NOAA's National Marine Fisheries Service
Endangered Species Act Section 7 Consultation

Biological Opinion (Corrected)

Agency: Permits, Conservation and Education Division of the Office of Protected Resources, NOAA's National Marine Fisheries Service

Activity Considered: Biological Opinion on the Permits, Conservation and Education Division's proposal to issue eight Permits (14682, 13846, 14451, 14585, 14599, 14122, 14296, 14353) and one Permit Amendment (10018-01) to scientific researchers, for research on multiple large whale species pursuant to section 10(a)(1)(A) of the Endangered Species Act of 1973 and section 104 of the Marine Mammal Protection Act.

Consultation Conducted by: Endangered Species Division of the Office of Protected Resources, NOAA's National Marine Fisheries Service

Approved by: _____

Date: APR 13 2011

Section 7(a)(2) of the Endangered Species Act (ESA) (16 U.S.C. 1531 *et seq.*) requires that each federal agency shall ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a federal agency "may affect" a listed species or critical habitat that has been designated for them, that agency is required to consult with either NOAA's National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the listed resources that may be affected. For the action described in this document, the action agency is NMFS' Office of Protected Resources – Permits, Conservation and Education Division. The consulting agency is NMFS' Office of Protected Resources – Endangered Species Division.

This document represents NMFS' biological opinion (Opinion) on the effects of the proposed studies on endangered and threatened species and designated critical habitat, and has been prepared in accordance with section 7 of the ESA. This Opinion is based on our review of the Permits, Conservation and Education Division's draft Environmental Assessment, draft amendment for Permit Numbers 14682, 10018-01, 13846, 14451, 14585, 14599, 14122, 14296, 14353, the most current stock assessment reports, the recovery plans, scientific and technical reports from government agencies, peer-reviewed literature, and other sources of information.

These actions also occur in part within certain areas in the northeast and southeast U.S. designated as critical habitat for the North Atlantic right whale. This ESA Section 7 consultation

as corrected (Opinion) considers the effects of the proposed research studies on endangered and threatened species and designated critical habitat.

A complete administrative record for this consultation is on file at NMFS' Office of Protected Resources.

CONSULTATION HISTORY

On April 20, 2010, NMFS' Office of Protected Resources – Permits, Conservation and Education Division (PR1) submitted a draft Environmental Assessment (EA) to NMFS' Office of Protected Resources – Endangered Species Division (PR3) for the proposed issuance of eight, large whale scientific research permits and one permit amendment. PR3 then began background research on PR1's proposed action and corresponded with PR1 on relevant questions pertaining to the research methodology, particular action areas, and species affected. There was no complete initiation package at this time.

On May 14, 2010, PR1 submitted a completed initiation package. Due to the correspondence that had already taken place after the draft EA was submitted on April 20, 2010, PR3 initiated consultation on May 14, 2010. Formal consultation was completed on July 14, 2010 and a Biological Opinion was issued with a determination that the proposed action was not likely to jeopardize the continued existence of any listed species and not likely to destroy or adversely modify designated critical habitat.

Due to concerns of NOAA's Office of General Council (NOAA GC) regarding the legal status of critical habitat for North Atlantic right whales, the abovementioned Biological Opinion did not consider effects to North Atlantic right whale critical habitat. This decision was based on a legal opinion issued by NOAA GC in 2004 that advised that critical habitat for North Atlantic right whales was rendered legally invalid after NMFS published a final rule on March 6, 2008 listing North Pacific right whales *(Eubalaena japonica)* and North Atlantic right whales *(Eubalaena glacialis)* as separate species under the ESA.

On August 19, 2010, NOAA GC informed NMFS of its intentions to issue a new legal opinion concluding that the original 1994 critical habitat designation would in fact remain viable for North Atlantic right whales.

Based on the revised legal opinion regarding the validity of North Atlantic right whale critical habitat, the Endangered Species Division is correcting the previously issued Biological Opinion to include analysis of effects to North Atlantic right whale designated critical habitat.

BIOLOGICAL OPINION (CORRECTED)

I. DESCRIPTION OF THE PROPOSED ACTION

The proposed action addressed in this Opinion is PR1's authorization of eight permits and one permit amendment (Table 1). Under the proposed action, five-year research permits would be

issued for activities proposed by the applicants for Permits 14682, 13846, 14451, 14585, 14599, 14122, 14296, and 14353, and an amendment would be issued for File No. 10018 which would be valid until that permit expires. The authority for PR1's permit issuance is pursuant to 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 Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et seq.*).

Table 1. List of proposed five-year research permits and amendment addressed in this Opinion.

Principal Investigator (PI)	Permit	Purpose of Research
Whit Au, Ph.D.	14682	To investigate the population dynamics and behavior of cetaceans around Hawaii and the Pacific, to determine aspects of the behavior and use of the acoustic environment by large whales, and to determine the effects of noise on behavior of cetaceans around Hawaii.
Jim Darling	13846	To study the social organization, behavior and communication of humpback whales in Hawaii (primarily off west Maui), and the population biology, ecology, and behavior of humpback and (non-ESA listed) Eastern gray whales along the coastlines of Washington and Alaska.
Joseph Mobley, Jr.	14451	To investigate short and long-term changes in population size, habitat use, and behavior of cetaceans off the coast of eastern and western United States, Hawaii, Alaska, Guam, and the Mariana Islands.
Adam Pack, Ph.D.	14585	To continue long-term population studies of humpback whales and other cetacean species in the Eastern, Western and Central North Pacific Ocean, primarily Hawaii and Alaska.
Fred Sharpe	14599	To conduct research on the social complexity of Alaskan humpback whale bubble feeding to gain insight into the manner in which environmental and social factors shape this behavior.
Jan Straley	14122	To study the biology of large whales in Alaskan waters to: (1) continue and expand a study of humpback whales; (2) study sperm whale movements, foraging behavior and depredation on longline fishing gear to reduce interactions; (3) study killer whale seasonal movements, foraging, migration patterns and depredation; (4) enhance the body of knowledge, stock structure and current status of gray, minke, fin, sei, blue, and North Pacific right whales; and (5) study killer whale predation events and collect dead parts from prey.
Briana Witteveen	14296	To conduct scientific research on cetaceans year-round in the Gulf of Alaska, with emphasis on examining prey use and foraging patterns of gray, fin, and humpback whales and exploring the responses of humpback whales to acoustic deterrent devices.
Ann Zoidis	14353	To conduct scientific research on humpback whales in Hawaiian waters to examine (1) underwater activity budgets of humpback whales, including during non-daylight hours; (2) mother/calf/escort interactions, including sound production and vocal/behavioral responses to sounds by conspecifics; (3) habitat use; and (4) behavioral and/or acoustic reactions to passing vessel traffic.

Principal Investigator (PI)	Permit	Purpose of Research
Rachel Cartwright	10018-01 (this amendment does not lengthen the original permit's expiration)	To broaden the action area of the currently authorized study on humpback whale female-calf behavior and habitat choice to include Alaskan waters, focused primarily in Chatham Straits, Frederick Sound, Sumner Strait, Lynn Canal and Icy Strait.

General Activities. This Opinion gives generalized descriptions that are common to all of the research activities proposed to be conducted on listed whales (some harassment could also occur with pinnipeds). General activities include aerial surveys, vessel surveys, close vessel approaches, underwater photography/videography, passive acoustic recording, acoustic playbacks, genetic sampling (biopsy, skin swabbing), suction cup and invasive tags, and collection of dead ESA-listed marine mammal parts. After these general activities are described in the following paragraphs this Opinion describes, in a *Specific Permit Request Activities* section, proposed research activities that deviate from general activities and are specific to each proposed permit.

Aerial surveys

Aerial surveys would be conducted using fixed-wing or rotary-wing aircraft. Aerial surveys using fixed-wing aircraft would generally be conducted at an altitude of above 750 ft (244m), with descents to a minimum of 500 ft (152m) for species identification and photo-identification. Helicopters would fly at an altitude of 500 feet or above. Surveys would not be flown over pinniped haulout sites.

Vessel surveys

Vessel surveys using random routes or line-transect sampling methods would be used to collect data for estimating abundance of cetaceans. Vessels would typically be up to ~30m (~98.4 ft), but larger vessels would be used if necessary (Barlow and Forney (2007) used 52m, 53m, and 62m vessels for similar surveys).

During surveys, three to eight observers would rotate through at least three positions (port and starboard observers and a data recorder) during daylight hours, weather permitting (sea state of Beaufort 0-7 with minimal rain). The naked eye, 7x handheld, or 25x "bigeye" pedestal mounted binoculars would be used to locate marine mammals. The port observer would survey from 10º right to 90º left of the trackline and the starboard observer from 10º left to 90º right of the trackline. The recorder would scan the entire 180º area forward of the ship, focusing primarily on the trackline, using 7x reticled binoculars to confirm sightings.

The ship's global positioning system (GPS) unit or a handheld GPS would interface with a portable computer at the recorder's station. A standardized survey software program such as WinCruz would be used to collect standard line-transect information. The date, time, and position of the vessel would be automatically entered into the survey program every 5 min and whenever data are entered by the recorder. At the start of each trackline, observer positions and environmental conditions would be entered. Environmental conditions include sea state (Beaufort scale), swell height and direction, weather (rain, fog, no rain or fog, both rain and fog), horizontal and vertical positions of the sun, wind speed and visibility. Sighting information includes cue (blow, splash, animal), method (binocular type or naked eye), vertical distance

(taken from reticles in the binoculars), angle relative to the ship's heading (from an angle ring on the binocular mount or an angle board), species, and group size (best, high, and low count).

When appropriate, the survey effort would be temporarily suspended to approach a group to facilitate species identification or group-size estimation or to conduct other activities such as photo-identification, acoustic recording, or biopsy sampling before returning to the line transect point where the vessel disengaged and continuing the survey.

Close vessel approach for photo-identification and behavioral observations
Vessels used for close approach would generally be less than 30 m in length; the majority of research would be conducted from vessels less than 20 m in length. For large whales, boat approaches would be within a whale's length from an individual (ca. 10-15 m for an adult-sized whale), although a whale might approach the boat closer than this distance.

Focal animal or group follows would be conducted, during which the behavior of the animal(s) would be recorded, pod composition determined, and behavioral roles identified when possible. Photographs of the tail flukes, dorsal fin shape, and distinctive scars and body markings of each member of a group would be taken. When feasible, behaviors would be videotaped. Observations and photography of the animal(s) would be of variable duration depending on circumstances, behaviors, social dynamics, and weather and water conditions.

During close vessel approaches for all activities, disturbance to animals would be minimized by:

- Approaching at minimal speeds from behind or beside the group.
- Remaining parallel to the animals.
- Matching speed with the group.
- Minimizing changes in speed.
- Terminating activities if active avoidance is occurring.

Underwater photography and videography

Pole- or vessel-mounted camera
Underwater cameras would include devices ranging from a small pole mounted lipstick camera (an extremely small video camera which is approximately the size of a typical tube of lipstick) to larger vessel-mounted units that would be considered part of the vessel's superstructure. Very slow approaches or drifting in the vicinity of foraging animals would be conducted to within 5 m of animals to collect underwater video data.

Snorkelers
In Hawaii only, if the whales under observation become stationary, mill, or are swimming slowly, a swimmer equipped with mask, snorkel, and fins and a still or video camera in an underwater housing would enter the water within approximately 20-30 meters of the targeted group. The swimmer would approach the animals quietly at the surface until they are a whale's length away (ca. 10-15m for an adult whale). Depending on the animal's behavior, a second swimmer equipped with an underwater camera would be deployed to obtain still photographs of key underwater displays, physical appearance, fluke photographs (if not obtainable from the surface), or affiliations. In some cases, a safety diver would be in the water. No more than two swimmers would be in the water at a time, unless specifically authorized by NMFS. The boat

crew would stand by with engine idling to assist the swimmer(s) when video recording is complete.

The amount of time the swimmer is in the water would depend on the number of animals in a group and that group's behavior. For example, more time is generally spent with large competitive groups than small competitive groups. Also, a group that is stationary may provide more opportunities for obtaining data than a group that is traveling. Usually, a single deployment of a swimmer for in-water data collection lasts about 20 min. However, on occasion, a group that dives for long periods (e.g., 40 min) and that is stationary between dives may provide an opportunity of an hour or longer for obtaining data.

Scuba
Some divers would be equipped with SCUBA gear and an electric scooter and some swimmers would use new, light re-breathers for silent (no bubble) observation at depth over long periods. The research vessel would approach foraging whales to within 30 m to deploy two divers, who would then approach by swimming or with the aid of an electric scooter to within one whale body length. Sound pressure levels for these devices are not readily available, although the scooters used are likely to have direct drive propulsion, variable pitch propellers, and brush motors, and are estimated to be below 77 dB re 1 µPa-m. It is estimated that most encounters with whales would be relatively brief, typically less than a minute before whales swim away; encounters could last up to 15 minutes.

Passive acoustic recording

Hydrophones or hydrophone arrays would be used for acoustic recordings of large whales and small cetaceans. Generally, recordings would be of individuals already approached for behavioral observation, and the vessel would not approach closer than five meters when passively recording humpback vocalizations. Some individuals would be unintentionally approached for acoustic recording more than once in a day and in a season.

Acoustic Playbacks

Playbacks would be conducted to gain insight into the function of humpback whale sounds and to determine whether particular classes of sounds evoke a mild alerting response in some large whale and small cetacean species. Sounds that cause mild alert responses could be used in the future to avoid vessel collisions, seismic exploration activities, and gear entanglements. A variety of sound types would be broadcast to tagged and untagged animals to determine their behavioral reactions. Sound levels received by target species would not exceed 180 dB re: 1µPa, NMFS' current threshold for Level A harassment under the Marine Mammal Protection Act.

Playbacks would include:

- Sounds produced by cetaceans
- Blank tape or silent stimulus control sound
- Non-impulsive synthetic sounds
- Impulsive signals between 1 kHz-50 kHz

Specific descriptions for playback projects are located in the descriptions of File Nos. 14682 (Au), 13846 (Darling), 14599 (Sharpe), 14122 (Straley), and 14296 (Witteveen).

Genetic sampling

Skin swabbing
Skin would be collected by swabbing the dorsal or lateral surface of each target whale using a sterile strip of nylon kitchen scrub pad or Velcro attached to a metal pole. Samples collected would consist of small amounts of exfoliated skin with a maximum surface area of about 20 cm^2.

Biopsy
Skin and attached blubber tissue samples would be collected from listed whales using a small stainless steel biopsy dart ranging from 5-9 mm in diameter and 40-60 mm in length. Darts would be fitted with a flange or "stop" that regulates penetration depth of the bolt/dart and causes recoil after sampling. In no instance would the dart extend through the blubber to the muscle layer. Crossbows, most commonly with a draw of 68 kg (150 lbs), and veterinary rifles using either compressed air or blank charges with adjustable pressure would be used for sample collection. Flotation material secured to the shaft of the bolt/dart would allow it to float and be retrieved after sampling.

Vessels would approach to within 10-30 m of the target animal. Darts would be aimed at the upper back just below the dorsal fin. Biopsy samples would be collected from both sexes and all age classes except neonates; species and take numbers are specified in the take tables for each permit.

In addition to the mitigation measures described above for close approach, mitigation measures used during biopsy sampling include:

- Using a new sterile dart tip for each sample collected.
- When possible, individuals would be identified prior to sampling to avoid duplication.

Samples would be stored in 20% DMSO in saturated NaCl solution or 70% ethanol and/or stored at –20°C. Tissues remaining after analyses would be archived (by researchers or sent to NMFS' Southwest Fisheries Science Center for archival).

Tagging

Tags would be attached to large whales and small cetaceans via suction cup or implanted into the skin and blubber of animals, depending on the research objectives. Tags would contain a variety of components, depending on the objectives of the research, to record temperature, depth, sound, acceleration, position, and video. Exact dimensions and weights would vary with the generation of tag and the specific components included; examples of current tags are provided in Table 2. Tags would be attached dorsally just in front of or beside the dorsal fin so that the antenna would be exposed when the animal surfaces. The tags would weigh less than 2500 grams (approximately 5.5 lbs) in air and maybe potted in syntactic foam, making them slightly buoyant in water. Most tags would weigh less than 500 g (approximately 1.1 lbs).

Advancements in technology have consistently led to smaller and more effective tags, and this trend is expected to continue in the future. Tagging equipment would be updated as newer models become available, and careful consideration of the primary research objective would be given before finalizing the tag package and deployment system to ensure that the smallest, lightest package is deployed.

Tagging would usually be conducted from small boats (less than 25 m in length), and only in relatively calm seas (i.e., Beaufort 0-2). Tagging would not be conducted from the longline vessel (Permit 14122; Straley). Animals would be approached to within 2-15 m using the methods described under *Close vessel approach for photo-identification and behavioral observations*. Tags would be attached using a hand-held or cantilevered pole or deployed with a crossbow or airgun. Behavioral responses of tagged individuals and of other animals in the group would be observed and recorded. In some instances, a hydrophone would be placed in the water to monitor acoustic response to tagging.

Tagged animals would be followed by boat at distances between 5 and 500 meters, depending on the species (larger species would be followed from a greater distance) and objectives, to monitor behavior and/or to obtain a trackline of movements. When possible, tags would be retrieved after they release from the animal. Photographs would be taken of the site of tag attachment to evaluate skin condition. In some instances, whales would be tagged twice annually.

Table 2. Approximate dimensions of tag types. Sizes are subject to variation depending on tag generation and specific research.

Tag Type	Dimensions	Weight*	Attachment Method	Expected Attachment Duration
VHF/TDR tags	9.5 cm long 2.5 cm diameter	42 g, positively buoyant with floatation	Suction cup	6-8 hours; maximum 72 hours
DTAGs	12 cm x 5 cm	300 g in air	Suction cup	6-8 hours; maximum 72 hours
Bioacoustic probes	19.3 cm long 3.25 cm diameter	66 g, positively buoyant with floatation	Suction cup	6-8 hours; maximum 72 hours
Acousonde tags	3.2 cm diameter 22.1 cm long	262 g in air; 86 g in seawater	Suction cup	6-8 hours; maximum 72 hours
Acousonde tags Model 3B, in development (dimensions subject to change)	20.2 cm long (includes floatation but not antenna) 7.9 cm wide 4.3 cm height (includes suction cup)	390 g in air	Suction cup	6-8 hours; maximum 72 hours
MANTA tags	20-42 cm long 4-5 cm diameter	positively buoyant with floatation	Suction cup	6-8 hours; maximum 72 hours
Crittercams	< 12 cm diameter < 35 cm long, including 15cm polyurethane flotation foam tail	< 2.5 kg	Suction cup	≤ 24 hours
Partially Implantable tags	< 2.5 cm wide 12 cm length (not including 18 cm antenna)	150-250 g	Implants up to 10 cm into blubber - "depth stop" limits penetration to < 10 cm	1-5 months
Barnacle/Limpet/Dart type tags	6.0 cm x 3.5 cm x 2.5 cm	50 g	Two barbed titanium or stainless steel darts implant < 10 cm into blubber	1-2 months

* Weight does not include floatation, housing, and attachments unless specified.

Suction cup attachments (Non-Invasive Tags)
Suction cup tags would be attached to large whales. Suction cups would be approximately 8-10 cm in diameter. Only the suction cups would be in prolonged contact with the animal's skin. Tags would release from the animal when the natural suction of the cup diminishes, or when a magnesium cap that corrodes in salt water causes the release of the tag. Tags would be retrieved by researchers upon release. The animal's behavior, including breaching, rolling, or rubbing, may cause the tag to shed prematurely. The amount of time that a tag would remain on an animal varies, but would generally be less than 72 hours. Attachments would likely last closer to six to eight hours (Baird *et al*. 2000, Lerczak *et al*. 2000, Croll *et al.* 2001, Calambokidis 2003, Witteveen *et al.* 2008).

Examples of these tags include:

- VHF/TDRs
- DTAGs
- Bioacoustic probes
- Acousonde tags
- MANTA tags
- Crittercams

VHF/Time-Depth-Recorders (TDRs):
VHF/TDRs record dive profiles for the focal animal, including position in the water column, maximum depth of dive, and ascent and descent rates. Time and depth would be recorded at intervals determined by the researcher.

DTAGs:
DTAGs are archival tags that were developed to monitor the behavior of marine mammals, and their response to sound, continuously throughout the dive cycle. The tag records audio, pitch, roll, heading, and depth 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).

DTAGs weigh approximately 300 g in air and are attached to the whale with up to four silicone suction cups using a 12 m cantilevered carbon fiber pole or a handheld carbon fiber pole. With the use of the poles, the tag is delivered without encroaching over the flukes of the animal (Johnson & Tyack 2003). The tags are programmed to release from the animal by venting the suction cups at the end of the recording time if they are still attached. A VHF beacon in the tag aids in tracking and recovering the device.

Bioacoustic Probes:
Bioacoustic Probes ("BProbe") combine a hydrophone, behavioral sensors, a digital recorder, data storage, and a field-replaceable battery in a single, self-contained instrument. Attached to a free-ranging subject, the BProbe can measure the underwater sound environment experienced by that individual, as well as potentially associated changes in dive behavior. In addition to its primary mission as a tool for assessing the impact of noise on marine wildlife, the BProbe can be used to study vocalization behavior of the tagged subject.

BProbes collect acoustic samples with 16-bit resolution at up to 14 kHz bandwidths. They have incorporated VHF/TDRs that record with 12-bit resolution. The duration of attachment is dependent on the attachment method.

Acousonde:
The Acousonde, made by Acoustimetrics, a brand of Greeneridge Sciences, Inc. (www.acousonde.com), is a miniature, self-contained, autonomous acoustic/ultrasonic recorder designed for underwater applications. The Acousonde incorporates hydrophones as well as depth, attitude and orientation sensors, digital recording electronics, data storage, and a field-replaceable battery in a single sealed unit. The Acousonde replaces the Bioacoustic Probe, which was discontinued in 2007.

The Model B003A cylindrical Acousonde with a battery cap and A-size lithium battery weighs 262 g (in air) in a volume of 172 cc. This weight does not include flotation, attachment, or recovery gear specific to each permit. The "torpedo" shape is 3.2 cm in diameter and 22.1 cm long. It is negatively buoyant; in seawater the tag weighs approximately 86 g. The duration of attachment is dependent on the attachment method.

MANTA tags:
MANTA is a high-resolution, real-time 3-D tracking, data-telemetry, and data-logging system for large marine vertebrates. It allows environmental sampling at the animal (e.g., temperature, light, and sound) as well as real-time monitoring of animal responses to stimuli (Norris *et al.* 2005).

It is a multi-modal system that integrates several complementary technologies:

- Acoustic telemetry
- Radio-telemetry
- Data-acquisition and logging
- GPS and navigation sensors

Vocal events (i.e., animal calls) can be detected and potentially telemetered in real-time to a surface tracking station. Potential applications include monitoring noise events at animals' locations (e.g., seismic air-guns, sonar, and vessel noise) and monitoring animals' sub-surface behaviors and movements.

