by marine mammals to these sounds will be minor. Any behavioral responses to the proposed activities are not expected to significantly affect the fitness of any individual ESA-listed species.

Acoustic Masking

Marine mammals use acoustic signals for a variety of purposes, which differ among species, but include communication, navigation, foraging, and reproduction (Erbe and Farmer 2000; Tyack 2000). Auditory masking occurs when the interfering sound is louder than, and of a similar frequency to, the auditory signal produced or received by the affected animal. Masking these acoustic signals can disturb the behavior of individual animals, groups of animals or entire populations.

For whales, the potential impacts that masking may have on individual survival and the energetic costs of changing behavior to reduce masking are poorly understood. A long-term study of odontocetes suggests that these animals may change their vocal behavior once background sounds reach a threshold level (Foote et al. 2004). For baleen whales, the frequencies of the sounds from the proposed sonar systems are well above the expected upper limit of hearing of baleen whales (see Southall et al. 2007a), but these species are subject to masking effects from the lower frequency sounds produced by the playback experiments and from the boats used in the proposed activities (Clark et al. 2009; Dunlop et al. 2010).

Most masking studies on pinnipeds have measured captive animals' ability to detect signals at a single frequency in the presence of broadband background masking sound (Southall et al. 2000). These studies demonstrated that acoustic masking was correlated with behavior changes such as producing more calls, longer calls, or shifting the frequency of the calls.

While acoustic masking in ESA-listed marine mammals is possible from the proposed activities, the low sound levels and short durations of these sounds should reduce the possibility of these events and reduce their severity should they occur. Any interruptions in behavior due to acoustic masking are expected to be temporary and minor and not to have significant impacts on the fitness of any ESA-listed animal.

6.3 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

This section attempts to identify the likely future changes and their impact on ESA-listed or proposed species and their designated critical habitats in the action area. This section is not meant to be a comprehensive socio-economic evaluation, but a brief outlook on future changes on the environment. Projections are based on recognized organizations producing best-available information and reasonable rough-trend estimates of change stemming from these data. However, all changes are based upon projections that are subject to error and alteration by complex economic and social interactions. During this consultation, we searched for information on future, state, tribal, local, or private (non-Federal) actions reasonably certain to occur in the action area. We did not find any information about non-Federal actions other than what has already been described in the Environmental Baseline, which we expect will continue in the future. Anthropogenic effects include commercial fishing, vessel traffic, ocean sound, pollution, discharged contaminants, research activities, and coastal development. An increase in these activities could result in an increased effect on ESA-listed species; however, the magnitude and significance and any anticipated effects remain unknown at this time. The best scientific and commercial data available provide little specific information on any long-term effects of these potential sources of disturbance on ESA-listed whale and fur seal populations.

6.4 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and designated critical habitat as a result of implementing the proposed action. In this section, we add the *Effects of the Action* (Section 6) to the *Environmental Baseline* (Section 5) and the *Cumulative Effects* (Section 6.3) to formulate the agency's opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the *Status of the Species and Designated Critical Habitat* (Section 4).

The following discussions separately summarize the probable risks the proposed action poses to threatened and endangered species and designated critical habitat that are likely to be exposed. These summaries integrate the exposure profiles presented previously with the results of our response analyses for each of the actions considered in this opinion.

As explained in the *Approach to the Assessment* (Section 3), risks to listed individuals are measured using changes to an individual's "fitness." When ESA-listed animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (e.g., Anderson 2000; Brandon 1978; Mills and Beatty 1979; Stearns 1992).

When individual, ESA-listed animals are expected to experience reductions in fitness in response to an action, those fitness reductions can reduce the abundance, reproduction, or growth rates of the populations that those individuals represent (see Stearns 1992). If we determine that reductions in individual plants' or animals' fitness reduce a population's viability, we consider all available information to determine whether these reductions are likely to reduce the viability of any species as a whole.

The proposed issuance by the Permits Division of scientific research Permit No. 19116 would authorize direct "takes" of blue, fin, humpback, sei, and sperm whales, and Guadalupe fur seals primarily in the U.S. Navy's SOCAL Range Complex, in Southern California offshore waters. The proposed activities under this permit include active acoustics, PAM, close approaches, tagging and the collection of sloughed skin. The permit would be valid for five years and allow for total "takes" listed in Table 1.

The assessment for this consultation identified several possible stressors associated with the activities to be authorized under proposed permit: (1) potential boat strikes, (2) sound and visual disturbances generated by research boats and human presence while engaged in close approaches, photography, tracking, focal follows, passive recording, tagging activities and skin collection activities (3) effects from tagging, and (4) effects from recorded playback activities. For this consultation, we are particularly concerned about behavioral disruptions that may result in animals that fail to feed or breed successfully or fail to complete their life history because these responses are likely to have population-level consequences.

As explained in the *Response Analyses* section of this opinion, because of their small size and maneuverability, boat strikes are extremely unlikely and therefore discountable. Sound and visual disturbances that would result from the proposed activities are expected to be brief and not to have any long-term consequences to individual listed animals or the populations or species that they comprise. Proposed tagging procedures will be non-invasive and will incorporate several mitigation procedures to limit harassment. Any behavioral responses to tagging activities are expected to be minor and temporary and any effects from these activities are therefore discountable. Any behavioral responses to ESA-listed species resulting from playback experiments are also expected to be minor and temporary and therefore also discountable.

6.4.1 Blue Whale

Most blue whales would only be exposed periodically or episodically to the SOCAL BRS activities proposed to be conducted in the Southern California action area. While some blue whales detect and response to MFAS, MFAS is considered to be at periphery of blue whale hearing sensitivity.

Blue whales in the Southern California action area seem likely to respond to the vessel traffic associated with each of the activities in ways that approximate their responses to whale watch vessels. Those responses are likely to depend on the distance of a whale from a vessel, vessel speed, vessel direction, vessel sound, and the number of vessels involved in a particular maneuver, as well as the activity the whale is involved with at the time. Blue whales seem most likely to try to avoid being exposed to the SOCAL BRS activities and their avoidance response is likely to increase as an exercise progresses. We do not have the information necessary to determine which of the many sounds associated with an activity is likely to trigger avoidance behavior in blue whales (for example, engine sound, audio playbacks, or some combination of these) or whether blue whales would avoid being exposed to specific received levels, the entire sound field associated with a playback, or the general area in which a U.S. Navy exercise would occur.

Individual blue whales might not respond to the vessels, while in other circumstances, whales are likely to change their surface times, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social. Some of these whales might experience physiological stress (but not “distress”) responses if they attempt to avoid one ship and encounter a second ship during that attempt. However, because of the relatively short duration of individual activity, the small number of playbacks, and the short duration of the SOCAL BRS activities, we do not expect these responses of blue whales to reduce the fitness of those whales.

We do not anticipate any mortality of blue whales from acoustic stressors or vessel strike associated with the SOCAL BRS activities.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that SOCAL BRS activities planned to be conducted in the Southern California action area on an annual basis, or cumulatively over the five year period from 2016 to 2021, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual blue whales in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual whales would not be likely to reduce the viability of the populations those individual whales represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations). As a result, the SOCAL BRS activities planned to be conducted in the Southern California action area would not appreciably reduce the blue whales' likelihood of surviving and recovering in the wild.

6.4.2 Fin Whale

Most fin whales would only be exposed periodically or episodically, to the SOCAL BRS activities proposed to be conducted in the Southern California action area. Frequencies associated with MFAS have generally been considered above the hearing range of fin whales. However, recent observations of blue whale responses to the MFAS sounds support the possibility that this ecologically, physiologically, and taxonomically similar species may be capable of detecting and responding to them. Additional data are necessary to determine the impact that MFAS may or may not have on fin whales. Considering information presented in this opinion, we consider fin whales to be able to hear and respond to MFAS as blue whales appear to.

Fin whales in the action area seem likely to respond to the ship traffic associated with the activities in ways that approximate their responses to whale watch vessels. Those responses are likely to depend on the distance of a whale from a vessel, vessel speed, vessel direction, vessel sound, and the number of vessels involved in the proposed action, as well as the activity the whale is involved with at the time. Fin whales seem most likely to try to avoid being exposed to the activities and their avoidance response is likely to increase as a playback or real exercise progresses. We do not have the information necessary to determine which of the many sounds associated with an activity is likely to trigger avoidance behavior in fin whales or whether fin whales would avoid being exposed to specific received levels, the entire sound field associated with a playback or exercise, or the general area in which the activity would occur.