Crittercam:
Crittercam is a small recording unit capable of simultaneously recording video, audio, and additional parameters such as dive depth or swim speed (Marshall 1998). The most advanced versions (Gen 5) include a solid state video/sound capture and 3-D dive path data logging. The 5.7 model's dimensions are 25.4 cm length by 5.7 cm outer diameter. Crittercam is designed considering weight, pressure tolerance, robustness, and low hydrodynamic profile (Marshall 1998). Crittercam has been applied to a multitude of species, including sharks, bottlenose dolphins (*Tursiops truncatus*), harbor *(Phoca vitulina)* and Hawaiian monk seals (*Monachus schauinslandi*), and narwhals (*Monodon monoceros*). It has been successfully applied to adult

balaenopterids. A description of Crittercams and how they have changed over time is available

at: www.nationalgeographic.com/crittercam/about.html#e.

Blubber Implant Attachments (Invasive Tags)
Satellite-linked transmitters would be used to quantify movement patterns and dive behavior of large whales. The transmitters send ultra-high frequency (UHF) radio signals to Argos receivers on five NOAA TIROS-N weather satellites. The signals are sent only when the whales come to the surface, and consist of a 750 ms phase-modulated transmission at 401.650 MHz.

Tags would be attached by implanting into blubber to varying degrees, depending on the species to be tagged and the desired duration of attachments. Attachment methods could include:

- Darts with backwards facing barbs (tag electronics external to animal).
- Sub-dermal attachments that spread out under the skin, mimicking barnacle attachment (tag electronics external to animal).
- Implanted or partially-implanted electronics packages.

Dart/Limpet/Barnacle Tags:
The dart/limpet type tag is an electronics package attached that is attached to the dorsal fin or the body just below the fin with two barbed darts that implant into the skin and/or blubber (Andrews *et al.* 2005). Barnacle tags would include sub-dermal attachments that spread out under the skin. For all types, the tag would remain external to the animal. These tags would be deployed from a crossbow or an air gun.

Partially Implantable Tags:
The implant tag is an electronics package that implants into the blubber of the dorsal flank, near the dorsal fin, with only the top (~2 cm) of the tag and the antenna remaining outside the whale. The tag would be similar to that used successfully on sperm whales (*Physeter macrocephalus;* Mate *et al.* 2007), but would be smaller, with a reduced level of penetration. A "depth stop" consisting of 2 lateral extensions would limit the penetration depth to no more than 10 cm, to ensure the tag would not penetrate the muscle layer. Implant tags would be deployed with an air-gun. Target whales would be greater than 15 m standard length.

In addition to the mitigation measures described above for close approach, mitigation measures used during tagging include:

- Attempts to tag an individual would be discontinued if that animal demonstrates a strong negative response to tagging.
- During any single encounter, no more than three tag deployment attempts per individual would be made.

Collection of marine mammal and pinniped parts and Export/Re-Import of samples
Parts of dead marine mammals would be collected following a killer whale (*Orcinus orca*) predation event to identify the diet composition of transient killer whales in Alaska. Parts of marine mammals would be collected from the water using a skim net or sieve. It is possible that Steller sea lions (*Eumetopias jubatus*) or other species could be harassed during the collection of prey samples, but they would not be intentionally approached.

Sloughed skin and feces would be collected from large whales and small cetaceans following certain surface activities (e.g., breaching, tail slapping). Sloughed skin would be collected from the site of the surface activity only after the animals have moved greater than 100 yards from the location. Skin that remains attached to suction cups after tagging would be collected. These marine mammal parts and biopsy samples collected during research would be exported for analysis and remaining samples may be re-imported.

Specific Permit Request Activities. Information specific to each permit application and methods that differ from or are more detailed than those described in *General Activities* section are described below.

Au (Permit 14682)

The purpose of the research under this proposed permit would be to investigate the population dynamics and behavior of cetaceans around Hawaii and the Pacific, to determine aspects of the behavior and use of the acoustic environment by large whales, and to determine the effects of noise on behavior of cetaceans around Hawaii. Proposed research would take place in Hawaiian waters between November and June annually and would target humpback whales. This research also would target other non-listed marine mammals at other times of the year.

Genetic sampling (biopsy, skin swabbing, collection of sloughed skin, and fecal), suction-cup tagging, passive acoustic recording, behavioral observation, photo-identification, underwater photography/videography, and close vessel approaches would be used to answer questions about population size, diving and feeding behaviors (including diurnal differences in these behaviors), and local movement patterns. The research would include three discrete projects. Projects 1-2 involve listed humpback whales, while Project 3 involves non-listed cetaceans.

- Project 1: Population dynamics of marine mammals around Hawaii.
- Project 2: Noise, the acoustic environment, and the use of sound by whales around Hawaii.
- Project 3: Behavioral effects of sound on marine mammals around Hawaii (this portion of the research would not include listed species).

Table 3. Proposed takes for humpback whales in the Pacific Ocean around Hawaii for Au Permit 14682.

Species	Life Stage	Sex	Maximum Takes Over Five Years	Observe/Collect Method	Proposed Activities
Whale, humpback	All	Male and Female	80 (maximum 20 animals tagged annually; calves >1month old)	Survey, vessel	Acoustic, passive recording; Close vessel approach; Instrument, suction-cup (e.g., VHF, TDR); Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Underwater photo/videography
Whale, humpback	Adult	Male and Female	150 (maximum 50 animals sampled annually)	Survey, vessel	Acoustic, passive recording; Collect, sloughed skin; Import/export/receive, parts; Close vessel approach; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy; Sample, skin biopsy
Whale, humpback	All	Male and Female	540	Survey, vessel	Acoustic, passive recording; Close vessel approach; Observation, monitoring; Observations, behavioral; Photo-id; Photogrammetry; Photograph/Video; Tracking; Underwater photo/videography

Project 1: The overall objective of the project is to determine many aspects of the population dynamics and behavior of cetaceans (including listed Humpback whales) around Hawaii, including genetic population structure and variability, dispersal patterns, social structure, and foraging and diving behavior in order to enhance effective management.

Activities conducted during Project 1, as described in *General Activities*, would include:

- Close approach for photo-identification and behavioral observation.
- Collection of feces.
- Genetic sampling by skin swabbing or biopsy sampling (if skin swabbing does not yield sufficient amounts of DNA).
- Suction-cup tagging.

Research activities for this project would focus on two non-ESA listed cetaceans; however, other species including humpback whales would also be targeted for research. Take numbers are specified in Table 3 above.

Male and female humpbacks of all ages and reproductive conditions would be approached for photo-identification and behavioral research. Male and female humpbacks of all ages, except calves or females with calves, would be subject to genetic sampling or tagging. Biopsy sampling of adult humpback whales in the northwest Hawaiian Islands would be conducted.

Project 2: The overall objective of the project is to determine many aspects of the behavior and use of the acoustic environment by large whales, including listed humpbacks. Data would provide information on how cetaceans use acoustics to coordinate and mediate behavior within a group environment, to understand how echolocation is used in foraging, and to determine the acoustic characteristics of the animals' sound production, especially when they dive to deep depths.

Activities conducted during Project 2, as described in *General Activities*, would include:

- Close approach for photo-identification and behavioral observation.
- Passive acoustic recording.
- Suction-cup tagging.

Research activities for this project would focus on humpback whales and two non-ESA listed whales as models; other non-listed species would also be targeted for research. Take numbers are specified in Table 3 above.

Adult male and female humpback whales would be targeted for research. This would include tagging of mothers accompanying calves older than one month and tagging of calves older than one month.

Acoustic recording will take place in conjunction with tagging with acoustic behavioral tags. A three-hydrophone array will be towed behind the research vessel for recording of vocalizations, localization of individuals, including the tagged individual, comparison with acoustic recordings from the tag, and overall assessment of acoustic environment. Sections of the hydrophone array will be constructed of PVC piping material, which will add rigidity to the array and will make it more visible. On occasion, a single hydrophone may be used depending on research conditions and group behavior. Close approach to groups of whales is necessary to assure good quality sound recording and localization of individuals from the towed hydrophone array. Maintaining a safe distance from the animals will protect both the equipment and the whales from any type of entanglement or damage. The safe approach distance will vary depending on weather conditions, number of whales in the group, and behavior and movement patterns of the group, but during acoustic recording will not be less than five meters. Any disturbance or harassment due to acoustic recording activities should therefore not impact the whales more than standard behavioral and photo-identification research activities. Generally, acoustic recording will take place with groups already approached for behavioral observation.

Project 3: ESA-listed species would not be targeted for project 3 research. The overall objective of the project is to determine the effects of noise on the behavior of cetaceans around Hawaii and to research low-level sounds that could alert marine mammals and alter their behavior for potential future use as a mitigation tool. The specific objective is to determine types of low-level sounds that elicit mild alerting responses from marine mammals (e.g., submerged mammals surface or move short distances (about 500 m)). Playbacks would occur in U.S. waters of Hawaii and adjacent international waters throughout the year, except during humpback season in Hawaii (December to April).

Cartwright (Permit Amendment 10018-01)
The proposed research would expand Cartwright's current study of humpback whale female-calf behavior and habitat choice to add humpback whales in Alaskan waters to the currently authorized humpback whales on the breeding grounds of the Central North Pacific stock. Collecting data from the Alaskan feeding grounds of this stock would allow data to be compiled with that collected on the breeding grounds (Hawaii) to provide a comprehensive description of the ontogeny of humpback whale calves across their natal year. The study would also examine habitat choice in female-calf pairs by attempting to identify favored feeding regions and determine how over-riding bathymetric or biological parameters define preferred habitat for female-calf pairs on the feeding grounds. The proposed activities would occur in Alaska's Inside Passage, including Chatham Strait and adjacent bodies of water, and potentially extending on occasion into Frederick Sound, Stephen's Passage, Sumner Straits, Icy Straits and Lynn Canal. Proposed activities include close vessel approach, focal follows, passive acoustic recording, underwater observations, and collection of sloughed skin.

Research would focus on humpback whales. Take numbers for all activities are specified in Table 4. Males and females of all ages and reproductive conditions would be targeted for close approach to conduct photo-identification, behavioral observation, and passive acoustic recording. Most calves encountered on the feeding grounds of Alaska are more than 6 months old (*i.e.*, not newborns).

Table 4. Proposed takes for humpback whales in the Pacific Ocean near Hawaii and Alaska for Cartwright Amendment 10018-01. *Already authorized under existing permit 10018.

Species	Life Stage	Sex	Take Number	Take Action
Humpback whales in Hawaii*	Calves	Male and female	120*	Close approach by vessel for photo-i.d., focal follows, underwater observations, collection of sloughed skin, and harassment
	Juveniles and adults	Male and female	420*	Close approach by vessel for photo-i.d., focal follows, underwater observations, collection of sloughed skin, and harassment
Humpback whales in Alaska	Juveniles and adults	Male and female	108	Close approach by vessel for photo-i.d., behavioral observations, and passive acoustics
	adults	Female	54	Close approach by vessel for photo-i.d., behavioral observations, and passive acoustics
	calves	Male and female	54	Close approach by vessel for photo-i.d., behavioral observations, and passive acoustics
	juveniles	Male and female	54	Close approach by vessel for photo-i.d., behavioral observations, and passive acoustics

Activities that would occur under the proposed modification are described in *General Activities* and would include:

- Close vessel approach for photo-identification and behavioral observation.
- Passive acoustic recording.

Measures to minimize disturbance to animals would include:

- Research activities would be suspended if there is indication that the same individuals would be disrupted from foraging on a repetitive basis.

- Research activities would not occur if other vessels are in the immediate or auditory vicinity of whales.
- Researchers would consult with other researchers in Alaska to: avoid harassing the same animals, explore collaborations, contribute to the cumulative research in the area, and share photo-identification images.

Darling (Permit 13846)
The proposed permit would continue long-term research designed to contribute to understanding the social organization, behavior, and communication of humpback whales and other non-listed whales. Proposed activities would target humpback whales in the Pacific Ocean off Hawaii, Alaska, and Washington and would include close vessel approaches with behavioral observations and photo-i.d., aerial surveys, underwater videography/photography, collection of sloughed skin, biopsy, acoustic playbacks, passive acoustic recording, and suction-cup tagging.

The proposed activities would occur in Hawaii, primarily off west Maui, and along coastlines of Washington and Alaska. In Hawaii, activities would occur from November 1 - May 15. During the peak season (Dec 15 – Apr 15) activities would occur daily. In Alaska and Washington the sampling season is primarily summer (May 15 - Oct 30), however some sampling would occur throughout the year. During field sessions that may be a month or two long sampling would be daily; otherwise sampling would be weekly or monthly.

Research would focus on target humpback and non-listed Eastern gray whales; other listed non-target species could be harassed during acoustic playbacks or vessel surveys (North Pacific right, Hawaiian monk seals, and Steller sea lions (Eastern)). Aerial surveys would not fly over pinniped haulout sites. Species and take numbers are specified in Tables 5 and 6. Males and females of all ages and reproductive conditions would be targeted for research; calves would not be biopsy sampled or tagged. Adult females accompanied by calves would be tagged. Small vessels (5-20 m) would be used for all activities.

Table 5. Proposed Annual takes for listed whales in Pacific Coastal Waters of Hawaii and Southeast Alaska for Darling Permit 13846.

Species	Lifestage	Authorized Take[1]	Procedures
Whale, humpback	All	4,000	Survey, vessel; Acoustic, passive recording; Collect, sloughed skin; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Underwater photo/videography
Whale, humpback	All	1,000	Survey, aerial; Observations, behavioral; Photograph/Video
Whale, humpback	All	300	Survey, vessel; Observation, monitoring; Photo-id; Photogrammetry; Photograph/Video; Underwater photo/videography
Whale, humpback	Adult/ Juvenile	300	Survey, vessel; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin biopsy; Underwater photo/videography; Tissue samples may be exported to Sweden
Whale, humpback	All	300	Survey, vessel; Acoustic, active playback/broadcast; Acoustic, passive recording; Observation, monitoring; Observations, behavioral; Photo-id; Photogrammetry; Photograph/Video; Underwater photo/videography; harassment

Species	Lifestage	Authorized Take[2]	Procedures
Whale, humpback	Adult	30	Survey, vessel; Acoustic, passive recording; Instrument, suction-cup tag (e.g., VHF, TDR); Observation, monitoring; Observations, behavioral; Photo-id; Photogrammetry; Photograph/Video; Sample, skin biopsy; Underwater photo/videography; Burgess tag, Crittercam, Dtag, or similar

[1] Takes = the **maximum** number of animals, not necessarily individuals, that may be targeted for research annually in each row of the table. If any animal is harassed more than once during research, each additional attempt (i.e., take) reduces the number of total takes remaining. E.g., if two *attempts* were required to biopsy an animal for which 10 annual *takes* are authorized, the researcher has used 2 takes and has 8 takes remaining.

[2] Takes = the **maximum** number of animals, not necessarily individuals, that may be targeted for research annually in each row of the table. If any animal is harassed more than once during research, each additional attempt (i.e., take) reduces the number of total takes remaining. E.g., if two *attempts* were required to biopsy an animal for which 10 annual *takes* are authorized, the researcher has used 2 takes and has 8 takes remaining.

Whale, humpback	Adult	30	Survey, vessel; Acoustic, passive recording; Instrument, dart/barb tag (e.g., satellite tag); Observation, monitoring; Observations, behavioral; Photo-id; Photogrammetry; Photograph/Video; Sample, skin biopsy; Underwater photo/videography; Andrews satellite tag; Tissue samples may be exported to Sweden
Whale, North Pacific right	All	5	This is a non-target animal. Harassment could occur by survey, vessel or during playback trials in HI.
Seal, monk	All	5	This is a non-target animal. Harassment could occur by survey, vessel or during playback trials in HI.
Sea lion, Steller, (Eastern)	All	100	This is a non-target animal. Harassment could occur by survey, vessel or during playback trials in AK.

Table 6. Proposed Annual Takes for Humpback Whale Research in the Coastal Waters of Washington for Darling Permit 13846.

Species	Lifestage	Authorized Take[6]	Procedures
Whale, humpback	All	200	Survey, vessel; Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id

Activities that would occur under the proposed permit, as described in *General Activities*, would include:

- Aerial surveys.
- Close vessel approach for photo-identification and behavioral observation.
- Underwater photography and videography.
- Passive acoustic recording.
- Suction cup tagging.
- Blubber attachment tagging (dart types only).
- Biopsy sampling.
- Export of samples.
- Acoustic playbacks, as detailed below.

Specific details or variations from activities described in *General Activities* are described here.

Humpback whales in the U.S. Pacific Northwest would be approached for photo-identification and behavioral observation only when those whales are followed into U.S. waters during studies around Vancouver Island, Canada. Humpback whales that feed off the west coast of Vancouver Island straddle the Canadian/U.S. border in Straits of Juan De Fuca between Vancouver Island and Olympic Peninsula and Haro Straits between Victoria, BC and San Juan Island, WA.

Humpback whales in Alaska and Hawaii would be subject to all Dr. Darling's proposed activities.

Close approaches for behavioral observation would be made using 6-8m vessels, underwater observers, small planes, or helicopters. Surface observations would include:

1. Focal follows where a specific whale or social group (e.g., singer or mother with calf) is followed for set period of time (e.g., two hours) and during that time its movements, associates, and behavior are documented.
2. Periods of documenting behavior prior to, during, and after playbacks. The boat would slowly follow the whales from a distance of approximately 30-80 m.

Photogrammetry would be conducted from the vessel. Measurements would be made after approaching whales from directly behind (at a 90 degree angle from the tail) to a distance 50-80 m and taking a photograph, just as with photo-identification. Three photographs would be obtained from each individual. Analysis involves photogrammetric ratios to determine the width of the tail. This allows individuals to be placed in an age class: juvenile or adult.

Acoustic Playbacks

Whale songs or social sounds would be played to various social groups in Alaska and Hawaii and behavioral responses would be documented. Social groups include:

- Singers.
- Lone non-singing adults.
- Adult pairs of male and female.
- Females with calf and male escort.
- Females.

Sounds would be broadcast through a small underwater speaker (Lubell LL-9162 Underwater Acoustic Transducer) suspended over the side of the vessel. Humpback songs and social sounds would be projected at levels as close to the volume and quality of a real singer as possible. The playback system would be calibrated so precise levels of sound can be projected. The source broadcast level would depend on the distance of the whales from the transducer. The best estimate of maximum source levels from singers is approximately 187 dB (W. Au pers. comm. to J. Darling 2003). At this source level, the received level for a conspecific about 90 ft. (two whale lengths) away would be 158 dB. All playbacks would be initiated more than 100 ft from the target animals. If whales approach the sound source, the maximum received level would be no more than 187 db. Each session would consist of a maximum of two playbacks and would last no more than 60 minutes, with many complete in 30 min.

At least two vessels would be present during playbacks. One vessel would deploy the playback equipment, another would approach the target animal and observers would listen to the playback via hydrophone. Playbacks would be conducted relatively early (Jan.) and late (Apr.) in the season when there is a reduced density of whales and activity in the region. All whales in the vicinity of the target whale would be documented from a third vessel and hillside observer, or a helicopter hovering at 1,000 ft., to determine if other whales are present in a 1 km square around the playback.

Following playbacks, target whales would be observed for varying amounts of time, depending on whether the subjects are singers or groups that include a female. If singers approach the playback boat, their behavior would be monitored until the singer departs (generally 15-45 minutes). If singers do not approach the boat or react to playback, they would be observed for a minimum of 30 minutes after playback.

Female groups would be monitored for a minimum of one hour prior to playbacks; when possible they would be monitored for the same amount of time after playback.

Tagging
The following suction-cup and implant tags, described in *General Activities*, would be used to investigate relative movement patterns of humpback whales: Crittercam, Acousonde, Dtag, and Andrews dart tag. Whenever possible suction cup tags would be used; dart tags would be used to address longer-term movements, such as the geographic relationship of individual whales over a period of days and weeks.

Measures to minimize disturbance to animals during research activities would include:

- Playbacks would not be conducted if there is indication the target whales are disturbed or otherwise in the midst of interactions whereby one could not distinguish between a reaction to the playback and a reaction to ongoing natural events. Trials would be aborted if other whales enter the vicinity of target whales.
- Use of specific types of tags would be terminated if any evidence arises that the tag type harms the animals.

Mobley (Permit 14451)
The proposed research would investigate short- and long-term changes in population size, habitat use, and behavior of listed whales in the Pacific and Atlantic Oceans, particularly with regard to the impact of anthropogenic sound in the ocean. More specifically, the proposed activities would take place annually in U.S. waters of Hawaii, Alaska, Pacific and Atlantic coasts of the U.S. including the Gulf of Mexico, and in The Bahamas, Guam, and the Northern Mariana Islands. Listed whales that will be targeted include fin, humpback, sei, sperm, blue, and Western North Pacific gray whales. Methods employed would include aerial and vessel surveys, close approaches for observation and photo-i.d., underwater photography/videography, and passive acoustic recording. Takes for each species in each area are displayed in Tables 7 - 11 below.

Table 7. Annual takes for aerial/vessel surveys in the North Atlantic Offshore Waters by Mobley Permit 14451.

Species	Life Stage	Takes	Procedures
Fin whale	All	345	Count/survey aerial and vessel; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Humpback whale	All	475	Count/survey aerial and vessel;close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Sei whale	All	50	Count/survey aerial and vessel;close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Sperm whale	All	495	Count/survey aerial and vessel;close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Blue whale	All	65	Count/survey aerial and vessel;close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Unidentified baleen whale (some combination of fin, humpback, sei, sperm, blue, North Atlantic right, or unlisted whale) and unidentified toothed whale (some combination of sperm or unlisted whale)	All	50 baleen; 50 toothed	Count/survey aerial and vessel;close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video

In the Atlantic, the permit would authorize takes in all waters offshore of the Gulf of Mexico and the east coast of the U.S. Activities would occur primarily at designated instrumented training ranges and adjacent waters, but may also occur outside these ranges, for example in more broadly designated Navy operational areas (OPAREAS), military special use airspace complexes, the Atlantic Fleet Active Sonar Training (AFAST) study area, or any of the waters under the responsibility of Naval Facilities Engineering Command Atlantic (NAVFAC Atlantic). Activities would occur during active U.S. Navy and military exercises, immediately before and after such exercises, as well as during inactive periods between exercises. Instrumented ranges, OPAREAS, and complexes ranging across waters of Alabama, Connecticut, Delaware, Florida, Georgia, Louisiana, Massachusetts, Maryland, Maine, Mississippi, North Carolina, New Hampshire, New Jersey, New York, Rhode Island, South Carolina, Texas, and Virginia include, but would not be limited to:

- Boston
- Narragansett Bay
- Atlantic City
- Virginia Capes (VACAPES)
- Charleston (CHASN)
- Cherry Point
- Jacksonville (JAX)
- Key West
- AUTEC
- Gulf of Mexico (Western GOMEX offshore TX, and Eastern GOMEX offshore LA, MS, AL and western FL)
- Naval Sea Systems Command (NAVSEA) Naval Surface Warfare Center (NSWC) at Panama City, FL.