Particular fin whales might not respond to the vessels, while in other circumstances, fin whales are likely to change their surface times, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. Some of these whales might experience physiological stress (but not "distress") responses if they attempt to avoid one ship and encounter a second ship during that attempt. However, because of the relatively short duration of individual activities, the small number of playbacks, and the short duration of the training exercises and testing activities, we do not expect these responses of fin whales to reduce the fitness of those whales.

In the event of a vessel strike to a fin whale resulting in severe injury or mortality, individuals would likely experience significant fitness consequences that may affect feeding and reproduction or would be totally removed from a population. Removal of one or more individual fin whales will have different consequences on the population depending on sex and maturity of the animal.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that SOCAL BRS activities plans to conduct in the action area on an annual basis, or cumulatively over the permit's five year period 2016 to 2021 cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual fin whales in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual whales would not be likely to reduce the viability of the populations those individual whales represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations). As a result, the SOCAL BRS activities in the Southern California action area would not appreciably reduce the fin whales' likelihood of surviving and recovering in the wild.

6.4.3 Sei Whale

Most marine mammals would only be exposed periodically or episodically, to the SOCAL BRS activities proposed to be conducted in the Southern California action area. Many training playbacks will occur without any marine animals being exposed to research vessels, U.S. Navy vessels, and sound fields associated with MFAS. Nevertheless, sei whales are not likely to respond to MFAS because they are not likely to hear those sonar transmissions.

We have no specific information on the sounds produced by sei whales or their sensitivity to sounds in their environment. Based on their anatomical and physiological similarities to both blue and fin whales, we assume that the hearing thresholds of sei whales will be similar as well and will be centered on low-frequencies in the 10 to 200 Hz. This information would lead us to conclude that, like blue and fin whales, sei whales exposed to these received levels of MFAS are not likely to respond if they are exposed to mid-frequency sounds.

Sei whales seem likely to respond to the ship traffic associated with each of the SOCAL BRS activities in ways that approximate their responses to whale watch vessels. Those responses are likely to depend on the distance of a whale from a vessel, vessel speed, vessel direction, vessel sound, and the number of vessels involved in a particular maneuver, as well as the activity the whale is involved with at the time. Sei whales seem most likely to try to avoid being exposed to the activities and their avoidance response is likely to increase as SOCAL BRS activities progress. We do not have the information necessary to determine which of the many sounds associated with an activity is likely to trigger avoidance behavior in sei whales (for example, MFAS playbacks, engine sound, or some combination of these) or whether sei whales would avoid being exposed to specific received levels, the entire sound field associated with an exercise, or the general area in which an exercise would occur.

Particular sei whales' might not respond to the vessels, while in other circumstances, sei whales are likely to change their surface times, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. Some of these whales might experience physiological stress (but not "distress") responses if they attempt to avoid one vessel and encounter another vessel during that attempt. However, because of the relatively short duration of individual activities, the small number of SOCAL BRS activities, and the short duration of the SOCAL BRS activities, we do not expect these responses of sei whales to reduce the fitness of those whales.

We do not anticipate any mortality of sei whales from acoustic stressors or vessel strike associated with the SOCAL BRS activities..

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that SOCAL BRS activities planned to be conducted in the Southern California action area on an annual basis or cumulatively over the five year period from 2016 to 2021, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual sei whales in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual whales would not be likely to reduce the viability of the populations those individual whales represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations). As a result, the SOCAL BRS activities planned to be conducted in the Southern California action area would not appreciably reduce the sei whales' likelihood of surviving and recovering in the wild.

6.4.4 Humpback Whale

Most humpback whales would only be exposed periodically or episodically, to the SOCAL BRS activities proposed to conducted in the Southern California action area. Studies have demonstrated that humpback whales will exhibit short-term behavioral reactions to boat traffic and playbacks of low frequency industrial sound, the long-term effects of these disturbances on the individuals exposed to them are not known.

The evidence available suggests that humpback whales are likely to detect MFAS playbacks. In most circumstances, humpback whales are likely to try to avoid that exposure or are likely to avoid specific areas. Those humpback whales that do not avoid the sound field created by the MFAS might experience interruptions in their vocalizations. In either case, humpback whales that avoid these sound fields or stop vocalizing are not likely to experience significant disruptions of their normal behavior patterns. As a result, we do not expect these disruptions to reduce the fitness (reproductive success or longevity) of any individual animal or to result in physiological stress responses that rise to the level of distress.

The increase in the number of humpback whales suggests that the stress regime these whales are exposed to in the Southern California action area has not prevented these whales from increasing their numbers. Humpback whales have been exposed to SOCAL BRS playbacks and U.S. Navy training exercises in the Southern California action area, including vessel traffic, aircraft traffic, active sonar, and underwater detonations, for more than a generation. Although we do not know if more humpback whales might have used the action area or the reproductive success of humpback whales would be higher absent their exposure to these activities, the rate at which humpback whales occur in the Southern California action area suggests that humpback whale numbers have increased substantially in these important feeding areas despite exposure to earlier training regimes.

We do not anticipate any mortality of humpback whales from acoustic stressors or vessel strike associated with the SOCAL BRS activities.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that SOCAL BRS activities planned to be conducted in the Southern California action area on an annual basis or cumulatively over the five year period from 2016 to 2021, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual humpback whales in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual whales would not be likely to reduce the viability of the populations those individual whales represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations). As a result, the SOCAL BRS activities planned to be conducted in the Southern California action area would not appreciably reduce the humpback whales' likelihood of surviving and recovering in the wild.

6.4.5 Sperm Whale

If exposed to MFAS transmissions, sperm whales are likely to hear and respond to those transmissions. The only data on the hearing range of sperm whales are evoked potentials from a stranded neonate (Carder and Ridgway 1990). These data suggest that neonatal sperm whales respond to sounds from 2.5 to 60 kHz. Sperm whales also produce loud broad-band clicks from about 0.1 to 20 kHz (Goold and Jones 1995; Weilgart and Whitehead 1993). These have source levels estimated at 171 dB re: 1µPa (Levenson 1974). Current evidence suggests that the disproportionately large head of the sperm whale is an adaptation to produce these vocalizations (Clarke 1979; Cranford 1992; Norris and Harvey 1972). This suggests that the production of these loud low frequency clicks is extremely important to the survival of individual sperm whales. The function of these vocalizations is relatively well-studied (Goold and Jones 1995; Weilgart and Whitehead 1993). Long series of monotonous regularly spaced clicks are associated with feeding and are thought to be produced for echolocation. Distinctive, short, patterned series of clicks, called codas, are associated with social behavior and interactions within social groups (Weilgart and Whitehead 1993).

Based on the frequencies of their vocalizations, which overlap the frequency range of MFAS, sonar transmissions might temporarily reduce the active space of sperm whale vocalizations.

There is some evidence of disruptions of clicking and behavior from sonars, pingers (Watkins and Schevill 1975a), the Heard Island Feasability Test (Bowles et al. 1994), and the Acoustic Thermometry of Ocean Climate (Costa et al. 1998). Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders. They may also stopped vocalizing for brief periods when codas were being produced by other individuals, perhaps because they can hear better when not vocalizing themselves.

As discussed previously, sperm whales have been reported to have reacted to military sonar, apparently produced by a submarine, by dispersing from social aggregations, moving away from the sound source, remaining relatively silent and becoming difficult to approach. Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure or to avoid the location of the exposure.

Other studies identify instances in which sperm whales did not respond to anthropogenic sounds. Sperm whales did not alter their vocal activity when exposed to levels of 173 dB re: 1µPa from impulsive sounds produced by 1g trinitrotoluene (i.e., TNT) detonators (Madsen and Mohl 2000a). Richardson et al. (Richardson et al. 1995c) citing a personal communication with J. Gordon suggested that sperm whales in the Mediterranean Sea continued calling when exposed to frequent and strong military sonar signals. When Andre and Jurado (1997) exposed sperm whales to a variety of sounds to determine what sounds may be used to scare whales out of the path of vessels, sperm whales were observed to have startle reactions to 10 kHz pulses (180 dB re: 1µPa at the source), but not to the other sources played to them.