The Cherry Point, Jacksonville, Key West, AUTEC, and VACAPES OPAREAS include fully instrumented ocean training ranges that may more frequently host major training exercises compared to other OPAREAS. These include Fleet Area Control And Surveillance Facility Virginia Capes (FACSFAC VACAPES), Fleet Area Control and Surveillance Facility Jacksonville (FACSFAC Jacksonville), Atlantic Undersea Test and Evaluation Center (AUTEC) (also known as NATO FORACS AUTEC, or NFA), South Florida Testing Facility (SFTF) at Fort Lauderdale, and the planned Undersea Warfare Training Range (USWTR) for which the Department of the Navy in summer 2009 issued a Record of Decision planning to develop this range within the Jacksonville OPAREA.

Table 8. Take Numbers for year-round aerial/vessel surveys in Pacific waters of Alaska, Oregon, Washington, and Northern California (Federal and State) by Mobley Permit 14451.

Species	Life Stage	Takes	Procedures
Fin whale	All	70	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Humpback whale	All	460	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Sei whale	All	50	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Sperm whale	All	245	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Blue whale	All	50	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Unidentified baleen whale (some combination of fin, humpback, sei, blue, or unlisted whale); unidentified toothed whale (some combination of sperm or unlisted whale)	All	50 baleen; 50 toothed	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video

Table 9. Annual takes Authorized for Year-round Aerial/vessel Surveys in Pacific Waters off Southern California (State and Federal) by Mobley Permit 14451.

Species	Life Stage	Takes	Procedures
Fin whale	All	315	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Humpback whale	All	345	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Sei whale	All	50	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Sperm whale	All	70	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Blue whale	All	305	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video

Species	Life Stage	Takes	Procedures
Unidentified baleen whale (some combination of fin, humpback, sei, blue, or unlisted whale); unidentified toothed whale (some combination of sperm or unlisted whale)	All	50 baleen; 50 toothed	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video

In the Pacific, the permit would authorize takes in all waters offshore of Alaska, Washington, Oregon, California, the Main and Northwest Hawaiian Islands, and Guam and the Mariana Islands. Activities would occur primarily at designated instrumented training ranges and adjacent waters, but may also occur outside these ranges, for example in more broadly designated Navy operational areas (OPAREAS), military special use airspace complexes, or any of the waters under the responsibility of Naval Facilities Engineering Command Pacific (NAVFAC Pacific).

Activities would occur during active U.S. Navy and military exercises, immediately before and after such exercises, as well as during inactive periods between exercises.

Instrumented ranges, OPAREAS, and complexes ranging across waters of AK, WA, OR, and northern CA include, but would not be limited to:

- Gulf of Alaska
- Whidbey Island
- Pacific Northwest (PACNW)

These OPAREAS support subsurface training and also have fully instrumented ocean training ranges that may host major training exercises. These include Northwest Training Range Complex (NWTRC) including the Nanoose Bay ranges off the eastern shore of Vancouver Island, the Naval Sea Systems Command (NAVSEA) Naval Undersea Warfare Center (NUWC) Division Keyport, as well as the Southeast Alaska Acoustic Measurement Facility (SEAFAC) in Ketchikan, AK.

Instrumented ranges, OPAREAS, and complexes ranging across waters of southern CA include, but would not be limited to:

- Southern California Offshore complex (SOCAL)
- Point Mugu complex

These OPAREAS and complexes range across waters offshore of San Diego, Orange, Los Angeles, Ventura, Santa Barbara, San Luis Obispo, Monterey, and Santa Cruz counties. The OPAREAS support subsurface (i.e. submarine) training and also have fully instrumented ocean training ranges that may more frequently host major training exercises. These include the Southern California Offshore Range (SCORE), San Clemente Island Underwater Range (SCIUR) of the San Clemente Island Range Complex (SCIRC), the Outer Sea Test Range (OSTR), and the Anti-Submarine Warfare Range (SOAR).

Instrumented ranges, OPAREAS, and complexes ranging across waters of HI include, but would not be limited to:

- Hawaiian OPAREA
- Hawaiian Range Complex (HRC)

Subsurface training and instrumented training ranges include those of Fleet Area Control and Surveillance Facility [FACSFAC] Pearl Harbor, the Pacific Missile Range Facility (PMRF) in waters off Kauai, Barking Sands Tactical Underwater Range (BARSTUR), Barking Sands Underwater Range Expansion (BSURE), and Large Area Tracking Range (LATR).
In addition, activities occurring in the waters of the Main and Northwest Hawaiian Islands would continue the investigation of long-term population trends of cetaceans in Hawaiian waters, including the Hawaiian Islands Humpback Whale National Marine Sanctuary and Papahanaumokuakea Marine National Monument. Aerial and vessel surveys related to these activities would not necessarily overlap with research on the effects anthropogenic noise in Hawaiian waters.

Instrumented ranges, OPAREAS, and complexes ranging across waters of Guam and the Mariana Islands include, but would not be limited to:

- Marianas Complex

Table 10. Annual takes for Aerial/Vessel Surveys off Hawaii by Mobley Permit 14451.

Species	Life Stage	Takes	Procedures
Blue whale	All	50	Acoustic, passive recording; Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video; Underwater photo/videography
Fin whale	All	50	Acoustic, passive recording; Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video; Underwater photo/videography
Humpback whale	All	5335	Acoustic, passive recording; Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video; Underwater photo/videography
Sei whale	All	50	Acoustic, passive recording; Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video; Underwater photo/videography
Sperm whale	All	50	Acoustic, passive recording; Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video; Underwater photo/videography
Unidentified baleen whale (some combination of blue, fin, humpback, sei or unlisted whale); unidentified toothed whale (some combination of sperm or unlisted whale)	All	50; 50	Acoustic, passive recording; Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video; Underwater photo/videography

Table 11. Annual takes for year-round aerial/vessel surveys in Pacific waters off Guam and the Northern Mariana Islands (State and Federal) by Mobley Permit 14451.

Species	Life Stage	Takes	Procedures
Blue whale	All	50	Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video
Fin whale	All	50	Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video
Humpback whale	All	505	Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video
Sei whale	All	50	Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video
Sperm whale	All	50	Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video
Gray Whale Western North Pacific DPS	All	50	Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video
Unidentified baleen whale (some combination of blue, fin, humpback, sei, gray, or unlisted whale); unidentified toothed whale (some combination of sperm or unlisted whale)	All	50; 50	Count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video

Males and females of all ages and reproductive conditions would be targeted for close approach and photo-identification.

Directed research would involve a combination of activities, as described in *General Activities*, involving only Level B harassment, including:

- Aerial surveys
- Vessel surveys
- Close vessel approach for behavioral observation and photo-identification
- Underwater photography/videography.

Individuals would be taken more than once in a day but in a different manner, i.e., an individual may be photographed from both aerial and surface vessel platforms. Up to three close approaches would occur per animal per day over each season. The observational research would take place aboard a vessel or a fixed- or rotary-wing aircraft. Aerial surveys would be conducted at an altitude of 800 ft (244m), and would descend to 500 ft (152m) only if required for species identification of smaller delphinids.

The research involves a comprehensive list of target species; it is not expected that non-target cetacean species would often be encountered. If non-target species are encountered, they would be avoided, especially in the case of critically endangered species such as the Hawaiian monk seal or North Atlantic right whale.

Measures to minimize disturbance to animals would include:

- Every effort would be made not to separate animal(s) from a group.
- Telephoto lenses and binoculars would be used to obtain quality photographs and video from a distance.
- Animals would be monitored at all times and if an animal or animals appear to be in serious distress, the operation would be halted.
- During shoreline aerial surveys in Hawaiian waters where Hawaiian monk seals (*Monachus schauinslandi*) could potentially be hauled out, the aircraft would fly at least 100 yds (91.4m) away from shorelines at an altitude of at least 800 ft (244m) to avoid harassment.

Pack (Permit 14585)

The proposed research would continue long-term studies of the behavior and biology of North Pacific humpback whales in the Pacific, ongoing since 1975, and would investigate the behavior and biology of humpbacks focusing on several objectives that either build on current databases or address new areas of inquiry. The proposed research will opportunistically include listed sperm, North Pacific right, fin, sei, and blue whales. Methods employed would include passive acoustic recording, collection of sloughed skin, close vessel approach with observations and photo-i.d., fecal samples, underwater photography/videography, and suction-cup tagging. Methods employed on each species and in each area are displayed in Tables 12 and 13 below.

The proposed activities for humpback whales would take place annually:

- Around all of the main Hawaiian Islands during the winter/spring humpback season, from approximately December 1 through May 30.
- Along the rim of the North Pacific from California northward to Southeast Alaska and then westward through the Gulf of Alaska, Aleutian Islands, and regions of the upper western Pacific. Activities in Southeastern Alaska would focus on humpback whales in Frederick Sound and its adjoining passages and straits from approximately June 1 to November 30.

Table 12. Authorized Annual Takes of Cetaceans for Pack 14585 study during Vessel Surveys in U.S. Waters of: Hawaii, California to Southeast Alaska, the Gulf of Alaska, along the Aleutian Islands, and regions of the upper western Pacific Ocean.

Species	Lifestage	Authorized Take[3]	Procedures
Whale, humpback	All	1,880	Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id; Sample, fecal; Underwater photo/videography
Whale, humpback	Adult/ Juvenile	150	Acoustic, passive recording; Instrument, suction-cup tag (e.g., VHF, TDR); Crittercam; Observations, behavioral; Photo-id; Sample, skin biopsy; Underwater photo/videography; Observations, behavioral; Collect, sloughed skin; Sample, fecal;
Whale, humpback	All but neonates	900	Acoustic, passive recording; Collect, sloughed skin; Observation, monitoring; Photo-id; Sample, fecal; Sample, skin biopsy; Underwater photo/videography
Whale, sperm	All	25	Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id; Sample, fecal
Whale, North Pacific right	All	10	Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id; Sample, fecal

Table 13. Authorized Annual Takes of Cetaceans during Pack 14585 Vessel Surveys in the Hawaiian Islands Exclusive Economic Zone.

Species	Lifestage	Authorized Take	Procedures
Whale, fin	All	10	Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id; Sample, fecal
Whale, sei	All	10	Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id; Sample, fecal
Whale, blue	All	10	Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id; Sample, fecal

Dr. Pack's research activities would focus on humpback whales; other listed (North Pacific right, fin, sei, blue, sperm whales) and non-listed cetacean species would opportunistically be targeted for research in the above described study areas year-round. Male and female humpbacks of all ages and reproductive conditions would be targeted for close approach, photo-identification, and biopsy sampling; however attempts would be made to avoid biopsy sampling neonate calves as defined by Cartwright and Sullivan (2009) (e.g., calf length is less than 3.7m, calf is very light in

[3] Takes = the **maximum** number of animals, not necessarily individuals, that may be targeted for research annually in each row of the table. If any animal is harassed more than once during research, each additional attempt (i.e., take) reduces the number of total takes remaining. E.g., if two *attempts* were required to biopsy an animal for which 10 annual *takes* are authorized, the researcher has used 2 takes and has 8 takes remaining.

body pigmentation, calf's dorsal fin is flopped over, calf is still being supported heavily by its mother). Only non-calf humpback whales would be tagged.

Directed research would involve a combination of activities, as described in *General Activities*, including:

- Close vessel approach for behavioral observation and photo-identification.
- Underwater photography/videography and videogrammetry (described below).
- Passive acoustic recording.
- Collection of sloughed skin, feces, and tissue from floating carcasses.
- Suction cup tagging.
- Biopsy sampling.

Specific details or variations from activities described in *General Activities* are described here.

Target species would be approached using one or two small (< 7m) outboard boats for behavioral observation, photo-identification, and passive acoustic recordings. Observations would typically last from one to three hours, but would be terminated earlier if target animals are actively avoiding the vessels. Animals would be monitored for a minimum of 15 minutes prior to and following all activities. A hydrophone (Cetacean Research Technology customized hydrophone or equivalent) or vertical hydrophone array would be deployed to a depth of 25m or less to verify that singing is occurring, and for obtaining song recordings for subsequent analyses. Once the singer is located, the boat would be positioned within 100m of the singer and shut down, and the hydrophone (or rigid array similar to Au, above) would be deployed over the side or bow of the boat to record signals. For the array, hydrophones would be spaced approximately 1.5 to 7m apart on a rigid bar perpendicular to the optical axis of the camera. Recordings on average would take 40-90 min.

If target whales are stationary, up to two swimmers equipped with mask, snorkel, fins, and digital cameras would enter the water as described in *General Activities.* One swimmer would carry a hand-held high-frequency (200-400 kHz) sonar device (Speedtech Depthmate), used to measure the distance from camera lens to whale. NMFS does not anticipate take of marine mammals to result from exposure to active sources that operate at or above frequencies of 200 kHz.

A dual laser method of determining distance from snorkeler to whale would be used that may provide more reliable distance measurements. Dual blue-green lasers (450-550 nm) would be affixed to or be carried adjoining the camera body. The distance between each laser beam would be fixed at the camera. The beam would be triggered and directed on the body of the whale during filming or photography to provide a scale on the whale's body. Size of the whale would later be determined from the images or video. To test the accuracy and reliability of videogrammetry using laser technology, the traditional videogrammetric technique using the hand-held sonar device would occur concurrently.

The amount of time swimmers remain in the water would be dependent on the number of whales in a group and the group's behavior. Normally, swimmers would be in the water with a group

for approximately 20 minutes; on occasion, circumstances may provide an opportunity of an hour or longer for obtaining behavioral and length measurement records.

Crittercam tags would be deployed from a 6-7m outboard boat when the boat is approximately 5m from the whale (i.e., the maximum extension length of the attachment pole). Crittercam tags would be deployed on all social roles in competitive groups, on whales in dyads, on escorts in mother-calf groups, and on single males that potentially may join a group with a female (e.g., lone singers). Crittercams would be deployed from the bow of the vessel with a suction cup device using a retractable pole. Air would be actively evacuated from the suction cup shouldering the Crittercam package by directing air from a SCUBA tank on board the vessel through flexible tubing past the nozzle on the suction cup, producing a Venturi effect vacuum that evacuates air from the cup, firmly emplacing the Crittercam system. Once the suction cup is secured, the Crittercam would be released from the attachment pole.

The tagging event would last less than 20 seconds from the attempt to deploy the tag to the release of tag from the deployment pole. The duration of an encounter during which tagging takes place (including preliminary assessment of the group, determining possible candidate whales, habituation of the group to the boat, and actual deployment) would vary with group size, speed, and behavior, and would range from approximately 30 minutes to 2 or more hours. Following deployment, the research boat would attempt to remain within visual range of the group to record surface behavior, continue to collect identification photographs, conduct videogrammetry to determine body length of whales in group, conduct biopsy sampling to determine sex of group members, possibly deploy a Crittercam on another whale in the group, and retrieve the Crittercam. Crittercam would remain attached from 8 to 24 hours, and would be pre-programmed to release at a particular time. Crittercam is positively buoyant, and after the seal is broken will float to the surface.

The Crittercam system would incorporate an internal VHF transmitter connected to an external antenna (Telonics MK-8 HP model). A brief (1 sec) pulsed signal (150.000-150.000 MHz band) would be transmitted while Crittercam is at the surface. If the Crittercam cannot be located visually at the surface, it can be located and retrieved using the VHF signal (32-km range). NMFS does not anticipate take of marine mammals to result from exposure to active sources that operate at or above frequencies of 200 kHz.

Each biopsy dart tip containing a tissue sample would be stored on ice in a sterile plastic bag for transport back to the lab. In the lab, samples would be subdivided as needed for analyses.

Sharpe (Permit 14599)

The proposed research would continue the study of sophisticated hunting tactics including long term bonding, division of labor, task specialization and bubble tool use by humpback whales in Alaska. Results would be used to characterize this social complexity and gain insight into the manner in which environmental and social factors shape this behavior. The proposed activities would occur annually in the waters of Southeast Alaska primarily from mid-May to mid-October and include aerial and vessel surveys, close vessel approaches with observation and photo-i.d., passive acoustic recording, vertical and side scan sonar profiling, fecal samples, underwater photography/videography, acoustic playbacks, and suction-cup tagging.

Directed research would involve a combination of activities, as described in *General Activities*, including:

- Aerial surveys.
- Close vessel approach for behavioral observation and photo-identification.
- Underwater photography using pole- or vessel-mounted cameras and SCUBA divers.
- Passive acoustic recording.
- Collection of feces.
- Suction cup tagging.
- Acoustic playbacks, as detailed below.

Research would also include vertical and side scan sonar profiling, as described below.

Species and take numbers are specified in Table 14. Humpback whales of both sexes and all ages and reproductive status would be targeted for research. This would include calves estimated to be older than 6 months, cows in a variety of reproductive stages, including mid-term females (approximately four to eight months pregnant), and lactating females with calves less than nine months of age.

Table 14. Permit 14599 humpback whale takes in Alaska.					
Species	**Life Stage**	**Sex**	**Takes (1 per animal)**	**Procedures**	**Details**
Whale, humpback	All, except calves less than 6 months	Male and Female	1580	Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Count/survey; Harassment; Observations, behavioral; Photo-id; Sample, fecal ; Underwater photo/videogr aphy	Annual takes combined for independently conducted photo ID, sonar, acoustic recording, pole cam, SCUBA, behavioral observations & scat collection, and harassment
Whale, humpback	All, except calves less than 6 months	Male and Female	300	Survey, vessel; Acoustic, active playback/broa dcast; Observations, behavioral; Photo-id	Annual takes for playbacks; playbacks may be conducted concurrent with suction-cup tagging, not to exceed a total of 300 individuals exposed to playbacks
Whale, humpback	All, except calves less than 6 months	Male and Female	200	Survey, aerial; Observations, behavioral; Other; Photo-id	Annual takes for helicopter surveys to document feeding behavior
Whale, humpback	All, except calves less than 6 months	Male and Female	90	Survey, vessel; Acoustic, active playback/ broadcast; Instrument, suction-cup (e.g., VHF,	Annual takes for Crittercam suction cup attachment; successful attachment to no more than 30 ind; up to 90 ind may be approached with tagging attempts; no more than 3 attempts

				TDR); Observations, behavioral; Photo-id	per individual per day; no more than 300 animals total exposed to acoustic playbacks

*Takes = the **maximum** number of animals, not necessarily individuals, that may be targeted for research annually in each row of the table. If any animal is harassed more than once during research, each additional attempt (i.e., take) reduces the number of total takes remaining. E.g., if two *attempts* were required to tag an animal for which 10 annual *takes* are authorized, the researcher has used 2 takes and has 8 takes remaining.

Specific details or variations from activities described in *General Activities* are described here.

All research activities will be conducted from vessels ranging in length from 4 to 18 m. Approaches would typically be no closer than 30m, except when deploying tags, and would be made by measured graduated approaches from behind. For photo-identification and recording behavioral data, images are obtained using video camera (25X zoom lens) and 300 mm digital single-lens-reflex (SLR) cameras. Passive acoustic recording will involve close approaches to individuals. Recordings will be obtained with a CRT C55RS or similar hydrophone at a distance ranging from 30 to 100 m.

Vertical and Side Scan Sonar Profiling
The sonar would be used to estimate prey biomass and track underwater movement of whales. The sonar transducer would be mounted to the research vessel and would be used at the maximum possible distance to minimize disturbance to prey and foraging whales. Since individuals may be pursuing/chasing prey up to the surface, sonar activities would occasionally occur within one body length of a whale. Sonar would be operated at frequencies from 30 to 800 kHz.

Underwater Photo/Video Using Pole- or Vessel-Mounted and SCUBA
Approaches to whales by vessel and SCUBA would be conducted using the methods described in *General Activities* and as above. Most encounters with whales would be relatively brief, typically less than a minute. However, if an individual was feeding in a restricted area, encounters could last up to 15 minutes. Pole cam images may be obtained as close as 5m to animals and 1m to bubble structures.

Suction Cup Tagging
Crittercam tags would be attached to whales using the methods described in *General Activities.* Tags would be deployed with a 5 m pole as close as 2 m to whales. A vacuum hose might be used to assist in adhesion of suction cups. The mean time of attachment is estimated to be 8 hours, and tag deployments would be programmed to not exceed 24 hours.

Acoustic Playbacks
The objective of playbacks is to gain insight into the function of humpback whale sounds by broadcasting sounds and noting the behavioral reactions of animals. Several sounds types would be played to humpbacks, including:

- Alaskan humpback whale feeding calls.
- Alaskan humpback whale social sounds.
- Hawaiian humpback whale winter song.
- Hawaiian humpback whale social sounds.
- Synthetic sounds (non-impulsive).
- Blank tape or silent stimulus control sound.

The order of sound presentation would be randomized and the monitoring team would be naïve to the specific status of the playbacks. Each playback trial would last 55 minutes:

1) The first 25 minutes would involve a pre-test passive observation period to document baseline behaviors.
2) The second 5 minutes would involve the playback stimulus.
3) The final 25 minutes would involve a post-test phase monitoring of animal activity.

A baseline of normal behaviors would be established for individual whales during the pre-test monitoring period so that each animal could serve as its own control in determining when a response to the playback occurs. The playbacks would be broadcast at a depth of 20 m at an SL not to exceed 170-dB re: 1uPa. No playbacks would be broadcast to animals closer than 100m. Animal position would be determined using a computer algorithm which integrates 1) vessel position obtained using a GPS unit, 2) distance to the whale(s) acquired with an optical range finder, and 3) a compass bearing obtained by sighting from the research vessel to the animal(s).

Individuals would be monitored up to 1.5 nautical miles from vessels and up to 3 nautical miles from shore stations.

Measures to minimize effects to animals would include:

- Aerial observations of individual whales would not exceed 15 minutes, and would be suspended if the whale(s) exhibited any adverse reactions such as the onset of surface percussive activity, underwater exhalations, lateral tail movements, premature dives or similar disturbance behaviors.
- No more than 8 helicopter hover episodes would occur per day per individual or group.
- Helicopters would include lighter models (such as Eurocopter AS35OBA or MDH 500D) that decrease the amount of noise and rotor wash.
- Prop guards would be used on all close approach vessels.
- No individuals or groups would be subject to more than one playback on a given day. Every attempt would be made to limit the total number of playbacks during the season to any given whale to 15.
- Playbacks would not be conducted to large feeding groups.
- Playbacks would be suspended if the whale(s) exhibited any adverse reactions such as the onset of surface percussive activity, underwater exhalations, lateral tail movements, premature dives or similar disturbance behaviors.
- Attempts to attach tags would be discontinued if any whale exhibits a strong adverse reaction to the presence of the tag or vessel, e.g., breaching, tail lobbing, underwater exhalation, or disassociation from the pod.

Straley (Permit 14122)
The proposed research would continue the study of biology of large whales in Alaskan waters including listed blue, fin, humpback, North Pacific right, sei, and sperm whales. The proposed activities would take place annually in Alaskan waters including, but not limited to, the waters along the outer continental shelf edge in the Gulf of Alaska, Prince William Sound and the inside waters of Southeastern Alaska from approximately 54-63 N latitude and 133-160 W longitude.

Directed research would involve a combination of activities, as described in *General Activities,* including:

- Close vessel approach for behavioral observation and photo-identification.
- Underwater photography/videography.
- Passive acoustic recording.
- Suction cup tagging.
- Blubber attachment tagging.
- Biopsy sampling.
- Collection of sloughed skin and feces.
- Collection of prey parts.
- Export of parts.
- Acoustic playbacks, as detailed below.