Some sperm whales are likely to avoid continued exposure to MFAS, although we assume these whales would respond to both the active sonar, any salient acoustic cues produced by surface vessels involved in an exercise, and their perception of whether ships are approaching them or moving away when they decide whether or not to avoid the active sonar. Based on the evidence available, sperm whales seem more likely to avoid continued exposure at lower, initial received levels and the avoidance would consist of horizontal movement away from an exercise at slow to moderate swimming speeds. Other sperm whales would engage in evasive travel which would involve faster swimming speeds, deeper dives, and short times at surface. Sperm whales may also exhibit behavioral disturbance or a shift from one behavioral state to another; they are most likely to shift from a resting behavioral state to an active behavioral state.

These studies suggest that the behavioral responses of sperm whales to anthropogenic sounds are highly variable, but do not appear to result in the death or injury of individual whales or result in reductions in the fitness of individuals involved. Responses of sperm whales to anthropogenic sounds probably depend on the age and sex of animals being exposed, as well as other factors. There is evidence that many individuals respond to certain sound sources, provided the received level is high enough to evoke a response, while other individuals do not.

The sperm whales that might be exposed to the SOCAL BRS activities in the Southern California action area annually, or over the five years of the permit, particularly playbacks, ship traffic, and prey mapping. The evidence available suggests that sperm whales are likely to detect MFAS transmissions. In most circumstances, sperm whales are likely to try to avoid that exposure or are likely to avoid areas specific areas. Those sperm whales that do not avoid the sound field created by the MFAS might interrupt communications, echolocation, or foraging behavior. In either case, sperm whales that avoid these sound fields, stop communicating, echolocating, or foraging might experience significant disruptions of normal behavior patterns that are essential to their individual fitness. Because of the relatively short duration of the acoustic transmissions associated with the playbacks, we do not, however, expect these disruptions to result in the death or injury of any individual animal or to result in physiological stress responses that rise to the level of distress.

Individual sperm whales are likely to respond to the ship traffic in ways that might approximate their responses to whale watch vessels. Those responses are likely to depend on the distance of a whale from a vessel, vessel speed, vessel direction, vessel sound, and the number of vessels involved in a particular maneuver. The closer sperm whales are to these vessels and the greater the number of times they are exposed, the greater their likelihood of being exposed and responding to that exposure. Particular whales might not respond to the vessels, while in other circumstances, sperm whales are likely to change their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. Some of these whales might experience physiological stress (but not “distress”) responses if they attempt to avoid one vessel and encounter another vessel during that attempt. However, because of the relatively short duration of the activities, we do not expect these responses to continue long-enough to have fitness consequences for individual sperm whales because these whales are likely to have energy reserves sufficient to meet the demands of their normal behavioral patterns and those of a stress physiology.

We do not anticipate any mortality of sperm whales from acoustic stressors or vessel strike associated with the SOCAL BRS activities..

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that SOCAL BRS activities to be conducted in the Southern California action area annually or cumulatively over the next five years or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual sperm whales in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual sperm whales would not be likely to reduce the viability of the populations those individual whales represent by reducing the population dynamics, behavioral ecology, and social dynamics of those populations (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations). As a result, the SOCAL BRS activities in the Southern California action area annually and over the five years of the permit would not be expected to appreciably reduce the sperm whales' likelihood of surviving and recovering in the wild.

6.4.6 Guadalupe Fur Seal

The SOCAL BRS activities the planned to be conduct in the Southern California action area, on an annual basis from 2016 to 20121 are likely to cause some individual Guadalupe fur seals to experience changes in their behavioral states. These responses are not likely to alter the physiology, behavioral ecology, and social dynamics of individual Guadalupe fur seals in ways or to a degree that would reduce their fitness.

Guadalupe fur seals have been exposed to previous SOCAL BRS activities as well as U.S. Navy training exercises on the SCORE Complex, including vessel traffic, aircraft traffic, active sonar, and underwater detonations, for more than a generation. Despite this exposure, the Guadalupe fur seal population has been estimated to be increasing at a rate of about 13.7 percent per year; at the rate of growth, the population should double every five years. Although we do not know if the Guadalupe fur seal population might have increased at a much higher rate if they had not been exposed to SOCAL BRS and U.S. Navy activities, this rate suggests that the number of Guadalupe fur seals would continue to increases despite being exposed to stressors associated with these activities. As a result, the Guadalupe fur seals' probable responses to exposure to playbacks and prey mapping are not likely to reduce the current or expected future reproductive success of Guadalupe fur seals or reduce the rates at which they grow, mature, or become reproductively active. Therefore, these exposures are not likely to reduce the abundance, reproduction rates, and growth rates (or increase variance in one or more of these rates) of the populations those individuals represent.