Research activities would also include modifications to long-line fishing (sperm whale depredation studies) and collection of blow samples from humpback whales, as described below.

Table 15. Whale takes for research activities in Alaska under Permit 14122.

Species	Life Stage	Sex	Authorized Take	Procedures
Sperm whale	All	M & F	200; 4 takes per animal; includes missed attempts; total 100 successful biopsies annually	Acoustic, active playback/broadcast; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Other; Photo-id; Photograph/Video; Sample, fecal ; Sample, skin and blubber biopsy; Sample, skin biopsy; Underwater photo/videography
Sperm whale	Adult/juvenile	M & F	100; 2 takes per animal; Includes missed attempts. Total 10 successful tags annually	Acoustic, active playback/broadcast; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Measure; Observation, monitoring; Observations, behavioral; Other; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography
Sperm whale	All	M & F	200; 2 takes per animal; Includes missed attempts. Total 50 successful tags annually.	Acoustic, active playback/broadcast; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Harassment; Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Other; Photo-id; Photograph/Video; Sample, fecal
Sperm whale	All	M & F	500; 1 take per animal	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Harassment; Measure; Observation, monitoring; Observations, behavioral; Other; Photo-id; Photograph/Video; Sample, fecal
Sei whale	All	M & F	200; 4 takes per animal; Includes missed attempts. Total 50 successful biopsies annually	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey;Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Sample, skin and blubber biopsy; Sample, skin biopsy; Underwater photo/videography

Species	Life Stage	Sex	Authorized Take	Procedures
Sei whale	Adult/ Juv.	M & F	50; 2 takes per animal; Includes missed attempts. Total 10 successful tags annually	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography
Sei whale	All	M & F	50; 2 takes per animal; Includes missed attempts. Total 10 successful tags annually	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography
Sei whale	All	M & F	300	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Other; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography
North Pacific right whale	All	M & F	20	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Sample, skin and blubber biopsy; Sample, skin biopsy; Underwater photo/videography
North Pacific right whale	Adult/juvenile	M & F	10; 2 takes per animal; Includes missed attempts. Total 5 successful tags annually	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography

Species	Life Stage	Sex	Authorized Take	Procedures
North Pacific right whale	All	M & F	20; 2 takes per animal; Includes missed attempts. Total 5 successful tags annually	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography
North Pacific right whale	All	M & F	50	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography
Humpback	All	M & F	200; 4 takes per animal; Includes missed attempts. Total 200 successful biopsies annually.	Acoustic, passive recording; Acoustic, sonar for prey mapping; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, exhaled air; Sample, fecal ; Sample, skin and blubber biopsy; Sample, skin biopsy; Underwater photo/videography
humpback	Adult/juv	M & F	100; 2 takes per animal; Includes missed attempts. Total 10 successful tags annually.	Acoustic, active playback/broadcast; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, exhaled air; Sample, fecal ; Underwater photo/videography
humpback	All	M & F	200; 2 takes per animal; Includes missed attempts. Total 50 successful tags annually	Acoustic, active playback/broadcast; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, exhaled air; Sample, fecal ; Underwater photo/videography

Species	Life Stage	Sex	Authorized Take	Procedures
humpback	All	M & F	1000	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, exhaled air; Sample, fecal ; Underwater photo/videography
Fin whale	All	M & F	100; 4 takes per animal; Includes missed attempts. Total 50 successful biopsies annually	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photogrammetry; Photograph/Video; Sample, fecal ; Sample, skin and blubber biopsy; Sample, skin biopsy; Underwater photo/videography
Fin whale	Adult/juv	M & F	50; 2 takes per animal; Includes missed attempts. Total 10 successful tags annually	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Sample, sperm; Underwater photo/videography
Fin whale	All	M & F	50; 2 takes per animal; Includes missed attempts. Total 10 successful tags annually	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography
Fin whale	all	M & F	300	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Other; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography

Species	Life Stage	Sex	Authorized Take	Procedures
Blue whale	All	M & F	100; 4 takes per animal; Includes missed attempts. Total 50 successful biopsies annually	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Sample, skin and blubber biopsy; Underwater photo/videography
Blue whale	Adult/juv	M & F	50; 2 takes per animal; Includes missed attempts. Total 10 successful tags annually	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography
Blue whale	All	M & F	50; 2 takes per animal; Includes missed attempts. Total 10 successful tags annually	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography
Blue whale	All	M & F	300	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography
Unidentified pinniped	All	M & F	20	Collect, dead remains for predation study
Unidentified cetacean	All	M & F	5	Collect, dead remains for predation study

Specific details or variations from activities described in *General Activities* are described here.

Humpback, killer, and sperm whales would be targeted for biopsy sample collection, attachment of suction cup or implant tags, and acoustic playbacks; minke *(Balaenoptera acutorostrata)*, gray, blue *(Balaenoptera musculus)*, North Pacific right *(Eubalaena japonica)*, sei *(Balaenoptera borealis)*, and fin *(Balaenoptera physalus)* whales would opportunistically be targeted for biopsy sample collection, and attachment of suction cup or implant tags. Fishing modification activities would focus on sperm whales only. Species and take numbers are specified in Table 15. All age and sex classes would be targeted in all aspects of this research, with the following exception:

females and their calves less than approximately six months would not be suction cup or satellite tagged or subject to acoustic playbacks.

Cameras Attached to Longline Gear
Permit 14122 would include video cameras mounted on demersal longlines under normal fishing operations to identify and record sperm and killer whales at depth interacting with fishing gear.

Fishing Modifications
Activities would typically be conducted from 20-30 ft vessels equipped with 50-200hp outboard motors; vessels 14 to 80 feet long would also be used. Working with the Southeast Alaska Sperm Whale Avoidance Project (SEASWAP), 20 longline deployments/hauls would be utilized annually. SEASWAP is a group of fishermen, managers and scientists (including the applicant) investigating sperm whale depredation (i.e., removing fish from commercial fishing gear) on the sablefish longline fishery in Alaska. The study began in 2003 aiming to reduce sperm whale depredation and the resulting economic hardship it presents for fishermen, as well as to reduce the risk of entanglement to sperm whales. This study would be continued to investigate what acoustical clues sperm whales are using as attractants to the fishing vessels and how they are actually feeding off the longlines. A goal of SEASWAP is to better understand sperm whale distribution and behavior in the Gulf of Alaska and make recommendations to fishermen on how they may modify their fishing practices to reduce depredation on their catch (i.e., increase catch rates).

Modifications to fishing behavior would be used to determine cues sperm whales use to locate vessels and how whales remove fish from longline fishing gear to reduce this behavior. Normal fishing operations would be directed to deliberately activate the hydraulic system, fisheries sonar, and engines during times when fishing gear is not being hauled from the water. Fishing operations that would occur with or without Permit 14122 would be utilized to study sperm whale behavioral responses to potential cues.

During normal fishing operations, a longliner would arrive in a deployment area and immediately begin deploying longline gear on the ocean floor. The vessels would then either depart the area or loiter in the vicinity in neutral gear. After 3-17 hours the vessel would then travel to one end of the longline, marked by a surface flag, turn on its hydraulic system, and begin hauling the line to the surface. Once hooks arrive on the surface, the fishing vessel would generally engage and disengage its engine in an attempt to adjust the angle at which the fishing line is emerging from the water, with a goal of keeping the line as vertical as possible. At the same time the vessel would be running its echosounder. Thus under normal operations up to four distinct acoustic signals would be generated simultaneously: hydraulic system, cavitation bubble clouds from engine cycling operations, engine sounds, and the echosounder.

The cavitation sounds from a fishing vessel range from 100 Hz to 4 kHz, with a sound exposure level rate of 110 dB re: 1 uPa^2 at a source depth of 2 m in water column, and a duty cycle of approximately 10% (Thode *et. al.* 2007). Previous work has documented from zero to ten sperm whales near the vessel during the haul, with fewer present at the set or soak. The length of a haul (retrieving caught fish) depends on the amount of gear in the water, but generally lasts from three to six hours.

The modifications to normal vessel operations that would occur under Permit 14122 are:

- Upon arrival, fishing vessels would deploy autonomous passive acoustic recording devices to monitor all subsequent acoustic activity in the area. Recording devices would be attached to the vertical anchor lines of the longline or on their own buoyed line. The deployment of this gear generally takes one to two hours. The recorders would remain in the water prior to and after all fishing activities have been completed.
- The vessel operator would be requested to activate various systems in sequential fashion before the haul, to isolate the effects of various cues on animals' acoustic behavior. These activities would take place over times varying from eight hours to 30 minutes before the start of a haul. Specifically, the vessel operator would be asked to suspend then activate the echosounder, then after two minutes activate the hydraulics, then two minutes after that cycle the engines in a manner that simulates an active haul. After three to ten such engine cyclings the deliberate manipulation of the engine controls would cease.

During the proposed activities, an observer would be present on the fishing vessel to monitor whale behavior before, during, and after fishing operation modifications and to photo-identify individuals. Individuals would not be approached more than three times per year.

Tagging Activities
For tag deployment, whales would be approached to 3 to 10m using small vessels, not from the longline vessel.

Bioacoustic and Crittercam tags would be attached via suction cup, and are expected to remain attached to whales for 2-18 hours. Individual whales would be suction cup tagged up to two times annually.

Tagged whales would be tracked to monitor post tagging effects and to obtain a trackline of movements for as long as whales and sea state permit. Monitoring would include photographing the attachment site to evaluate tag attachment to the body (skin condition) and tag movement and observing whale behavior. Approaches for photography and behavioral observation would be from a distance of 75 feet or more from the whale. Tracklines would be determined after the whale dives and the boat moves to the dive location to record position.

Satellite-linked transmitters would also be used in conjunction with the Service Argos satellite system to determine whale movements and behavior. “Barnacle/limpet tags” would be used on all species, as described in *General Activities*, and are expected to remain attached for 1-2 months. Implant tags would only be used on sperm and humpback whales, and only after an attempt to attach the barnacle/limpet tag has been made and has proven to be unsuccessful in achieving attachment durations in excess of 1 month. Individual whales would be satellite tagged up to two times annually.

Playback Activities
Various acoustic signals would be directed at sperm, killer, and humpback whales in order to determine whether particular classes of sounds evoke a mild alerting response. All playbacks would be deployed from an autonomous playback device with a self-contained power supply and electronics that permit it to be deployed without external connections to a power or signal source.

Signals between 1 kHz-50 kHz would be played, with signal durations between 1-5 seconds. Playback operations would occur in two-hour bursts, during which playbacks would only be conducted 40% of time.

The playback device would be:

- Deployed during the day from the bow of a fishing vessel or skiff for real-time visual and/or acoustic monitoring during playback activities. Playbacks would be broadcast at levels of up to 170 dB re 1uPa @ 1 m (rms pressure), and would only be broadcast when visual observers are available, or
- Attached to open-water buoys or fishing anchorlines, independent of any surface vessel, at depths of 20 meters or less. Playbacks would be broadcast at levels no greater than 160 dB re 1 uPa @ 1m (rms pressure) to ensure that target and non-target animals would not be exposed to received levels greater than 160 dB. Playbacks would be broadcast at any time of day and monitored by autonomous passive acoustic recorders, which would document the signals being broadcast and record the presence of acoustically active animals during playbacks. Fishing vessels with visual observers would be present (generally within 200 to 1,000 m) to observe behaviors.

Playback signals:
A review of previous literature on playback experiments and acoustic harassment device tests finds that most "alert" signals to date consist of narrowband pulses or FM sweeps. The signals selected for broadcast under Permit 14122 represent a blend of signals used in previous experiments to establish consistency between studies, as well as signals of interest to the current effort. Note that while some signals are described as "transient" or "tonals" in the table, all playback signals would be broadcast for only 1-5 seconds per signal, with 3 seconds of silence in between.

Table 16 lists signals proposed to be broadcast during playbacks, including frequency range, source level, signal duration, and a reference that describes previous use of the signal. Transient source levels are expressed in terms of both SPL and sound exposure level (SEL) (Madsen *et al.* 2006; Southall *et al.* 2007), while tonal sounds are expressed in terms of rms level only. Note that SEL levels are given only for a single "pulse" or "nonpulse"; cumulative SEL is not provided here. Signal parameters that will be randomized during the playback are designed by the symbol 'R' followed by the range of the parameter in brackets (e.g., R[2-4] sec interval). During playback these parameters would be selected from a uniform distribution.

Table 16. Signals proposed for broadcast under Permit 14122.

Signal characteristic	Frequency range (Hz)	Goal source level (GSL)	Duration/ Interval	Reference
Airgun, high-pass filtered above 2 kHz	2-25 kHz (approximate)	170 dB, if whale is ≥ 10m, 160 dB re 1uPa rms if ≤ 10m	2.5 msec and 400 msec/R [1-4] sec interval	JIP 3-D calibration, Tashmukhambetov *et al.* 2008
Tonal	2-50 kHz, 10 evenly spaced frequencies	170 dB, if whale is ≥ 10m, 160 dB re 1uPa rms if ≤ 10m	R[0.5-3] sec/R [5-20] sec	Kastelein *et al.* 2001, Kastelein *et al.* 2006a, 2006b
Logarithmic FM sweep	R[1-4.5] kHz start R[4.5-10] kHz end R[upsweep/ downsweep]	170 dB, if whale is ≥ 10m, 160 dB re 1uPa rms if ≤ 10m	[1-5] sec/ [3-5] sec	Nowacek *et al.* 2004
Sperm whale "slow click"	1-15 kHz	170 dB, if whale is ≥ 10m, 160 dB re 1uPa rms if ≤ 10m	20 msec/ r[0.1-1] sec	SEASWAP fieldwork, Mathias *et al.* 2009
White noise bursts	2-50 kHz broadband	170 dB, if whale is ≥ 10m, 160 dB re 1uPa rms if ≤ 10m	R[10-30 msec] /R[0.25-2] sec	SEASWAP fieldwork
"Silence"	0	0	0	
Transient killer whale whistles and pulsed calls from NE Pacific	1-20 kHz	170 dB, if whale is ≥ 10m, 160 dB re 1uPa rms if ≤ 10m	Varies/ 5 sec	Deecke *et al.* 2005
Humpback whale feeding call	Loud, relatively low-frequency, uniform pulses between 1 and 10 kHz	155 dB re 1up at 1m, and will not be broadcast to animals closer than 100m	Varies/ 30 sec interval	Baker 1985, Straley unpublished data

All playbacks would be monitored by an HTI 96 min hydrophone placed one meter from the playback device, and recorded on a separate autonomous recorder. The playback device would also internally log the time and playback level of each signal broadcast. After 5 minutes the

device would automatically start the playback session. The total playback duration would be 48 minutes within a 12 hour period.

During playbacks conducted from the vessel:

1. The playback device would randomly select whether to broadcast "signal" or "silence", with a 10% chance of the latter. During a "silence" playback the device input file would consist of a set of binary zeros, but any incidental noises or pops made by the playback device would still be generated, although none are expected. If "signal" is selected, one of seven signals would be chosen with equal probability. Any random parameters needed to synthesize the signal would be selected from a uniform distribution.
2. The device would broadcast the playback sequence at 20 dB below goal source level (GSL) for 2 minutes.
3. A 60 second period of silence would follow the playback sequence, during which the device could be deactivated remotely.
4. The playback sequence would be repeated at a 10 dB greater source level, using the same values for the random parameters that were selected for the first 2 minute sequence.
5. The cycle would continue to repeat until the GSL is attained.
6. A 5 minute period of silence, during which the device can be shut down remotely,
7. The playback device would randomly select "signal" or "silence", and the process would begin again.

If any observer notes signs of major disturbance, e.g., breaching, tail slaps, or underwater bubble cloud releases, the "disable" signal would be sent to the acoustic playback device to halt the trial.

During playbacks conducted from buoys or fishing gear all playback signals and protocols described above would remain the same, except:

1. The device would be deployed to depths of 20 meters or less.
2. The playback device would be programmed to start the playback schedule at a future time (hours to days later).
3. Playback periods would be programmed to coincide with the expected presence of an observing vessel within 4 km of the playback device.

Individuals would be not be taken by playback more than two times each year. During a playback encounter an individual would not be approached for any other permitted activity.

Blow samples from humpback whales

Blow samples would be collected to study the microbial communities of the respiratory system of free-swimming whales and to provide DNA material for individual identity. Microbial communities may provide a proxy to follow population health as well as being a tool to look at social relationships between whales by examining the patterns of shared microbial communities between whales. Additionally, blow samples would be evaluated if sufficient DNA material is present for genetic analysis as this may provide a non-invasive alternative to biopsy sampling.

Blow samples, or exhaled breath condensate (EBC), would be collected with a frame composed of a 40cm x 35cm clear Perspex sheet (4 mm width) with smooth, rounded edges. Eight 6cm and eight 0.8cm circles would be cut from the sheet to reduce the weight, decrease resistance to the

wind, increase maneuverability, and provide multiple attachment points for a variety of simultaneous collection media including: Petri dish, cotton gauze, nylon, microbial swabs, and agar plates, which are secured over the collection frame. In this manner, only one approach would be required to collect replicate samples from an individual and ensure statistical power.

Individual whales would be approached to within 10 m from behind and the boat maneuvered so the wind pushes the blow sample towards the sampling device. The collection device would be attached to a 6-10m aluminum pole which would be extended towards the exhaled blow of the whale.

Samples would be collected from individuals no more than once per year. This activity would be combined with tagging activities that also require close approach for attachment using a long pole.

Biopsy sampling
Individuals would be biopsy sampled up to four times annually except North Pacific right whales, which would only be sampled once annually. Multiple biopsies over time are necessary to assess diet for foraging studies across seasons and changes in prey and habitat over time.

Measures to minimize effects to animals would include:

- Coordination with other researchers in Alaska to avoid harassing the same whales.
- If a whale approaches the vessel, the engine would be placed in neutral to let the whale pass. Changes in engine speed and gear changes would be minimized within a 1/4 mile of any whale in the vicinity of the vessel.
- If disturbance is evident (i.e., changes in behavior, stress vocalizations, abrupt shifts in direction of movement, apparent displacement) the approach would be terminated. If a serious adverse reaction occurs in direct connection with a proposed activity, the activity would cease.
- Researchers would not disturb feeding killer whales, but would search the area for remains of prey left after killer whales depart.
- The controlled experiment to direct fishing operations would occur once per deployment of fishing gear.
- If a whale becomes entangled during deployment of scientific instrumentation during directed fishing operation modifications, the line would be cut and all research activity stopped.
- An individual would be not be intentionally tagged more than twice per year.
- Portions of satellite tags that would be inserted into whales would be thoroughly disinfected before attachment. The parts of the tag that are implanted into the whale and are in contact with whale tissue would be constructed of medical grade stainless steel, titanium, or other material proven to be biocompatible.
- If inter-species interactions are observed, playbacks would cease to avoid harassment to non-target animals.
- If signs of "major disturbance" (e.g., repeated breaching, tail slaps, and underwater bubble cloud releases) are observed, the playback device would be disabled remotely.
- Proposed research would not occur in Steller sea lion rookeries and haul-outs or right whale habitat. Non-target marine mammals would be avoided.

- No mothers and calves under six months would be subject to acoustic playback studies.

Witteveen (Permit 14296)
The proposed research would address predator-prey interactions and foraging overlap in the Gulf of Alaska's (GOA) near-coastal waters and would target blue, humpback, North Pacific right, sei, and sperm whales. Steller sea lions (Western) would not be targeted but could be harassed. Researchers would use a combination of techniques to concurrently assess prey availability and monitor the distribution and foraging behavior of resident and transitory cetaceans sharing common prey resources, and to explore the fine-scale responses of whales to point-source noise generated by acoustic deterrent devices.

Research activities would be conducted year-round during open water surveys; the majority of effort would occur from May to October. All surveys would be conducted from small- to medium-sized vessels less than 25m in length powered by either inboard diesel or outboard gas motors. Surveys are designed to find aggregations of whales and would not follow a set route.

Directed research would involve a combination of activities, as described in *General Activities*, including:
- Close vessel approach for photo-identification and behavioral observation.
- Collection of prey parts.
- Biopsy sampling.
- Suction-cup tagging.
- Acoustic playbacks.

Table 17. Annual Take Information for Marine Mammals in the Pacific Ocean in the Coastal Waters of the Gulf of Alaska (Primary Focus Near the Kodiak Archipelago and the Shumagin Islands) under Permit 14296.

Species	Life stage/sex	Expected takes	procedures
Steller sea lion (Western)	All; male and female	50	Harassment by vessel close approach during directed research on target species
Blue whale	Adult/Juvenile; male and female	10	Harassment by vessel close approach; observations; behavioral; photo-i.d.; sample, skin and blubber biopsy
	All; male and female	40	Acoustic, passive recording; harassment by close vessel approach; observations; behavioral; photo-i.d.
Fin whale	Adult/juvenile; male and female	60	Harassment by vessel close approach; Instrument, suction-cup (e.g., VHF, TDR); observations; behavioral; photo-i.d.
	All; male and female	300	Harassment by vessel close approach; observations; behavioral; photo-i.d.; sample, skin and blubber biopsy
	All; male and female	640	Acoustic, passive recording; harassment by close vessel approach; observations; behavioral; photo-i.d.
	All; male and female	100	Harassment by vessel close approach; observations, behavioral; photo-i.d.; sample, skin & blubber biopsy

Species	Life stage/sex	Expected takes	Procedures
Humpback whale	Adult/juvenile; male and female	60	Harassment by vessel close approach; Instrument, suction-cup (e.g., VHF, TDR); observations; behavioral; photo-i.d.
	All; male and female	300	Harassment by vessel close approach; observations; behavioral; photo-i.d.; sample, skin and blubber biopsy
	All; male and female	610	Acoustic, passive recording; harassment by close vessel approach; observations; behavioral; photo-i.d.
North Pacific right whale	Adult/juvenile; male and female	10	Harassment by vessel close approach; observations; behavioral; photo-i.d.; sample, skin and blubber biopsy
	All; male and female	40	Acoustic, passive recording; harassment by close vessel approach; observations; behavioral; photo-i.d.
Sei whale	Adult/juvenile; male and female	10	Harassment by vessel close approach; observations; behavioral; photo-i.d.; sample, skin and blubber biopsy
	All; male and female	40	Acoustic, passive recording; harassment by close vessel approach; observations; behavioral; photo-i.d.
	All; male and female	20	Harassment by vessel close approach during directed research on target species
Sperm whale	Adult/juvenile; male and female	10	Harassment by vessel close approach; observations; behavioral; photo-i.d.; sample, skin and blubber biopsy
	All; male and female	40	Acoustic, passive recording; harassment by close vessel approach; observations; behavioral; photo-i.d.
	All; male and female	20	Harassment by vessel close approach during directed research on target species
Humpback whale	Adult/juvenile; male and female	30	Acoustic, active playback/broadcast; harassment by vessel close approach; instrument suction-cup (e.g., VHF, TDR); observations; behavioral; photo-i.d.
Unidentified cetacean	All; male and female	50	Collection of dead parts following killer whale predation events; collection of sloughed skin following aerial or surface behaviors
Pinniped, unidentified	All; male and female	50	Collection of dead parts following killer whale predation events

Photo-identification and biopsy sampling would focus on humpback, fin, killer, and gray whales; other cetacean species would be targeted for research on an opportunistic basis. Only humpback and fin whales would be tagged. Species and take numbers for all activities are specified in Table 17. Males and females of all ages and reproductive conditions would be targeted for close approach, photo-identification, and biopsy sampling; mothers and calves would not be tagged. Most calves encountered on the feeding grounds of Alaska are more than 6 months old (i.e., not newborns).

Parts of dead marine mammals would be collected following a killer whale predation event to identify the diet composition of transient killer whales in Alaska. Researchers would observe

and acoustically record feeding killer whales from a distance. Prey remains would be collected after killer whales depart the area.

Photo-identification and biopsy sample collection would be conducted using the methods described in *General Activities.* Whales would not be biopsied more than once unless they cannot be identified in the field. All efforts would be made to minimize multiple biopsies of the same whale.

Fin and humpback whales would be approached and tagged with acoustic time depth tags (ATDT) attached by suction cup for foraging studies; humpback whales would also be tagged with archival (Acousonde) tags attached by suction cup for research on acoustic deterrents. Past success rates have been 25 to 35% (1 in 3 or 4 attempts) while tagging; the proposed number of takes for tagging includes both successful and unsuccessful attempts. No animal would be knowingly approached for tagging attempts more than 4 times. No animal would be intentionally tagged more than once a year; multiple tag attachments are possible, though highly unlikely, over the life of the permit.

In foraging and acoustic deterrent studies, two vessels would be used for each tagging event.

Foraging studies: One vessel (~7-8m) would be used to photo-identify and observe target whales, perform focal follows and monitor tagged whales, and aid in tracking tagged whales through VHF signals should visual contact be lost. A smaller vessel (~3-5m) would be used to attach the tag. After successful tag attachment, a focal follow of the tagged whale would be initiated to observe surface behaviors and habitat use and to allow for successful tag recovery. Tags would be equipped with a radio transmitter (VHF); therefore focal follows would be conducted with telemetric assistance from a distance of 100-500 yards to minimize effects to behavior.

Acoustic deterrent studies: The observing and tagging vessel (~3-5m) would be used to photo-identify target animals and, once the tag is attached, would observe and monitor the tagged whale. A second vessel (~8-10m) would be used to activate a suite of acoustic deterrent devices, all of which are currently legally used by commercial fisherman to deter cetaceans from entanglement in fishing gear. Acousticians at Greenridge Sciences, Inc. would characterize the sounds generated by the devices. Prior to tagging whales the signal frequency, spectral characteristics, and attenuation rate of the deterrents would be quantified; the effectiveness of deterrents that generate sounds within the assumed hearing range of humpback whales (20 Hz to 24k Hz; Au *et al.* 2006) would then be tested. The acoustic deterrent devices to be tested include:

- Commercial pingers.
- Bottle rockets.
- Large chains banging on a metal skiff.
- Pulling seine nets taut.
- Changes in outboard motor RPMs.

Once a tag is successfully attached, tagged whales would be tracked and monitored for approximately 1 hour in order to establish dive patterns and behavior. While the whale tracking vessel continues to monitor behavior, the second vessel would activate acoustic deterrent devices

for a period of five seconds at varying distances (approximately 500, 300, and 100 m) from the whales. Only one acoustic device would be tested at a time and testing would be initiated approximately 1 minute into a whale's dive. Each tagged whale would be exposed to a given deterrent device for a maximum total of 15 seconds (three exposures at five seconds each) during three surface intervals, or approximately 20-25 minutes. A minimum of three dive cycles would separate testing of different deterrents.

The Acousonde tag would record the sound of the acoustic deterrent device, as received at the whale, while simultaneously recording changes in the whales' swim direction, pitch, and speed. Abrupt changes in these parameters immediately after acoustic deterrent device deployment would signify a response to the sound. Researchers would continue to monitor the whale until "normal" pre-exposure behavior is observed, for a maximum of one hour post-exposure time. Given the minimum pre-test, test, and post-test dive times, an individual whale would only be exposed to 15 seconds of sound generated by a single deterrent during a two hour period. A second deterrent would be tested in a similar manner if the tag remains attached following the post-test dive intervals and the whale has not shown negative effects to previous exposures.

Measures to minimize effects to animals would include:

- Mother/calf pairs would be cautiously approached.
- Mother/calf pairs would not be approached when resting or suckling.
- Efforts would be made not to separate mother/calf pairs.
- If non-target species are observed, they would not be approached within 100 yards and research operations would be halted until non-target species have left the area.
- Equipment used in biopsy sampling and tagging would be cleaned and disinfected between uses.
- If disturbance is evident from a whale (e.g., changes in behavior, stress vocalizations, abrupt shifts in direction of movement) an approach episode would be terminated.
- Bottle rockets would never be aimed at whales, rather directly off the side of the vessel, and would never be fired when within one body length of any animal.
- Other researchers would be communicated with extensively in order to minimize duplication of efforts. PR1 is not aware of other researchers currently conducting research of this nature within the study area.

Zoidis (Permit 14353)

The proposed research would build on previous research conducted on humpback whales in Hawaiian waters by determining activity budgets/diel patterns and potential impacts of passing vessel traffic, investigating social sound production and responses between conspecifics. The research would have an emphasis on social sounds between mothers and calves. Using new, in-depth methods would lead to more comprehensive and focused findings (i.e. night-time data, mother/calf/escort data, etc.). Tagging mothers and calves, and escorts where possible, would add a new, previously uninvestigated perspective to the literature.

Research activities for humpback whales would be conducted for five field seasons during the months of January, February, and March in the four-island area off of Maui, Hawaii both within waters of the Hawaiian Island Humpback Whale National Marine Sanctuary (HIHWNMS) and in other adjacent waters. Minke whale photo-identification research would occur in February

and March of each year off the islands of Hawaii, mainly off Kauai. All surveys would be conducted from small vessels less than 20m in length.

During vessel surveys, a combination of the following *General* activities would occur:

- Close vessel approach for photo-identification and behavioral observation.
- Underwater photography/videography.
- Passive acoustic recording.
- Suction-cup tagging.

Table 18. Annual Takes in Hawaiian Waters under Permit 14353.

Species	Life stage	Sex	Take	Takes per animal	Procedures
Humpback whale	all	Male and female	1110	3	Acoustic, passive recording; harassment; Observations, behavioral; photo-i.d.; underwater photo/videography
	adult	Male and female adult escorts	90 (max. 30 animals tagged per year)	3	Acoustic, passive recording; Instrument, suction-cup (e.g. VHF, TDR); Observations, behavioral; photo-i.d.; underwater photo/videography
	adult	Female mothers	150 (max. 50 animals tagged per year)	3	Acoustic, passive recording; Instrument, suction-cup (e.g. VHF, TDR); Observations, behavioral; photo-i.d.; underwater photo/videography
	calf	Male and female calves	150 (max 50 animals tagged per year)	3	Acoustic, passive recording; Instrument, suction-cup (e.g. VHF, TDR); Observations, behavioral; photo-i.d.; underwater photo/videography

Humpback whales would be targeted for all activities. Species and take numbers for all activities are specified in Table 18. Humpback whales of both sexes and all ages, except neonates and their mothers, would be targeted activities.

Target animals would be approached and all activities would occur using the methods described in *General Activities.* Animals would be observed for a minimum of 15 minutes before other activities take place. All types of suction cup tags described in *General Activities* would be used but only one tag would be attached to a whale at a time.

Measures to minimize effects to animals would include:

- Individual humpbacks would not be taken more than 3 times per day by close approach, and not more than once per day if harassment is apparent (e.g., change of behavior, obvious reactions, etc.).
- No animal would be taken more than three times per field season.

- Animals would be approached at a slow speed and obliquely (rather than direct movement towards them) to allow them to continue their activities, and to not overtake or disturb.
- Researchers would cease approach after suitable identification photographs have been obtained topside and after their 30 minute underwater video time allotment is complete or as soon as a tag has been deployed.
- Researchers would avoid multiple approaches of the same groups of whales on a given day.
- Researchers would not work any humpback whale mother/calf group that does not seem "at ease" with an approach or that does not remain in rest mode.
- Activities would be suspended if researchers determine that activities result in any disruption of normal whale activities.
- Researchers would not travel in front of or too close to, or block any intended path for pairs or small groups of whales that are attempting to stay together.
- Researchers would be especially prudent and cautious when approaching any mother/calf pods, assess behavior prior to close approach, and have stationed experienced observers looking for any indication of take. They would avoid separating or coming between a mother/calf pair.
- An experienced collection team would conduct research.
- Researchers would coordinate activities with other researchers and avoid unnecessary duplication and harassing the same pods.
- Researchers would attempt to tag the calf first, then the mother if possible.
- Researchers would slowly and cautiously approach locations where females with calves are resting at depth and attempt to tag the calf when it surfaces to breathe.
- Researchers would abandon tagging efforts if resting behavior is disrupted for more than a few minutes, or if there is any risk to mother/calf nursing or bonding behaviors.
- Tagging efforts would not be conducted on the same animal more than once per month.
- Equipment that would be in contact with a whale would be sterilized.
- Tags would be designed with a tag-release mechanism to allow detachment of the tag body after tracking is terminated (also necessary for tag retrieval).
- Research and development into reducing the effects of the tag and attachment techniques would be ongoing throughout the research effort and would be based on feedback from the tagging and deployment results and from other researchers.

II. PERMIT CONDITIONS

Permit Duration

- Researchers must suspend permitted activities in the event serious injury or mortality[4] of protected species occurs. The Permit Holder must contact the Chief, NMFS Permits, Conservation and Education Division (hereinafter "Permits Division") by phone (301-713-2289) within two business days. The Permit Holder must also submit a written incident report. The Permits Division may grant authorization to resume permitted

[4] This permit does not allow for unintentional serious injury and mortality caused by the presence or actions of researchers. 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 while attempting to avoid researchers or escape capture. Note that for marine mammals, a serious injury is defined by regulation as any injury that will likely result in mortality.

activities based on review of the incident report and in consideration of the Terms and Conditions of this permit.

- If authorized take[5] is exceeded, Researchers must cease permitted activities and notify the Chief, Permits Division, by phone (301-713-2289) as soon as possible, but no later than within two business days. The Permit Holder must also submit a written incident report. 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.

Counting and Reporting Takes

- Any "approach"[6] of a cetacean constitutes a take by harassment and must be counted and reported.

- Regardless of success, any attempt, which includes the associated close approach, to tag or sample an animal constitutes a take and must be counted and reported.

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

- No individual animal may be taken more than 2 (or 3 depending on permit and activity) times in one day specified in each permit.

- During aerial surveys, any cetacean observed below 1,000 ft should be counted and reported as a take.

General

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

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[5] 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.

[6] An "approach" is defined as a continuous sequence of maneuvers (episode) involving a vessel or researcher's body in the water, including drifting, directed toward a cetacean or group of cetaceans closer than 100 yards for large whales, or 50 yards for smaller cetaceans.

- Where females with calves are authorized to be taken, Researchers:

  -Must immediately terminate efforts if there is any evidence that the activity may be interfering with pair-bonding or other vital functions;

  -Must not position the research vessel between the mother and calf;

  -Must approach mothers and calves gradually to minimize or avoid any startle response;

  -Must not approach any mother or calf while the calf is actively nursing; and

  -Must, if possible, tag the calf first to minimize the mother's reaction when tagging mother/calf pairs.

- When practicable, Researchers should monitor and record the behavior of target animals at least 15 minutes before and after conducting research activities. Observed negative impacts should be included in annual reports.

<u>For underwater filming and/or photography</u>

- No more than 2 divers may be in the water at any time during underwater observations. An underwater approach/activity must be terminated if a whale is observed to exhibit adverse/evasive changes in behavior. Use of an additional diver is subject to review and approval by the NMFS Permits Division.

- With the exception of professional and/or experienced photographers/videographers, Research Assistants are NOT authorized to carry out underwater observations and/or photography.

<u>For Hawaiian humpback research</u>:

- At all times when vessels engaging in research activities are on the water ("port-to-port") in Hawaii, such vessels must fly a clearly visible triangular pennant. The pennant must be yellow in color with minimum dimensions of 18"H x 26"L and with the permit number displayed in 6" high black numerals.

<u>For research in the inland waters of Washington state</u>:

- At all times when vessels engaging in research activities are in the inland waters of Washington, such vessels must fly a clearly visible triangular pennant. The pennant must be yellow in color with minimum dimensions of 18"H x 26"L and with the permit number displayed in 6" high black numerals.

- This permit does not authorize research activities off the Northwest Olympic Peninsula, particularly the Cape Flattery and Neah Bay areas. This includes the waters located south

of the U.S./Canada border, west of 124º W and north of 48º N. To conduct research in this area, the permit holder is required to obtain authorization from the native Makah Nations.

For research in CA/OR/WA:

- For activities occurring in near-shore kelp beds in California, Oregon or Washington waters between mid-July and Dec 31, if marbled murrelets are present, researchers must reduce boat speed to 10 miles per hour, maintain a consistent heading, and make only 1 pass through per day.

Non-target Species

To minimize disturbance of Hawaiian monk seals the Permit Holder must:

- Not enter the water when monk seals are present, and if approached by a seal, leave the area; and

- Report any opportunistic monk seal sightings to: Thea Johanos, NMFS Pacific Islands Fisheries Science Center, Marine Mammal Research Program, 1601 Kapiolani Boulevard, Suite 1110, Honolulu, HI 96814-4700; phone (808)944-2174; email Thea.Johanos-Kam@noaa.gov; fax (808)944-2200.

- This permit does not authorize takes of any protected species not identified in Table 1 of Appendix 1 of the permit, including those species under the jurisdiction of the USFWS (e.g. sea otters). Should other protected species be encountered during the research activities authorized under this permit, researchers must exercise caution and remain a safe distance from the animal(s) to avoid take, including harassment.

Sampling Activities: Biopsy, Tagging

- All biopsy tips must be disinfected between and prior to each use.

- Researchers may suction cup tag humpback whale calves greater than 1 month old and females accompanied by these calves.

- For all other species authorized in Appendix 1, no calves of any age will be tagged.

- No calves of any age will be biopsy sampled.

- No more than three (3) attempts per day will be made to tag or biopsy an individual.

- No individual will be intentionally tagged or biopsy sampled more than once annually.

- Before attempting to sample an individual, Researchers must take reasonable measures (e.g., compare photo-identifications) to avoid repeated sampling of any individual.

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

- In no instance will the Permit Holder attempt to biopsy or tag a cetacean anywhere forward of the pectoral fin.

- Straley Permit - During sampling of killer whales' dead prey items: Up to 5 cetaceans total (humpback, gray, minke, sei and fin whales; harbor porpoise, Dall's porpoise, or beaked whale spp.) and up to 20 pinnipeds total (northern fur seals, Steller sea lions, or harbor seals) may be harassed annually.

Aerial Surveys

- Aerial surveys must be flown at an altitude of 500 ft. or higher. Aerial surveys must be flown at an altitude of 750 ft. Descents for photo-identification must be made to no less than an altitude of 500 feet.

- Helicopter aerial surveys must be flown at an altitude of 500 ft or higher.

- To minimize disturbance: If an animal shows a response to the presence of the aircraft, the aircraft must leave the vicinity and either resume searching or continue on the line-transect survey.

- Aerial flights must not be conducted over marine mammal haul out areas.

Active Acoustics

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

- Au Permit - A playback episode must not exceed a source level of 190 dB re: 1uPa and must not expose animals to received sound pressure levels greater than 160 dB re: 1uPa, as described in the application.

- Darling Permit - Playback studies must be limited to 60 minutes in duration, not to exceed 187 dB re 1 µPa at 1 meter.

- Sharpe Permit - Playback studies must be limited to 55 minutes in duration (25 minutes pre-test passive observation, 5 minute stimulus, 25 minute post-test monitoring), not exceed 170 dB re 1 µPa at 1 meter (broadcast at a depth of 20m), and must not be broadcast to animals closer than 100 meters.

- Straley Permit - Playback studies must not exceed 170 dB RMS re 1 µPa at 1m.

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

For underwater filming and/or photography:

- No more than 2 divers may be in the water at any time during underwater observations. An underwater approach/activity must be terminated if a whale is observed to exhibit adverse/evasive changes in behavior. Use of an additional diver is subject to review and approval by the NMFS Permits Division.

- With the exception of professional and/or experienced photographers/videographers, Research Assistants are NOT authorized to carry out underwater observations and/or photography.

Depredation studies

- When conducting fishing operation modification research, if an animal becomes entangled in the longline or other types of fishing gear, research shall cease and all attempts to free the animal shall be made under the appropriate MMPA/ESA permit authorization. Researchers must notify the NMFS Permits Division as outlined in Condition A.2, and must notify the NMFS Alaska Region as soon as feasible at 907-586-7235.

Reports

- The Permit Holder must submit annual, final, and incident reports, and papers or publications resulting from the research authorized herein to the Permits Division. Reports may be submitted

- through the online system at https://apps.nmfs.noaa.gov,

- by email attachment to the permit analyst for this permit, or

- by hard copy mailed or faxed to the Chief, Permits Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Suite 13705, Silver Spring, MD 20910; phone (301)713-2289; fax (301)713-0376.

- Written incident reports related to serious injury and mortality events or to exceeding authorized takes, must be submitted to the Chief, Permits Division within two weeks of the incident. 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 research-related mortality or exceedence of authorized take.

- An annual report must be submitted to the Chief, Permits Division at the conclusion of each year for which the permit is valid. The annual report describing activities conducted during the previous permit year must follow the format in Appendix 2.

- A final report must be submitted to the Chief, Permits Division within 180 days after expiration of the permit, or, if the research concludes prior to permit expiration, within 180 days of completion of the research.

- Research results must be published or otherwise made available to the scientific community in a reasonable period of time.

Notification and Coordination

- The Permit Holder must provide written notification of planned field work to the appropriate Assistant Regional Administrator(s) for Protected Resources at the address of the nearest NMFS regional office. Such notification must be made at least two weeks prior to initiation of a field trip/season and must include the locations of the intended field study and/or survey routes, estimated dates of research, and number and roles (for example: PI, CI, veterinarian, boat driver, safety diver, animal restrainer, Research Assistant "in training") of participants.

- 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. The appropriate Regional Office may be contacted at the address listed above for information about coordinating with other Permit Holders.

III. APPROACH TO THE ASSESSMENT

NMFS approaches its section 7 analyses of agency actions through a series of steps. The first step identifies those aspects of proposed actions that are likely to have direct and indirect physical, chemical, and biotic effects on listed species or on the physical, chemical, and biotic environment of an action area including areas designated as critical habiat. As part of this step, we identify the spatial extent of these direct and indirect effects, including changes in that spatial extent over time. The result of this step includes defining the *action area* for the consultation. The second step of our analyses identifies the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our *exposure analyses*). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. Once we identify which listed resources are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (these represent our *response analyses*).

The final steps of our analyses – establishing the risks those responses pose to listed resources – are different for listed species and designated critical habitat (these represent our *risk analyses*). Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. Because the

continued existence of species depends on the fate of the populations that comprise them, the continued existence of these "species" depends on the fate of the populations that comprise them. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them – populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our risk analyses reflect these relationships between listed species, the populations that comprise that species, and the individuals that comprise those populations. Our risk analyses begin by identifying the probable risks actions pose to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those individual risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

We measure risks to listed individuals using the individuals' "fitness," or the individual's growth, survival, annual reproductive success, and lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable lethal, sub-lethal, or behavioral responses to an action's effect on the environment (which we identify during our response analyses) are likely to have consequences for the individual's fitness.

When individual, listed plants or animals are expected to experience reductions in fitness in response to an action, those fitness reductions are likely to reduce the abundance, reproduction, or growth rates (or increase the variance in these measures) of the populations those individuals represent (*see* Stearns 1992). Reductions in at least one of these variables (or one of the variables we derive from them) is a *necessary* condition for reductions in a population's viability, which is itself a *necessary* condition for reductions in a species' viability. As a result, 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 (e.g., Brandon 1978; Mills and Beatty 1979; Stearns 1992; Anderson 2000). As a result, if we conclude that listed plants or animals are *not* likely to experience reductions in their fitness, we would conclude our assessment.

Although reductions in fitness of individuals is a *necessary* condition for reductions in a population's viability, reducing the fitness of individuals in a population is not always *sufficient* to reduce the viability of the population(s) those individuals represent. Therefore, if we conclude that listed plants or animals are likely to experience reductions in their fitness, we determine whether those fitness reductions are likely to reduce the viability of the populations the individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, variance in these measures, or measures of extinction risk). In this step of our analyses, we use the population's base condition (established in the *Environmental Baseline* and *Status of Listed Resources* sections of this Opinion) as our point of reference. If we conclude that reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent, we would conclude our assessment.

Reducing the viability of a population is not always *sufficient* to reduce the viability of the species those populations comprise. Therefore, in the final step of our analyses, we determine if reductions in a population's viability are likely to reduce the viability of the species those populations comprise using changes in a species' reproduction, numbers, distribution, estimates of extinction risk, or probability of being conserved. In this step of our analyses, we use the species' status (established in the *Status of the Species* section of this Opinion) as our point of reference. Our final determinations are based on whether threatened or endangered species are likely to experience reductions in their viability and whether such reductions are likely to be appreciable.

To conduct these analyses, we rely on all of the evidence available to us. This evidence might consist of monitoring reports submitted by past and present permit holders; reports from NMFS Science Centers; reports prepared by natural resource agencies in States, Tribes, and other countries; reports from non-governmental organizations involved in marine conservation issues; the information provided by the Permits Division when it initiates formal consultation; and the general scientific literature. We supplement this evidence with reports and other documents – environmental assessments, environmental impact statements, and monitoring reports – prepared by other federal and state agencies like the Minerals Management Service, U.S. Coast Guard, and U.S. Navy whose operations extend into the marine environment.

During the consultation, we conducted electronic searches of the general scientific literature using search engines, including *Agricola, Aquatic Sciences and Fisheries Abstracts, Conference Papers Index, Oceanic Abstracts, BioOne, Science Direct, Ingenta Connect, Scopus, JSTOR, Web of Science - Science Citation Index, First Search (Article First, ECO, WorldCat),* and *Google Scholar*. We supplemented these searches with electronic searches of doctoral dissertations and master's theses. These searches specifically tried to identify data or other information that supports a particular conclusion (for example, a study that suggests whales will exhibit a particular response to close approach) as well as data that does not support that conclusion.

IV. DESCRIPTION OF THE ACTION AREA

The action area for the proposed activities under the permit amendment includes the U.S. exclusive economic zone (EEZ) and state waters of the Atlantic Ocean, Pacific Ocean (including waters off Alaska, Hawaii, Guam, and the Mariana Islands), and the Gulf of Mexico.