We do not expect any Guadalupe fur seals to be involved in a ship strike associated with the SOCAL BRS activities in the Southern California action area.

An action that is not likely to reduce the fitness of individual animals would not be likely to reduce the viability of the populations those individuals represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of such populations). For the same reasons, an action that is not likely to reduce the viability of those populations is not likely to increase the extinction probability of the species those populations comprise. As a result, the SOCAL BRS activities planned to be conduct annually in the Southern California action area, or over the period of the permit from 2016 to 2021, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline) are not likely to appreciably reduce the Guadalupe fur seals' likelihood of surviving and recovering in the wild.

7 CONCLUSION

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's opinion that the proposed action is not likely to jeopardize the continued existence or recovery of the blue, fin, sei, humpback, and sperm whale as well as the Guadalupe fur seal. No critical habitat has been designated or proposed for these species; therefore, none will be affected.

8 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to ESA-listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this Incidental Take Statement.

As discussed in the accompanying opinion, only the species targeted by the proposed research activities would be harassed as part of the intended purpose of the proposed action. Therefore, the NMFS does not expect the proposed action would unintentionally take additional threatened or endangered species. No incidental take is authorized.

9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or designated critical habitat, to help implement recovery plans or develop information (50 CFR 402.02).

We recommend the following conservation recommendation, which would provide information for future consultations involving the issuance of permits that may affect ESA-listed cetaceans and pinnipeds as well as reduce harassment related to the authorized activities:

- We recommend that the Permits Division develop a programmatic approach to the issuance of scientific research permits on a species-specific or geographic basis, or other programmatic approach. A programmatic approach to research permit issuance would allow for a better understanding of all proposed research efforts and their effects to ESA-listed species and designated critical habitat.
- We recommend that annual reports submitted to the Permits Division by the Applicant require detail on the response of blue, fin, sei, humpback, and sperm whales as well as Guadalupe fur seals to permitted activities. The number and types of responses observed should be summarized and include responses of both target and non-target individuals. This will greatly aid in analysis of likely impacts of future activities.

In order for NMFS' Office of Protected Resources ESA Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting, ESA-listed species or their designated critical habitat, the Permits Division should notify the ESA Interagency Cooperation Division of any conservation recommendations they implement in their final action.

10 Reinitiation of Consultation

This concludes formal consultation on NMFS Permits and Conservation Division's proposed issuance of Permit No. 19116 to Dr. Brandon Southall (Southall Environmental Associates, Inc.) to conduct behavioral response studies of Pacific marine mammals using controlled sound exposure, research applications to support management decisions and conservation. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of authorized directed or incidental take is exceeded, (2) new information reveals effects of the agency action that may affect ESA-listed species or designated critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the ESA-listed species or designated critical habitat that was not considered in this opinion, or (4) a new species is ESA-listed or critical habitat designated that may be affected by the action.

In instances where the amount or extent of authorized take is exceeded, the Permit Holder and NMFS's Permits Division must contact the ESA Interagency Cooperation Division, Office of Protected Resources immediately and request reinitiation of section 7 consultation.

If the proposed listings of humpback whale DPSs are finalized as proposed, the Permits Division may ask the ESA Interagency Cooperation Division to confirm the conference opinion as the biological opinion through formal consultation. The request must be in writing. An opinion issued at the conclusion of the conference may be adopted as the biological opinion when the species is listed or critical habitat is designated, but only if no significant new information is developed (including that developed during the rulemaking process on the proposed listing or critical habitat designation) and no significant changes to the Federal action are made that would alter the content of the opinion. If NMFS reviews the proposed action and finds that there have been no significant change in the action as planned or in the information used during the conference, NMFS will confirm the conference opinion as the biological opinion on the project and no further Section 7 consultation will be necessary.

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