Table 19. Summary of action area locations specific to each permit/research project and take types requested in each application. Not all take types are requested for all species in each permit and not all research projects will work in the entire action area.

					Level B harassment								Level A harassment				
Applicant	***Hawaii***	***Alaska***	***Other Pacific Locations***	***Atlantic Ocean***	***Aerial Surveys***	***Vessel Surveys***	***Close Vessel Approach, Behavioral Observations, and Photo-ID***	***Underwater photo/video***	***Collect Breath Samples***	***Collect skin/fecal***	***Passive Acoustic Recording***	***Export/Re-import***	***Suction Cup Tagging***	***Blubber Attachment Tagging***	***Biopsy***	***Playback of Natural Sounds***	***Playback of Other Sounds***
Au No. 14682	X						X	X		X	X		X		X	X	X
Cartwright No. 10018-01	*	X					X				X						
Darling No. 13846	X	X	***		X		X	X			X	X	X	X	X	X	
Mobley No. 14451	X	X	***	X	X	X	X	X			**						
Pack No. 14585	X	X	***				X	X		X	X		X		X		
Sharpe No. 14599		X			X		X	X		X	X		X			X	X
Straley No. 14122		X					X	**	X	X	X	X	X	X	X	X	X
Witteveen No. 14296		X				X	X				X		X		X		X
Zoidis No. 14353	X						X	X		X	X		X				

* Takes are currently authorized in Permit 10018.
** Recording would be stationary and does not require additional takes.
*** Requested locations include Pacific locations in addition to Hawaii and Alaska, and are detailed in the section on *Specific permit requests*.

Designated North Pacific and North Atlantic right whale critical habitat, green sturgeon critical habitat, and Steller sea lion critical habitat for the Western distinct population segment occur within the action area.

V. STATUS OF THE SPECIES/CRITICAL HABITAT

NMFS has determined that the action considered in this Opinion may affect the following listed species provided protection under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.; ESA).

Common name (Distinct Population Segment or Evolutionarily Significant Unit)	*Scientific name*	*Status*
Cetaceans		
Humpback whale	*Megaptera novaeangliae*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
Blue whale	*Balaenoptera musculus*	Endangered
North Atlantic right whale	*Eubalaena glacialis*	Endangered
North Pacific right whale	*Eubalaena japonica*	Endangered
Gray whale, Western North Pacific Distinct Population Segment	*Eschrichtius robustus*	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered
Southern resident killer whale	*Orcinus orca*	Endangered
Marine turtles		
Green sea turtle (all other areas except Florida and Mexico's Pacific coast breeding colonies)	*Chelonia mydas*	Threatened
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Olive ridley sea turtle (all other areas except Mexico's Pacific coast breeding colonies)	*Lepidochelys olivacea*	Threatened
Loggerhead sea turtle	*Caretta caretta*	Threatened
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Anadromous fish		
Atlantic salmon	*Salmo salar*	Endangered
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	Threatened
Chinook salmon (California coastal)	*Oncorhynchus tschawytscha*	Threatened
Chinook salmon (Central valley Spring-run)		Threatened
Chinook salmon (Puget Sound)		Threatened
Chinook salmon (Sacramento River Winter-run)		Endangered
Chinook salmon (Lower Columbia River)		Threatened
Chinook salmon (Upper Columbia River Spring-run)		Endangered
Chinook salmon (Snake River Fall-run)		Threatened
Chinook salmon (Snake River Spring/Summer-run)		Threatened
Chinook salmon (Upper Willamette River)		Threatened
Chum salmon (Columbia River)	*Oncorhynchus keta*	Threatened
Chum salmon (Hood Canal Summer-run)		Threatened
Coho salmon (Lower Columbia River)	*Oncorhynchus kisutch*	Threatened
Coho salmon (Southern Oregon & Northern California Coast)		Threatened
Coho salmon (Oregon Coast)		Threatened
Coho salmon (Central California coast)		Endangered
Green sturgeon (Southern)	*Acipenser medirostris*	Threatened
Sockeye salmon (Ozette Lake)	*Oncorhynchus nerka*	Threatened
Sockeye salmon (Snake River)		Endangered
Steelhead (Lower Columbia River)	*Oncorhynchus mykiss*	Threatened
Steelhead (Middle Columbia River)		Threatened
Steelhead (Northern California)		Threatened
Steelhead (Snake River Basin)		Threatened
Steelhead (Puget Sound)		Threatened
Steelhead (Central California coast)		Threatened

Common name (Distinct Population Segment or Evolutionarily Significant Unit)	*Scientific name*	*Status*
Steelhead (Southern California)		Endangered
Steelhead (South-Central California coast)		Threatened
Steelhead (California Central Valley)		Threatened
Steelhead (Upper Columbia River)		Endangered
Steelhead (Upper Willamette River)		Threatened
Pinnipeds		
Steller sea lion, Western Distinct Population Segment	*Eumetopias jubatus*	Endangered
Steller sea lion, Eastern Distinct Population Segment	*Eumetopias jubatus*	Endangered
Hawaiian monk seal	*Monachus schauinslandi*	Endangered
Invertebrates		
Elkhorn coral	*Acropora cervicornis*	Threatened
Staghorn coral	*Acropora palmata*	Threatened
White abalone	*Haliotis sorenseni*	Endangered
Black abalone	*Haliotis cracherodii*	Endangered

Proposed activities would occur in North Pacific right whale critical habitat, Steller sea lion critical habitat, and green sturgeon critical habitat. Researchers would not directly work in any other designated critical habitat within the action area. Critical habitat has not been designated for humpback, fin, sei, blue, gray (Western North Pacific Distinct Population Segment), or sperm whales.

The biology and ecology of these species are described below, and inform the effects analysis for this Opinion. Summaries of the global status and trends of these species are presented to provide a foundation for the analysis.

A. Listed Resources Not Considered Further in this Opinion

Directed research would target on sperm, sei, fin, blue, humpback, North Pacific and North Atlantic right, and Western North Pacific gray whales. Eastern and western Steller sea lions, as well as Hawaiian monk seals would be non-target animals that could be harassed. ESA-listed resources occurring within the action that are either not likely to be exposed to the proposed research or are not likely to be adversely affected are discussed below.

Cetaceans

For southern resident killer whales (SRKWs), we believe an encounter would be rare in the proposed action area. In the eastern North Pacific Ocean, three distinct forms, or ecotypes, of killer whales--"residents," "transients," and "offshores"--are recognized (Ford *et al.* 2000). Residents are not as widely distributed as their transient or offshore counterparts and would not be likely to swim into the North Pacific from their more inshore critical habitat area (Ford *et al.* 2000). The critical habitat of SRKWs includes the Haro Strait, waters surrounding the San Juan Islands, Strait of Juan de Fuca, and Puget Sound. Since it would be rare for SRKWs to leave this area and swim into more offshore areas of the North Pacific where these activities would be conducted and authorized, we believe the probability of an encounter with these whales during research activities would be discountable. For these reasons, we did not consider SRKWs further in this Opinion.

Sea Turtles
Authorized activities would not be conducted in sea turtle critical habitat or near nesting sites. Furthermore, research efforts under the proposed permit amendment would be directed on baleen whale species and would be conducted in ways that should only affect targeted species. We believe that encounters with sea turtles would be uncommon due to the fact that proposed activities are designed with the purpose of finding and conducting procedures on cetaceans. With regard to active acoustic playback activities, sea turtles do not respond to sounds in the frequency range of the proposed activities, as their hearing sensitivity is highest in the low frequency range (Ridgway *et al.* 1969, Bartol *et al*. 1999). It is therefore unlikely that the proposed playback actions will affect sea turtles. For these reasons, we did not consider green, hawksbill, Kemp's ridley, olive ridley, loggerhead, or leatherback sea turtles further in this Opinion.

Anadromous Fish
Anadromous fish spend years in the marine environment before returning to natal streams to spawn. Therefore, these fish could occur in the proposed action area. However, tagging research efforts under the proposed permit amendment would be directed on baleen whale species and would be conducted in ways that should only affect targeted species. Although the proposed activities include a tracking buoy array, no netting of any kind will be placed in the water column that could pose a risk to fish species. For these reasons, we did not consider listed anadromous fish (*see* tabled list above) further in this Opinion.

Invertebrates
Listed abalone and corals may occur in the action area. Because of the small sizes and the corresponding low draft and maneuverability of the boats proposed to be used, the proposed activities should not affect the benthic habitat where these species are found. The proposed audio playback and prey survey activities are also not likely to affect listed invertebrate species. For these reasons, we did not consider elkhorn coral, staghorn coral, white abalone, or black abalone further in this Opinion.

Critical Habitat Areas
As stated above, proposed activities would take place in North Pacific right whale, green sturgeon, and Steller sea lion critical habitat areas. We believe that the proposed activities are not likely to adversely affect the conservation value of any designated critical habitat areas.

Critical habitat has been designated for the North Pacific right whale in the Gulf of Alaska[7] (GOA) and in the Southeastern Bering Sea[8] (73 FR 19000; April 8, 2008). The PCEs for the North Pacific right whale are the physical presence of species of large zooplankton in areas

[7] Critical habitat in the GOA is described as an area delineated by a series of straight lines connecting the following coordinates in the order listed: 57° 03′ N/153° 00′ W, 57° 18′ N/151° 30′ W, 57° 00′ N/151° 30′ W, 56° 45′ N/153° 00′ W, and returning to 57° 03′ N/153 00′ W.

[8] Critical habitat in the Bering Sea is described as an area delineated by a series of straight lines connecting the following coordinates in the order listed: 58° 00′ N/168° 00′ W, 58° 00′ N/163° 00′ W, 56° 30′ N/161° 45′ W, 55° 00′ N/166° 00′ W, 56° 00′ N/168° 00′ W and returning to 58° 00′ N/168° 00prime; W.

where right whales are known or believed to feed, and physical forcing mechanisms present to concentrate these prey species in densities which allow for efficient foraging by right whales. Accordingly, the critical habitat encompasses areas in which the physical and biological oceanography combines to promote high productivity and aggregation of large copepods into patches of sufficient density for right whales. The proposed permit would authorize activities in critical habitat areas of the North Pacific right whale, but studies are not expected to adversely affect any of the physical, chemical, or biotic features that form the critical habitat. The proposed activities would not affect zooplankton composition or areas of high productivity. Furthermore, the proposed activities would not adversely affect the population ecology or population dynamics of prey species, predators, or competitors of right whales. As a result, the proposed activities are not likely to adversely affect the conservation value of the designated critical habitat for North Pacific right whales, and North Pacific right whale critical habitat is not addressed further in this Opinion**.**

Critical habitat has been designated for the endangered North Atlantic right whale in the Great South Channel, Cape Cod Bay, and off the states of Georgia and Florida (59 FR 28793; June 3, 1994). The critical habitat designation encompasses three primary feeding and nursery habitats in the United States used by right whales during their annual migration. The physical, chemical, and biotic features that form right whale critical habitat include the composition of zooplankton in feeding areas, the topographic and seasonal oceanographic characteristics conducive to zooplankton growth; and water depth, water temperatures, and distance from shore for calving and nursery areas (59 FR 28793; June 3, 1994). NMFS believes that the proposed research activities would not affect zooplankton composition, topographic or oceanographic characteristics, water depth, water temperature, or distance of the critical habitat areas from shore. Furthermore, the proposed activities would not adversely affect the population ecology or population dynamics of prey species, predators, or competitors of right whales. As a result, the proposed research activities are not likely to adversely affect the conservation value of the designated critical habitat for North Atlantic right whales, and this listed resource is not addressed further in this Opinion**.**

Authorized activities could be conducted in critical habitat for green sturgeon which includes marine waters 360 feet deep or less from Monterey Bay, California to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington to the U.S.-Canadian border. Primary constituent elements of green sturgeon estuarine habitat include: food resources, water flow, water quality, migratory corridors, water depth, and sediment quality. Primary constituent elements of green sturgeon marine habitat include: food resources, water quality, and migratory corridors. Although most proposed activities would not be conducted in green sturgeon critical habitat, there is a possibility that the research vessel could transit through these green sturgeon critical habitat areas. If the researchers did end up leaving port and transiting through these areas, their transit would involve no more than routine vessel movements at the water surface which are not likely to alter the water quality or the chemical attributes of the habitat (salinity, temperature, O2 levels, prey resources, water flow). The potential for fuel/contaminant spill during transit would be slight given training of the researchers in conducting vessel-based surveys and the availability of high resolution bathymetric maps of the research area and, therefore, the unlikelihood of running aground. Therefore, the proposed activities are not likely

to adversely affect the conservation value of the designated critical habitat for green sturgeon, and green sturgeon critical habitat is not addressed further in this Opinion**.**

The proposed activities could also occur within the critical habitat of the Eastern and Western DPS of Steller sea lions. Critical habitat was designated on August 27, 1993, for both the eastern and western DPS Steller sea lions in California, Oregon, and Alaska (58 FR 45269). Steller sea lion critical habitat includes all major rookeries in California, Oregon, and Alaska and major haulouts in Alaska. Proposed activities would not target sea lions and aerial surveys conducted would not fly over these haulout areas. Therefore, the proposed activities are not likely to adversely affect the conservation value of the designated critical habitat for Steller sea lions, and Steller sea lion critical habitat is not addressed further in this Opinion**.**

B. Status of Species Considered in this Opinion

1. Humpback whale, *Megaptera novaeangliae*

a. Species Description, Distribution, and Population Structure

Humpback whales are a cosmopolitan species that occur in the Atlantic, Indian, Pacific, and Southern oceans. Humpback whales migrate seasonally between warmer, tropical or sub-tropical waters in winter months (where they breed and give birth to calves, although feeding occasionally occurs) and cooler, temperate or sub-Arctic waters in summer months where they feed (Gendron and Urban 1993). In both regions, humpback whales tend to occupy shallow, coastal waters. However, migrations are undertaken through deep, pelagic waters (Winn and Reichley 1985).

North Atlantic. Stocks have been relatively well defined for humpback whales. In the North Atlantic, Humpback whales range from the mid-Atlantic bight and the Gulf of Maine across the southern coast of Greenland and Iceland to Norway in the Barents Sea. Whales migrate to the western coast of Africa and the Caribbean Sea during the winter. These whales aggregate in four summer feeding areas:

- Gulf of Maine and eastern Canada,
- west Greenland,
- Iceland, and
- Norway (Katona and Beard 1990; Smith *et al.* 1999).

Increasing occurrence in the Mediterranean Sea coincides with population growth and may represent reclaimed habitat from pre-commercial whaling (Frantzis *et al*. 2004). The principal breeding range for Atlantic humpback whales lies from the Antilles and northern Venezuela to Cuba (Balcomb III and Nichols 1982; Whitehead and Moore 1982; Winn *et al*. 1975). However, the largest breeding aggregations occur off the Greater Antilles where humpback whales from all North Atlantic feeding areas have been photo-identified (Clapham *et al*. 1993; Katona and Beard 1990; Mattila *et al.* 1994; Palsbøll *et al*. 1997; Smith *et al*. 1999; Stevick *et al*. 2003b). Winter aggregations also occur at the Cape Verde Islands in the eastern North Atlantic and along Angola (Reeves *et al*. 2002; Reiner *et al*. 1996; Weir 2007). Accessory and historical aggregations also

occur in the eastern Caribbean (Levenson and Leapley 1978; Mitchell and Reeves 1983; Reeves *et al*. 2001a, 2001b; Schwartz 2003; Smith and Reeves 2003; Swartz *et al.* 2003; Winn *et al.* 1975). To further highlight the "open" structure of humpback whales, a humpback whale migrated from the Indian Ocean to the South Atlantic Ocean, demonstrating that interoceanic movements can occur (Pomilla and Rosenbaum 2005).

North Pacific. There are also recognized stocks in the North Pacific. Based on genetic and photo-identification studies, the NMFS currently recognizes four stocks of humpback whales in the North Pacific Ocean: two Eastern North Pacific stocks, one Central North Pacific stock, and one Western Pacific stock (Hill and DeMaster 1998). Humpback whales summer in coastal and inland waters from Point Conception, California, north to the 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. The central North Pacific stock winters in the waters around Hawaii while the eastern North Pacific stock (also called the California-Oregon-Washington-Mexico stock) winters along Central America and Mexico. However, Calambokidis *et al*. (1997) identified individuals from several stocks wintering in the areas of other stocks, highlighting the paucity of knowledge on stock structure and the potential fluidity of stock structure. Herman (1979) presented extensive evidence that humpback whales associated with the main Hawaiian Islands immigrated there only in the past 200 years. Winn and Reichley (1985) 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-March (Darling and Mori 1993; Eldredge 1991, 2003; 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 2007; Calambokidis 1997; Calambokidis *et al*. 2001).

Separate feeding groups of humpback whales are thought to inhabit Pacific U.S. and Canadian waters, with the boundary between them located roughly at the U.S./Canadian border (Carretta *et al.* 2006). The southern feeding ground ranges between 32°-48°N, with limited interchange with areas north of Washington State (Calambokidis *et al*. 2004a, 1996). Humpback whales feed along the coasts of Oregon and Washington from May-November, with peak numbers reported May-September, when they are the most commonly reported large cetacean in the region (Calambokidis *et al*. 2004a, 2000; Dohl *et al*. 1983; Forney and Barlow 1998; Green *et al.* 1992). Off Washington State, humpback whales concentrate between Juan de Fuca Canyon and the outer edge of the shelf break in a region called "the Prairie," near Barkley and Nitnat canyons, in the Blanco upwelling zone, and near Swiftsure Bank (Calambokidis *et al*. 2004b). Humpback whales also tend to congregate near Heceta Bank off the coast of Oregon (Green *et al*. 1992).

Humpback whales in the Pacific primarily feed along the shelf break and continental slope (Green *et al*. 1992; Tynan *et al.* 2005). Although humpback whales were common in inland Washington State waters in the early 1900s, severe hunting throughout the eastern North Pacific

has diminished their numbers and few recent inshore sighting have been made (Calambokidis and Steiger 1990; Pinnell and Sandilands 2004; Scheffer and Slipp 1948).

Similarly, humpback whales in the Pacific do not appear to frequent offshore waters in the region. Extensive aerial surveys conducted up to 550 km off the Oregonian and Washingtonian coasts, only one humpback whale was reported in offshore waters >200 m deep (Green *et al*. 1992). Encounter rates off Oregon/Washington during the summer were highest over the slope (2.16/1,000 individuals/km^2) followed by shelf waters (0.56 /1,000 individuals/km^2), with no sightings in offshore waters during the summer.

Because of the extensive rate of immigration and emigration that likely occurs between North Pacific stocks, these groups are unlikely to represent separate populations. Although significant life history differences exist, until further information is available to differentiate groups, North Pacific humpback whales herein represent a single population, along with a separate Arabian Sea population (along Oman, Pakistan, and India), North Atlantic, and ill-defined Southern Ocean/Indian Ocean/South Atlantic group. These groups seem to undergo migration between ocean basins (additional data is necessary to define these populations (Mikhalev 1997).

Southern Hemisphere. There are proposed stocks in the Southern hemisphere. Eight proposed stocks of humpback whales occur in waters off Antarctica (Figure 2). Based upon recent satellite telemetry, a revision of stocks A and G may be warranted to reflect stock movements within and between feeding areas separated east of 50º W (Dalla Rosa *et al*. 2008). A separate population of humpback whales appears to reside in the Arabian Sea in the Indian Ocean off the coasts of Oman, Pakistan, and India and movements of this group are poorly known (Mikhalev 1997; Rasmussen *et al*. 2007).

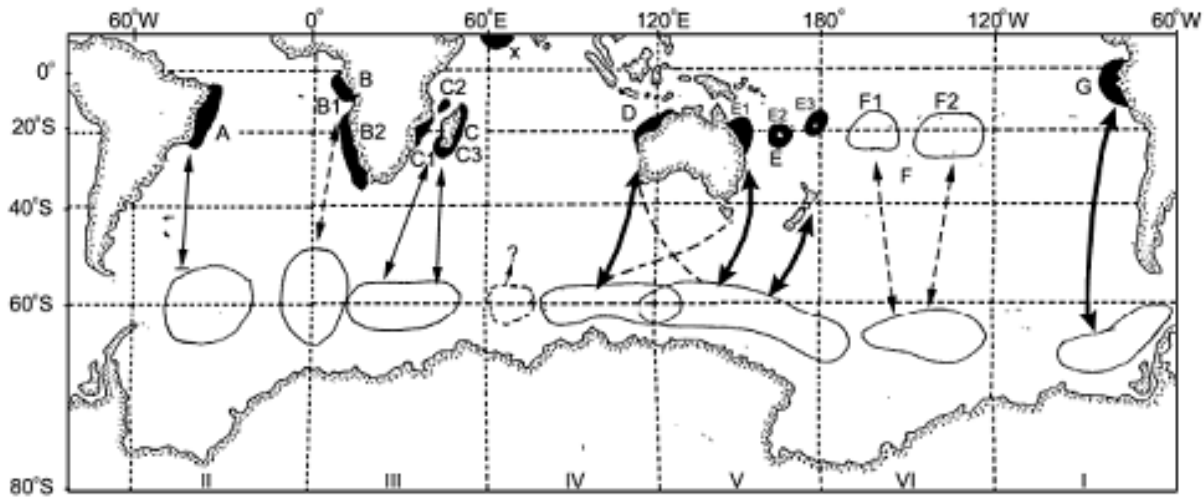

Figure 1. Southern Hemisphere humpback stocks as designated by the International Whaling Commission (IWC) (IWC 2005a).

Diving. Humpback dive times and depths have been studied, but more detail remains to be known as to dive necessities. Because most humpback prey is likely found within 300 m of the surface, most humpback dives are relatively shallow (<60m). Maximum diving depths are approximately 170 m (but usually <60 m), with a very deep dive (240 m) recorded off Bermuda

(Hamilton *et al*. 1997). Dives can last for up to 21 min, although feeding dives ranged from 2.1-5.1 min in the north Atlantic (Dolphin 1987; Goodyear unpublished manuscript). In southeast Alaska, average dive times were 2.8 min for feeding whales, 3.0 min for non-feeding whales, and 4.3 min for resting whales (Dolphin 1987). In the Gulf of California, humpback whale dive durations averaged 3.5 min (Strong 1990). In Hawaiian waters, humpback whales remain almost exclusively within the 1,800 m isobath and usually within waters depths of less than 182 m.

Hearing and Vocalization. Humpback whale vocalization is much better understood than hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls. 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 144-174 dB (Au 2000; Au *et al*. 2006; Frazer and Mercado 2000; Payne 1970; Richardson *et al*. 1995; 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 and Whitehead 1983). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson *et al*. 1995; Tyack and Whitehead 1983). While in northern feeding areas, both sexes vocalize in grunts (25 Hz to 1.9 kHz), pulses (25-89 Hz), and songs (ranging from 30 Hz to 8 kHz but dominant frequencies of 120 Hz to 4 kHz) which can be very loud (175-192 dB re 1 μPa at 1 m; (Au 2000; Erbe 2002; Payne and Payne 1985; Richardson *et al*. 1995; Thompson *et al.* 1986). However, humpbacks tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson *et al*. 1995).

b. Life History

Reproduction. Humpback whale calving and breeding generally occurs during winter at lower latitudes. Gestation takes about 11 months, followed by a nursing period of up to 1 year (Baraff and Weinrich 1993). Sexual maturity is reached between 5-7 years of age in the western North Atlantic, but may take as long as 11 years in the North Pacific, and perhaps over 11 years of age in the North Pacific (e.g., southeast Alaska, Gabriele *et al*. 2007). Females usually breed every 2-3 years, although consecutive calving is not unheard of (Clapham and Mayo 1987, 1990; Glockner-Ferrari and Ferrari 1985; Weinrich *et al*. 1993).

In calving areas, males sing long complex songs directed towards females, other males, or both. The breeding season can best be described as a floating lek or male dominance polygamy (Clapham 1996). Calving occurs in the shallow coastal waters of continental shelves and oceanic islands worldwide (Perry *et al*. 1999).

Feeding. Humpbacks feed in groups. 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, 1995; Jurasz and Jurasz 1979; Weinrich *et al*. 1992). The principal fish prey in the western North Atlantic are sand lance, herring, and capelin (Kenney *et al.* 1985). There is evidence of some territoriality on feeding and calving areas (Clapham 1994; Clapham 1996; Tyack 1981).

c. Listing Status

Humpback whales were originally listed as endangered in 1970 (35 FR 18319; December 2, 1970), and this status remains under the ESA. Humpback whales are also listed as "threatened with extinction," or Appendix I, of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Their International Union for Conservation of Nature and Natural Resources (IUCN) Redlist status is "least concern," or lowest risk of extinction.

Critical habitat has not been designated for humpback whales.

d. Status and Trends

Winn and Reichley (1985) 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. Table 20 provides estimates of historic and current abundance for ocean regions.

North Atlantic. The overall North Atlantic population (including the Gulf of Maine stock), derived from genetic tagging data collected by the Years of the North Atlantic Humpback project on the breeding grounds, was estimated to be 4,894 males (95% CI=3,374-7,123) and 2,804 females (95% CI=1,776-4,463) (Pallsboll *et al*. 1997) where the excess of males is presumed a result of sampling bias. Another estimate of North Atlantic abundance comes from 1992-1993 mark-recapture data, which generated an estimate of 11,570 humpback whales (Stevick *et al*. 2003a). Estimates of animals in Caribbean breeding grounds exceed 2,000 individuals (Balcomb III and Nichols 1982). Several researchers report an increasing trend in abundance for the North Atlantic population, which is supported by increased sightings within the Gulf of Maine feeding aggregation (Barlow and Clapham 1997; Katona and Beard 1990; Smith *et al.* 1999; Waring *et al.* 2001). The rate of increase for this stock varies from 3.2-9.4%, with rates of increase slowing over the past two decades (Barlow and Clapham 1997; Katona and Beard 1990; Stevick *et al.* 2003a). If the North Atlantic population has grown according to the estimated instantaneous rate of increase (r = 0.0311), this would lead to an estimated 18,400 individual whales in 2008 (Stevick *et al*. 2003a).

The Gulf of Maine stock in the North Atlantic is estimated to be 847 animals, with current data suggesting that the stock is steadily increasing in size (NMFS 2008a,b). This is consistent with an estimated average trend of 3.1% (SE=0.005) in the North Atlantic population overall for the period 1979-1993 (Stevick *et al.* 2003a), although there are no feeding-area-specific estimates.

North Pacific. The pre-exploitation population size may have been as many as 15,000 humpback whales, and current estimates are 6,000-8,000 whales (Calambokidis *et al*. 1997; Rice 1978). It is estimated that 15,000 humpback whales resided in the North Pacific in 1905 (Rice 1978). However, from 1905 to 1965, nearly 28,000 humpback whales were taken in whaling operations, reducing the number of all North Pacific humpback whale to roughly 1,000 (Perry *et al*. 1999). Population estimates have risen over time from 1,407-2,100 in the 1980s to 6,010 in 1997 (Baker 1985; Baker and Herman 1987; Calambokidis *et al*. 1997; Darling and Morowitz

1986). Because estimates vary by methodology, they are not directly comparable and it is not clear which of these estimates is more accurate or if the change from 1,407 to 6,010 is the result of a real increase or an artifact of model assumptions. Tentative estimates of the eastern North Pacific stock suggest an increase of 6-7% annually, but fluctuations have included negative growth in the recent past (Angliss and Outlaw 2005). However, based upon surveys between 2004 and 2006, Calambokidis *et al*. (2008) estimated that the current population of humpback whales in the North Pacific consisted of about 18,300 whales, not counting calves. Almost half of these whales likely occur in wintering areas around the Hawaiian Islands.

Southern Hemisphere. The International Whaling Commission (IWC) recently compiled population data on humpback whales in the Southern Hemisphere. Approximately 42,000 Southern Hemisphere humpbacks can be found south of 60° S during the austral summer feeding season (IWC 2007).

Table 20. Summary of past and present humpback whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% C.I.	Current estimate	95% C.I.	Source
Global	--	1,000,000	--	--	--	(Roman and Palumbi 2003)
North Atlantic	Basinwide	240,000	156,000-401,000*	11,570	10,005-13,135*	(Roman and Palumbi 2003) (Stevick *et al*. 2001) *in* (Waring *et al*. 2004)
	Basinwide - Females	--	--	2,804	1,776-4,463	(Palsbøll *et al.* 1997)
	Basinwide - Males	--	--	4,894	3,374-7,123	(Palsbøll *et al*. 1997)
	Western North Atlantic from Davis Strait, Iceland to the West Indies	>4,685*	--	--	--	*circa 1865; (Mitchell and Reeves 1983)
	NMFS - Gulf of Maine stock	--	--	845	CV=0.55	(NMFS 2008)
	NMFS - Gulf of Maine stock, including a portion of Scotian Shelf	--	--	902	177-1,627*	(Clapham *et al*. 2003)
	Northeast Atlantic - Barents and Norwegian Seas	--	--	889	331-1,447*	(Øien 2001) *in (Waring et al.* 2004)
North Pacific	Basinwide	15,000	--	6,000-8,000	--	(Calambokidis *et al.* 1997)
	NMFS - Western North Pacific stock	--	--	394	329-459*	(Angliss and Allen 2007)
	NMFS - Central North Pacific stock	--	--	4,005	3,259-4,751*	(Angliss and Allen 2007)
	NMFS - Eastern North Pacific stock	--	--	1,391	1,331-1,451*	(Carretta *et al*. 2008)
Indian Ocean	Arabian Sea	--	--	56	35-255	Minton *et al*. (2003) *in* (Bannister 2005)
Southern Hemisphere	Basinwide	100,000	--	19,851	--	(Gambell 1976; IWC 1996)
	South of 60°S	--	--	4,660	2,897-6,423	(IWC 1996)

*Note: Confidence Intervals (C.I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).

2. Fin whale, *Balaenoptera physalus*

a. Species Description, Distribution, and Population Structure

The fin whale is the second largest baleen whale and is widely distributed in the world's oceans. Most fin whales in the Northern Hemisphere migrate seasonally from Antarctic feeding areas in the summer to low-latitude breeding and calving grounds in winter. Fin whales tend to avoid tropical and pack-ice waters, with the high-latitude limit of their range set by ice and the lower-latitude limit by warm water of approximately 15° C (Sergeant 1977). Fin whale concentrations generally form along frontal boundaries, or mixing zones between coastal and oceanic waters, which corresponds roughly to the 200 m isobath (the shelf edge) (Nasu 1974).

There are two recognized subspecies of fin whales, *Balaenoptera physalus physalus*, which occurs in the North Atlantic Ocean, and *B. p. quoyi*, which occurs in the Southern Ocean. These subspecies and North Pacific fin whales appear to be organized into separate populations, although there is a lack of consensus in the published literature as to population structure.

North Atlantic. Fin whale stock structure has undergone only a rudimentary framing. In the North Atlantic, fin whales are common off the Atlantic coast of the U.S. in waters immediately off the coast seaward to the continental shelf (about the 1,800 m contour). The IWC recognizes seven management units or "stocks" of fin whales in the Atlantic:

- Nova Scotia,
- Newfoundland-Labrador,
- West Greenland,
- East Greenland-Iceland,
- North Norway,
- West Norway-Faroe Islands, and
- British Isles-Spain-Portugal.

In addition, a genetically distinct population resides year-round in the Ligurian Sea (IWC 2006a). Fin whales occur during the summer from Baffin Bay to near Spitsbergen and the Barents Sea, south to Cape Hatteras in North Carolina and off the coasts of Portugal and Spain (Rice 1998). In areas north of Cape Hatteras, fin whales account for about 46% of the large whales observed in surveys between 1978-1982 (CETAP 1982). Little is known about the winter habitat of fin whales, but in the western North Atlantic, the species has been found from off Newfoundland south to the Gulf of Mexico and Greater Antilles, and in the eastern North Atlantic the winter range extends from the Faroes and Norway south to the Canary Islands. In the Atlantic Ocean, a general migration in the fall from the Labrador and Newfoundland region, south past Bermuda, and into the West Indies has been theorized (Clark 1995).

North Pacific. In the North Pacific, 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.* 1999). Fin whales are sparsely distributed during November-April, from 60°N, south to the northern edge of the tropics, where mating and calving may take place (Mizroch *et al*. 1999). However, fin whales have been sighted as far north as

60°N throughout winter (Mizroch *et al.* 1999). 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 1997; Dohl *et al*. 1983; Forney *et al.* 1995). Peak numbers of fin whales 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.* 1999). 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.* 1968; Shallenberger 1981; Thompson and Friedl 1982). Fin whales in the western Pacific winter in the Sea of Japan, the East China, Yellow, and Philippine seas (Gambell 1985a).

The IWC recognizes two management stocks in the Pacific: 1. East China Sea and 2. the rest of the North Pacific (Donovan 1991), although other authors have structured subpopulations differently (Mizroch *et al*. 1984a). Genetic studies by Bérubé *et al.* (1998) indicate that there are significant genetic differences among fin whales in differing geographic areas (Sea of Cortez, Gulf of St. Lawrence, and Gulf of Maine). Further, individuals in the Sea of Cortez may represent an isolated population from other eastern North Pacific fin whales (Berube *et al*. 2002). Even so, mark-recapture studies also demonstrate that individual fin whales migrate between management units, which suggest that management units are not geographically isolated (Mitchell 1974b; Sigujónsson and Gunnlaugsson 1989). Until further information is available to reduce uncertainties in the fin whale population structure, under the MMPA, NMFS recognizes four stocks, or populations, of fin whales, one in the Atlantic and three in the Pacific: Western North Atlantic, Northeast Pacific (or Alaska stock), California-Oregon-Washington, and the Hawaii stock.

Southern Hemisphere. In the Southern hemisphere, fin whales range from near 40° S (Brazil, Madagascar, western Australia, New Zealand, Colombia, Peru, and Chile) during austral winter southward to Antarctica (Rice 1998). Fin whales in the action area likely would be from the New Zealand stock, which summers from 170º E to 145º W and winters in the Fiji Sea and adjacent waters (Gambell 1985a).

Diving. The amount of time fin whales spend at the surface varies. Some authors have reported that fin whales make 5-20 shallow dives, each of 13-20 s duration, followed by a deep dive of 1.5-15 min (Gambell 1985a; Lafortuna *et al*. 2003; Stone *et al*. 1992). Other authors have reported that the fin whale's most common dives last 2-6 min (Hain *et al*. 1992; Watkins 1981a). The most recent data support average dives of 98 m and 6.3 min for foraging fin whales, while non-foraging dives are 59 m and 4.2 min (Croll *et al*. 2001). However, foraging dives in excess of 150 m are known (Panigada *et al*. 1999). In waters off the U.S. Atlantic Coast, individuals or duos represented about 75% of sightings during the Cetacean and Turtle Assessment Program (Hain *et al*. 1992). Individuals or groups of less than five individuals represented about 90% of the observations. Barlow (2003) reported mean group sizes of 1.1–4.0 during surveys off California, Oregon, and Washington.

Hearing and Vocalization. Fin whales produce a variety of low-frequency sounds in the 10-200 Hz range (Edds 1988; Thompson *et al*. 1992; Watkins 1981a; Watkins *et al*. 1987).

Typical vocalizations are long, patterned pulses of short duration (0.5-2 s) in the 18-35 Hz range, but only males are known to produce these (Croll *et al.* 2002; Patternson and Hamilton 1964). Richardson *et al*. (1995) reported the most common sound as a 1 s 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 14-118 Hz, with a dominant frequency of 20 Hz, tonal vocalizations of 34-150 Hz, and songs of 17-25 Hz (Cummings and Thompson 1994; Edds 1988; Watkins 1981a). Source levels for fin whale vocalizations are 140-200 dB re 1μPa·m (*see also* Clark and Ellison 2004; as compiled by Erbe 2002). The source depth of calling fin whales, has been reported to be about 50 m (Watkins *et al*. 1987).

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).

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

b. Life History

Reproduction. The reproductive biology of fin whales is generally similar across the three stocks. Fin whales in populations near carrying capacity may not attain sexual maturity until 10 years of age or older, whereas those in exploited populations can mature as early as 6 or 7 years of age (Gambell 1985a). Reproductive activities for fin whales occur primarily in the winter. Gestation lasts about 12 months and nursing occurs for 6 to 11 months (Perry *et al.* 1999). The average calving interval in the North Atlantic has been estimated at about 2 years, based on whaling data (Christensen *et al.* 1992a).

Fin whales reach sexual maturity between 5-15 years of age (COSEWIC 2005; Gambell 1985a; Lockyer 1972). Mating and calving occurs primarily from October-January, gestation lasts ~11 months, and nursing occurs for 6-11 months (Boyd *et al*. 1999; Hain *et al*. 1992). The average calving interval in the North Atlantic is estimated at about 2-3 years (Agler *et al.* 1993; Christensen *et al*. 1992a). The location of winter breeding grounds is uncertain but mating is assumed to occur in pelagic mid-latitude waters (Perry *et al*. 1999).

Feeding. Fin whales in the North Atlantic eat pelagic crustaceans (mainly krill and schooling fish such as capelin, herring, and sand lance (Borobia and Béland 1995; Christensen *et al*. 1992a; Hjort and Ruud 1929; Ingebrigtsen 1929; Jonsgård 1966; Mitchell 1974b; Overholtz and Nicolas 1979; Sergeant 1977; Shirihai 2002; Watkins *et al*. 1984). In the North Pacific, fin whales also prefer euphausiids and large copepods, followed by schooling fish such as herring, walleye Pollock, and capelin (Kawamura 1982a, 1982b; Ladrón De Guevara *et al.* 2008; Nemoto 1970; Paloma *et al.* 2008). Fin whales frequently forage along cold eastern boundaries of currents (Perry *et al*. 1999). Antarctic fin whales feed on krill, *Euphausia superba*, which occurs in dense near-surface schools (Nemoto 1959). However, off the coast of Chile, fin whales are

known to feed on the euphausiid *E. mucronata* (Antezana 1970; Perez *et al*. 2006). Feeding may occur in waters as shallow as 10 m when prey are at the surface, but most foraging is observed in high-productivity, upwelling, or thermal front marine waters (Gaskin 1972; Nature Conservancy Council 1979).

c. Listing Status

Fin whales were originally listed as endangered in 1970 (35 FR 18319; December 2, 1970), and this status continues since the inception of the ESA in 1973. Fin whales are also listed as "threatened with extinction," or Appendix I, of the CITES. Their IUCN Redlist status is "endangered," or very high risk of extinction.

NMFS has not designated critical habitat for fin whales.

d. Status and Trends

Although fin whale population structure remains unclear, various abundance estimates are available (Table 21). Pre-exploitation fin whale abundance is estimated at 464,000 individuals worldwide; the estimate for 1991 was roughly 25% of this (Braham 1991). Historically, worldwide populations were severely depleted by commercial whaling, with more than 700,000 whales harvested in the twentieth century (Cherfas 1989). Aguilar and Lockyer (1987) suggested annual natural mortality rates in northeast Atlantic fin whales may range from 0.04 to 0.06. Fin whales live 70-80 years (Kjeld *et al*. 2006).

Table 21. Summary of past and present fin whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% C.I.	Current estimate	95% C.I.	Source
Global	--	>464,000	--	119,000	--	(Braham 1991)
North Atlantic						
	Basinwide	30,000-50,000	--	--	--	(Sergeant 1977)
		360,000	249,000-481,000	--	--	(Roman and Palumbi 2003)
	Central and Northeastern Atlantic	--	--	30,000	23,000-39,000	(IWC 2007)
	Western North Atlantic	--	--	3,590-6,300	--	(Braham 1991)
	NMFS - Western North Atlantic stock	--	--	2,269	CV=0.37	(NMFS 2008)
	Northeastern U.S. Atlantic Continental Shelf	--	--	2,200-5,000	--	(Hain *et al*. 1992; Waring *et al*. 2000)
	IWC - Newfoundland-Labrador stock	--	--	13,253	0-50,139*	(IWC 1992)
	IWC - British Isles-Spain and Portugal stock	10,500	9,600-11,400	4,485	3,369-5,600	(Braham 1991)
				17,355	10,400-28,900	(Buckland *et al*. 1992)
	IWC - North Norway stock	--	--	--	--	--
	IWC - East Greenland-Iceland stock	--	--	11,563	5,648-17,478*	(Gunnlaugsson and Sigurjónsson 1990)
	IWC - West Greenland stock	--	--	1,700	840-3,500	(IWC 2006a)
North Pacific	Basinwide	42,000-45,000	--	16,625	14,620-18,630	(Braham 1991; Ohsumi and Wada 1974)
	Central Bering Sea	--	--	4,951	2,833-8,653	(Moore *et al*. 2002)
	NMFS - Northeast Pacific stock, west of Kenai Peninsula	--	--	5,700	--	(Angliss and Allen 2007)
	NMFS - California/Oregon/ Washington stock	--	--	2,636	CV=0.15	(Carretta *et al*. 2008)
	NMFS - Hawaii stock	--	--	174	0-420*	(Carretta *et al*. 2008)
Southern Hemisphere	Basinwide	400,000	--	85,200	--	(Braham 1991; IWC 1979)
	South of 60°S	--	--	1,735	514-2,956	(IWC 1996)
	South of 30°S	--	--	15,178	--	(IWC 1996)
	Scotia Sea and Antarctic Peninsula	--	--	4,672	792-8,552*	(Hedley *et al*. 2001; Reilly *et al*. 2004)

*Note: Confidence Intervals (C.I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).

North Atlantic. Sigurjónsson (1995) estimated that between 50,000 and 100,000 fin whales once populated the North Atlantic, although he provided no data or evidence to support that estimate. However, over 48,000 fin whales were caught between 1860- 1970 (Braham 1991). Although protected by the IWC, from 1988-1995 there have been 239 fin whales taken from the North Atlantic. Recently, Iceland resumed whaling of fin whales despite the 1985 moratorium imposed by the IWC. The western Mediterranean fin whale population is estimated at 3,583 individuals (95% CI = 2,130- 6,027; Forcada *et al*. 1996).

North Pacific. The status and trend of fin whale populations in the North Pacific is largely unknown. Over 26,000 fin whales were harvested between 1914-1975 (Braham 1991). NMFS estimates roughly 3,000 individuals occur off California, Oregon, and Washington based on ship surveys in summer/autumn of 1996, 2001, and 2005, of which estimates of 283 and 380 have been made for Oregon and Washington alone (Barlow 2003; Barlow and Taylor 2001; Forney 2007). Barlow (2003) noted densities of up to 0.0012 individuals/km^2 off Oregon and Washington and up to 0.004 individuals/km^2 off California.

Southern Hemisphere. The Southern Hemisphere population was one of the most heavily exploited whale populations under commercial whaling. From 1904 to 1975, over 700,000 fin whales were taken in Antarctic whaling operations (IWC 1990). Harvests increased substantially upon the introduction of factory whaling ships in 1925, with an average of 25,000 caught annually from 1953-1961 (Perry *et al*. 1999). Current estimates are a tiny fraction of former abundance.

3. Sei whale, *Balaenoptera borealis*

a. Species Description, Distribution, and Population Structure

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*. 1999). 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.* 2004). 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*. 1999). When on feeding grounds, larger groupings have been observed (Gambell 1985b).

North Atlantic. The population structure of sei whales remains unknown and populations herein follow IWC recommendations. In the North Atlantic, the IWC groups sei whales into three stocks for management purposes: the Nova Scotia, Iceland-Denmark Strait, and Northeast Atlantic stocks, noting that identification of sei whale population structure is difficult and remains a major research problem (Donovan 1991; Perry *et al*. 1999). The official IWC boundaries of the Nova Scotia stock extend from the U.S. East Coast to Cape Breton, Nova Scotia, and from there east to longitude 42° W (Waring *et al*. 2004). In the western North Atlantic, a major portion of the sei whale population occurs in northern waters, potentially including the Scotian Shelf, along Labrador and Nova Scotia, south into the U.S. EEZ, including the Gulf of Maine and Georges Bank (Mitchell and Chapman 1977; Waring *et al*. 2004). These whales summer in northern areas before migrating south to waters along Florida, in the Gulf of Mexico, and the northern Caribbean Sea (Gambell 1985b; Mead 1977). Sei whales may range as far south as North Carolina. In the U.S. EEZ, the greatest abundance occurs during spring, with most sightings on the eastern edge of Georges Bank, in the Northeast Channel, and along the southwestern edge of Georges Bank in Hydrographer Canyon (CETAP 1982). In 1999, 2000, and 2001, NMFS aerial surveys found sei whales concentrated along the northern edge of Georges Bank during spring (Waring *et al.* 2004). Surveys in 2001 found sei whales south of

Nantucket along the continental shelf edge (Waring *et al.* 2004). During years of greater prey abundance (e.g., copepods), sei whales are found in more inshore waters, such as the Great South Channel (in 1987 and 1989), Stellwagen Bank (in 1986), and the Gulf of Maine (Payne *et al*. 1990; Schilling *et al*. 1992). In the eastern Atlantic, sei whales occur in the Norwegian Sea, occasionally occurring as far north as Spitsbergen Island, and migrate south to Spain, Portugal, and northwest Africa (Gambell 1985b; Jonsgård and Darling 1977).

North Pacific. In the North Pacific, the IWC groups all sei whales into one management stock (Donovan 1991). However, some mark-recapture, catch distribution, and morphological research indicate more than one population may exist – one between 155°-175° W, and another east of 155° W (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 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). 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°N (Gregr *et al*. 2000). Masaki (1977) reported sei whales concentrating in the northern and western Bering Sea from July-September, although other researchers question these observations because no other surveys have reported sei whales in the northern and western Bering Sea. Horwood (1987) evaluated Japanese sighting data and concluded that sei whales rarely occur in the Bering Sea. Horwood (1987) reported that 75-85% of the North Pacific population resides east of 180°. During winter, sei whales are found from 20°-23° N (Gambell 1985b; Masaki 1977). 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).

Southern Hemisphere. In the Southern hemisphere, sei whales occur throughout the Southern Ocean during the austral summer, generally between 40°-50° S (Gambell 1985b). During the austral winter, sei whales occur off Brazil and the western and eastern coasts of southern Africa and Australia. However, sei whales generally do not occur north of 30º S in the Southern Hemisphere and no records exist for the action area (Reeves *et al*. 1999). However, confirmed sighting records exist for Papua New Guinea and New Caledonia, with unconfirmed sightings in the Cook Islands. A sei whale stranded in New Caledonia during May of 1962 (Borsa 2006).

In the Southern Hemisphere, the IWC has divided the Southern Ocean into six baleen whale feeding areas – designated at 60° S latitude and longitude as:

- 60°-120° W (Area I),
- 0°-60° W (Area II),
- 0° to 70° E (Area III),
- 70°-130° E (Area IV),
- 130°-170° W (Area V), and
- 170°-120°W (Area VI).

There is little information on the population structure of sei whales in the Antarctic, although some degree of isolation appears to exist between IWC Areas I-VI (Donovan 1991; IWC 1980a).

Insufficient information exists to validate these management stock designations. However, links between some regions were found using tag data. For example, between the Brazilian coast and the western half of Area II, the Natal Coast of South Africa with the eastern half of Area III and the western half of Area IV, and western and southeastern Australia with Area IV (Perry *et al*. 1999). This information suggests that sei whale stocks are dynamic and that individuals are immigrating and emigrating between stocks. Consequently, until further information is available to suggest otherwise, we consider sei whales as forming "open" populations that are connected through the movement of individuals.

Hearing and Vocalization. Data on sei whale vocal behavior is limited, but includes records off the Antarctic Peninsula of broadband sounds in the 100-600 Hz range with 1.5 s duration and tonal and upsweep calls in the 200-600 Hz range of 1-3 s durations (McDonald *et al*. 2005). Differences may exist in vocalizations between ocean basins (Rankin and Barlow 2007). Vocalizations from the North Atlantic consisted of paired sequences (0.5-0.8 sec, separated by 0.4-1.0 sec) of 10-20 short (4 mess) FM sweeps between 1.5-3.5 kHz (Thomson and Richardson 1995).

b. Life History

Reproduction. Reproductive activities for sei whales occur primarily in winter. Gestation is about 12.7 months, calves are weaned at 6-9 months, and the calving interval is about 2-3 years (Gambell 1985b; Rice 1977). Sei whales become sexually mature at about age 10 (Rice 1977).

Feeding. Sei whales are primarily planktivorous, feeding mainly on euphausiids and copepods, although they are also known to consume fish (Waring *et al*. 2006). In the Northern Hemisphere, sei whales consume small schooling fish such as anchovies, sardines, and mackerel when locally abundant (Mizroch *et al.* 1984b; Rice 1977). Sei whales in the North Pacific feed on euphausiids and copepods, which make up about 95% of their diets (Calkins 1986) and sei whales appear to prefer feeding along the cold eastern currents (Perry *et al*. 1999). The dominant food for sei whales off California during June-August is northern anchovy, while in September-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, pollack, 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.

c. Listing Status

The sei whale was originally listed as endangered in 1970 (35 FR 18319; December 2, 1970), and this status remained since the inception of the ESA in 1973. Sei whales are also listed as

"threatened with extinction," or Appendix I, of the CITES. Their IUCN Redlist status is "endangered," or very high risk of extinction.

Critical habitat has not been designated for sei whales.

d. Status and Trends

Table 22 provides estimates of historic and current abundance for ocean regions.

North Atlantic. No information on sei whale abundance exists prior to commercial whaling (Perry *et al*. 1999). Between 1966 and 1972, whalers from land stations on the east coast of Nova Scotia engaged in extensive hunts of sei whales on the Nova Scotia shelf, killing about 825 sei whales (Mitchell and Chapman 1977). In 1974, the North Atlantic population was estimated to number about 2,078 individuals, including 965 whales in the Labrador Sea group and 870 whales in the Nova Scotia group (Mitchell and Chapman 1977). In the northwest Atlantic, Mitchell and Chapman (1977) estimated the Nova Scotia stock to contain between 1,393-2,248 whales; and an aerial survey program conducted from 1978 to 1982 on the continental shelf and edge between Cape Hatteras, North Carolina, and Nova Scotia generated an estimate of 280 sei whales (CETAP 1982). These two estimates are more than 20 years out of date and likely do not reflect the current true abundance; in addition, the Cetacean and Turtle Assessment Program estimate has a high degree of uncertainty and is considered statistically unreliable (Perry *et al*. 1999; Waring *et al*. 2004; Waring *et al*. 1999). The total number of sei whales in the U.S. Atlantic EEZ remains unknown (Waring *et al*. 2006). Rice (1977) estimated total annual mortality for adult females as 0.088 and adult males as 0.103.

North Pacific. Ohsumi and Fukuda (1975) estimated that sei whales in the north Pacific numbered about 49,000 whales in 1963, had been reduced to 37,000-38,000 whales by 1967, and reduced again to 20,600-23,700 whales by 1973. From 1910-1975, approximately 74,215 sei whales were caught in the entire North Pacific Ocean (Horwood 1987; Perry *et al*. 1999). From the early 1900s, Japanese whaling operations consisted of a large proportion of sei whales: 300-600 sei whales were killed per year from 1911-1955. 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 1968-1969, after which the sei whale population declined rapidly (Mizroch *et al*. 1984b). When commercial whaling for sei whales ended in 1974, the population in the North Pacific had been reduced to 7,260-12,620 animals (Tillman 1977). There have been no direct estimates of sei whale populations for the eastern Pacific Ocean (or the entire Pacific). Between 1991-2001, during aerial surveys, there were two confirmed sightings of sei whales along the U.S. Pacific coast. The minimum population estimate based on transect surveys of 300 nautical miles between 1996-2001 was 35, although the actual population along the U.S. Pacific coast was estimated to be 56 (Carretta *et al.* 2006).

Table 22. Summary of past and present sei whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% C.I.	Current estimate	95% C.I.	Source
Global	--	>105,000	--	25,000	--	(Braham 1991)
North Atlantic	Basinwide	--	--	>4000	--	(Braham 1991)
	NMFS - Nova Scotia stock	--	--	207	--	(NMFS 2008a,b)
	IWC - Iceland-Denmark stock	--	--	1,290	0-2,815*	(Cattanach *et al*. 1993)
	IWC - Iceland-Denmark stock	--	--	1,590	343-2,837*	(Cattanach *et al*. 1993)
North Pacific	Basinwide	42,000	--	7,260-12,620*	--	(Tillman 1977); *circa 1974
	NMFS - eastern North Pacific stock	--	--	46	CV=0.61	(Carretta *et al*. 2008)
	NMFS - Hawaii stock	--	--	77	0-237*	(Carretta *et al*. 2008)
Southern Hemisphere	Basinwide	63,100	--	--	--	(Mizroch *et al*. 1984b)
	Basinwide	65,000	--	--	--	(Braham 1991)
	South of 60°S	--	--	626	553-699	(IWC 1996)
	South of 30°S	--	--	9,718	--	(IWC 1996)

*Note: Confidence Intervals (C.I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).

4. Blue whale, *Balaenoptera musculus*

a. Species Description, Distribution, and Population Structure

Blue whales are the world's largest animal, and they occur primarily in the open ocean from tropical to polar waters worldwide. Blue whales are highly mobile, and their migratory patterns are not well known (Perry *et al*. 1999; Reeves *et al*. 2004). Blue whales migrate toward the warmer waters of the subtropics in fall to reduce energy costs, avoid ice entrapment, and reproduce (NMFS 1998). Blue whales typically occur alone or in groups of up to five animals, although larger foraging aggregations of up to 50 have been reported including aggregations mixed with other rorquals such as fin whales (Corkeron *et al*. 1999; Shirihai 2002).

Several blue whale subspecies have been characterized from morphological and geographical variability, but the validity of blue whale subspecies designations remains uncertain (McDonald *et al*. 2006). The largest, the Antarctic or true blue whale (*Balaenoptera musculus intermedia*), occurs in the highest Southern Hemisphere latitudes. During austral summers, "true" blue whales occur close to Antarctic ice. A slightly smaller blue whale, *B. musculus musculus*, inhabits the Northern Hemisphere. The pygmy blue whale (B. *musculus brevicauda*), may be geographically distinct from *B. m. musculus* (Kato *et al*. 1995). Pygmy blue whales occur north of the Antarctic Convergence (60°-80° E and 66°-70° S), while true blue whales are south of the Convergence (58° S) in the austral summer (Kasamatsu *et al*. 1996; Kato *et al*. 1995). A fourth subspecies, *B. musculus indica*, may exist in the northern Indian Ocean (McDonald *et al*. 2006).

Little is known about population and stock structure[9] of blue whales. Studies suggest a wide range of alternative population and stock scenarios based on movement, feeding, and acoustic data. Some suggest that as many as 10 global stocks, while others suggest that the species is composed of a single panmictic stock (Gambell 1979; Reeves *et al*. 1998). For management purposes, the IWC considers all Pacific blue whales as a single stock, whereas under the MMPA, the NMFS recognizes four stocks of blue whales: western North Pacific Ocean, eastern North Pacific Ocean, Northern Indian Ocean, and Southern Hemisphere.

Until recently, blue whale stock structure had not been tested using molecular or nuclear genetic analyses (Reeves *et al*. 1998). A recent study by Conway (2005) suggested that the global population could be divided into four major subdivisions, which roughly correspond to major ocean basins: eastern North and tropical Pacific Ocean, Southern Indian Ocean, Southern Ocean, and western North Atlantic Ocean. The eastern North/tropical Pacific Ocean subpopulation includes California, western Mexico, western Costa Rica, and Ecuador, and the western North Atlantic Ocean subpopulation (Conway 2005).

Blue whales are found from the Arctic to at least mid-latitude waters, and typically inhabit the open ocean with occasional occurrences in the U.S. EEZ (Gagnon and Clark 1993; Wenzel *et al*. 1988; Yochem and Leatherwood 1985). Yochem and Leatherwood (1985) summarized records suggesting winter range extends south to Florida and the Gulf of Mexico. The U.S. Navy's Sound Surveillance System acoustic system has detected blue whales in much of the North Atlantic, including subtropical waters north of the West Indies and deep waters east of the U.S. Atlantic EEZ (Clark 1995). Blue whales are rare in the shelf waters of the eastern U.S. In the western North Atlantic, blue whales are most frequently sighted from the Gulf of St. Lawrence and eastern Nova Scotia and in waters off Newfoundland, during the winter (Sears *et al*. 1987). In the eastern North Atlantic, blue whales have been observed off the Azores, although Reiner *et al.* (1993) did not consider them common in that area.

North Pacific. Blue whales occur widely throughout the North Pacific. Acoustic monitoring has recorded blue whales off Oahu and the Midway Islands, although sightings or strandings in Hawaiian waters have not been reported (Barlow *et al.* 1997; Northrop *et al*. 1971; Thompson and Friedl 1982). Nishiwaki (1966) notes blue whale occurrence among the Aleutian Islands and in the Gulf of Alaska, but no one has sighted a blue whale in Alaska for some time, despite several surveys (Carretta *et al*. 2005; Forney and Brownell Jr. 1996; Leatherwood *et al*. 1982; Stewart *et al*. 1987).

Blue whales are thought to summer in high latitudes and move into the subtropics and tropics during the winter (Yochem and Leatherwood 1985). Minimal data suggest whales in the western region of the North Pacific may summer southwest of Kamchatka, south of the Aleutians, and in

[9] "Populations" herein are a group of individual organisms that live in a given area and share a common genetic heritage. While genetic exchange may occur with neighbouring populations, the rate of exchange is greater between individuals of the same population than among populations---a population is driven more by internal dynamics, birth and death processes, than by immigration or emigration of individuals. To differentiate populations, NMFS considers geographic distribution and spatial separation, life history, behavioral and morphological traits, as well as genetic differentiation, where it has been examined. In many cases, the behavioral and morphological differences may evolve and be detected before genetic variation occurs. In some cases, the term "stock" is synonymous with this definition of "population" while other usages of "stock" are not.

the Gulf of Alaska, and winter in the lower latitudes of the western Pacific (Sea of Japan, the East China, Yellow, and Philippine seas) and less frequently in the central Pacific, including Hawaii (Carretta *et al*. 2005; Stafford 2003; Stafford *et al*. 2001; Watkins *et al*. 2000). However, acoustic recordings made off Oahu showed bimodal peaks of blue whales, suggesting migration into the area during summer and winter (McDonald and Fox 1999; Thompson and Friedl 1982). In the eastern North Pacific, blue whales appear to summer off California and occasionally as far north as British Columbia, migrating south to productive areas off Mexico and as far south as the Costa Rica Dome (10° N) from June through November (Calambokidis *et al*. 1998; Calambokidis *et al*. 1990; Chandler and Calambokidis 2004; Mate *et al*. 1999; Reilly and Thayer 1990; Stafford *et al*. 1999; Wade and Friedrichsen 1979; Wade and Gerrodette 1993). However, some data indicate that some individuals may remain here year-round (Reilly and Thayer 1990; Wade and Friedrichsen 1979). The Costa Rican Dome's productivity may allow blue whales to feed during their winter calving/breeding season and not fast (Mate *et al.* 1999). A blue whale tagged off Vancouver Island in 1963 was recovered a year later in just south of Kodiak Island, supporting the idea that blue whales taken off British Columbia were en route to and from feeding areas in the Gulf of Alaska (COSEWIC 2002). One blue whale was photo-identified off the Queen Charlotte Islands in British Columbia and resighted off the Santa Barbara Channel in California, representing the first match between California and waters further north (COSEWIC 2002).

Blue whales off southern California appear to feed on dense euphausiid schools between 100-200 m below the surface (Croll *et al.* 1998; Fiedler *et al*. 1998). These concentrations of krill are associated with upwelling regions near steep topography off the continental shelf break (Croll *et al.* 1999). Blue whale migrations to and from California probably reflect seasonal patterns and productivity (Croll *et al*. 2005). Blue whales also feed in cool, offshore, upwelling-modified waters in the eastern tropical and equatorial Pacific (Palacios 1999; Reilly and Thayer 1990). Feeding areas may be associated with a greater incidence of blue whale vocalizations (Moore *et al.* 2002). During summer, blue whales calls in water of the Northwest Pacific were closely associated with cold water and sharp sea surface temperature gradients or fronts, probably corresponding to zooplankton concentrations. From fall through spring, call locations were concentrated primarily near seamounts (Moore *et al.* 2002).

Blue whale sightings have occurred in the Gulf of Aden, Persian Gulf, Arabian Sea, and across the Bay of Bengal to Burma and the Strait of Malacca (Clapham *et al*. 1999; Mikhalev 1997; Mizroch *et al*. 1984b).

Southern Hemisphere. In the Southern hemisphere, blue whales range from the edge of the Antarctic pack ice (40°-78°S) during the austral summer north to Ecuador, Brazil, South Africa, Australia, and New Zealand during the austral winter (Shirihai 2002). Blue whales are occasionally sighted in pelagic waters off the western coast of Costa Rica and Nicaragua, near the Galápagos Islands, and along the coasts of Ecuador and northern Peru (Aguayo 1974; Donovan 1984; LGL Ltd. 2007; Mate *et al*. 1999; Palacios 1999; Reilly and Thayer 1990). Although, recent analyses of vocalizations and photographs have linked blue whales found in the Costa Rica Dome to the North Pacific population (Chandler and Calambokidis 2004).

The IWC has designated Southern Hemisphere stock areas for management purposes based upon feeding areas. However, the overall population structure is unknown (Sears 2002).

Diving. Blue whales spend greater than 94% of their time underwater (Lagerquist *et al*. 2000). Generally, blue whales dive 5-20 times at 12-20 sec intervals before a deep dive of 3-30 min (Croll *et al*. 1999; Leatherwood *et al*. 1976; Mackintosh 1965; Maser *et al*. 1981; Strong 1990; Yochem and Leatherwood 1985). Average foraging dives are 140 m deep and last for 7.8 min (Croll *et al*. 2001). Non-foraging dives are shallower and shorter, averaging 68 m and 4.9 min (Croll *et al*. 2001). However, dives of up to 300 m are known (Calambokidis *et al*. 2003). Nighttime dives are generally shallower (50 m).

Hearing and Vocalization. Blue whales produce prolonged low-frequency vocalizations that include moans in the range from 12.5-400 Hz, with dominant frequencies from 16-25 Hz, and songs that span frequencies from 16-60 Hz that last up to 36 sec repeated every 1 to 2 min (see McDonald *et al*. 1995). Berchok *et al*. (2006) examined vocalizations of St. Lawrence blue whales and found mean peak frequencies ranging from 17.0-78.7 Hz. Reported source levels are 180-188 dB re 1μPa, but may reach 195 dB re 1μPa (Aburto *et al*. 1997; Clark and Ellison 2004; Ketten 1998; McDonald *et al*. 2001).

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 30-90 Hz calls are associated with socialization and may be displays by males based upon call seasonality and structure. Blue whale calls appear to vary between western and eastern North Pacific regions, suggesting possible structuring in populations (Rivers 1997; Stafford *et al*. 2001).

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*. 1995).

b. Life History

Blue whales may reach 70–80 years of age (COSEWIC 2002; Yochem and Leatherwood 1985). The age distribution of blue whales is currently unknown.

Reproduction. Blue whale reproductive activities occur primarily in winter (see Yochem and Leatherwood 1985). Gestation takes 10-12 months, followed by a 6-7 month nursing period. Sexual maturity occurs at 5-15 years of age and calves are born at 2-3 year intervals (COSEWIC 2002; NMFS 1998; Yochem and Leatherwood 1985).

Feeding. 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

(Fiedler *et al*. 1998; Schoenherr 1991).

Data indicate that some summer feeding takes place at low latitudes in upwelling-modified waters, and that some whales remain year-round at either low or high latitudes (Clarke and Charif 1998; Hucke-Gaete *et al*. 2004; Reilly and Thayer 1990; Yochem and Leatherwood 1985). One population feeds in California waters from June to November and migrates south in winter/spring (Calambokidis *et al.* 1990; Mate *et al*. 1999). Prey availability likely dictates blue whale distribution for most of the year (Burtenshaw *et al.* 2004; Clapham *et al.* 1999; Sears 2002). The large size of blue whales requires higher energy requirements than smaller whales and potentially prohibits fasting Mate *et al*. (1999). Krill are the primary prey of blue whales in the North Pacific (Kawamura 1980; Yochem and Leatherwood 1985).

c. Listing Status

Blue whales (including all subspecies) were originally listed as endangered in 1970 (35 FR 18319; December 2, 1970), and this status continues since the inception of the ESA in 1973. Blue whales are also listed as "threatened with extinction," or Appendix I, of the CITES. Their IUCN Redlist status is "endangered," or very high risk of extinction.

Critical habitat has not been designated for blue whales.

d. Status and Trends

Table 23 contains historic and current estimates of blue whales by region. Globally, blue whale abundance has been estimated at between 5,000-13,000 animals (COSEWIC 2002; Yochem and Leatherwood 1985); a fraction of the 200,000 or more that are estimated to have populated the oceans prior to whaling (Maser *et al*. 1981; U.S. Department of Commerce 1983).

North Atlantic. Commercial hunting had a severe effect on blue whales, such that they remain rare in some formerly important habitats, notably in the northern and northeastern North Atlantic (Sigurjónsson and Gunnlaugsson 1990). Sigurjónsson and Gunnlaugsson (1990) estimated that at least 11,000 blue whales were harvested from all whaling areas from the late nineteenth to mid-twentieth centuries. The actual size of the blue whale population in the north Atlantic is uncertain, but estimates range from a few hundred individuals to about 2,000 (Allen 1970; Mitchell 1974a; Sigurjónsson 1995; Sigurjónsson and Gunnlaugsson 1990). Current trends are unknown, although an increasing annual trend of 4.9% annually was reported for 1969–1988 off western and southwestern Iceland (Sigurjónsson and Gunnlaugsson 1990).

Sigurjónsson and Gunnlaugsson (1990) concluded that the blue whale population had been increasing since the late 1950s.

Table 23. Summary of past and present blue whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% C.I.	Current estimate	95% C.I.	Source
Global	--	200,000	--	11,200-13,000	--	(U.S. DOC 1983; Maser *et al*. 1981)
				5,000-12,000		(COSEWIC 2002)
North Atlantic	Basinwide	1,100-1,500	--	100-555	--	(Braham 1991; Gambell 1976)
	NMFS - Western North Atlantic stock	--	--	308	--	(Sears *et al*. 1987)
North Pacific	Basinwide	4,900	--	1,400-1,900	--	(Gambell 1976)
				3,300	--	(Wade and Gerrodette 1993) and (Barlow 1997) as combined in (Perry *et al*. 1999)
	Eastern Tropical Pacific	--	--	1,415	1,078-2,501	(Wade and Gerrodette 1993)
	EEZ of Costa Rica	--	--	48	22-102*	(Gerrodette and Palacios 1996)
	EEZs of Central America north of Costa Rica	--	--	94	34-257*	(Gerrodette and Palacios 1996)
	Eastern North Pacific	--	--	2,997	2,175-3,819*	(Calambokidis and Barlow 2004)
	NMFS - western North Pacific stock	--	--	n/a	--	(Carretta *et al*. 2006)
	NMFS - eastern North Pacific stock	--	--	1,368	CV=0.22	(Carretta *et al*. 2008)
Southern Hemisphere	Basinwide	150,000-210,000	--	5,000-6,000	--	(Gambell 1976; Yochem and Leatherwood 1985)
		300,000	--	--	--	(COSEWIC 2002)
		--	--	400-1,400	400-1,400	IWC, for years 1980-2000
		--	--	1,700	860-2,900	(IWC 2005b), point estimate for 1996
	Within IWC survey areas	--	--	1,255	--	(IWC 1996)
	Pygmy blue whale population	10,000	--	5,000	--	(Gambell 1976)
		13,000	--	6,500	--	(Zemsky and Sazhinov 1982)

*Note: Confidence Intervals (C.I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).

North Pacific. Estimates of blue whale abundance are uncertain. Prior to whaling, Gambell (1976) reported there may have been as many as 4,900 blue whales. Blue whales were also hunted in the Pacific Ocean, where approximately 5,761 killed from 1889–1965 (Perry *et al.* 1999). The IWC banned commercial whaling in the North Pacific in 1966, although Soviet whaling continued after the ban. In the eastern North Pacific, the minimum population is thought to be 1,384 whales, but no minimum population has been established (Carretta *et al.* 2006). Although blue whale abundance has likely increased since its protection in 1966, the possibility of unauthorized harvest by Soviet whaling vessel, incidental ship strikes, and gillnet mortalities make this uncertain.

Calambokidis and Barlow (2004) estimated roughly 3,000 blue whales inhabit waters off California, Oregon, and Washington based on line-transect surveys and 2,000 based on capture-

recapture methods. Carretta *et al*. (2006) noted that the best estimate of abundance off of California, Oregon, and Washington is an average of line-transect and capture-recapture estimates (1,744). Barlow (2003) reported mean group sizes of 1.0–1.9 during surveys off California, Oregon, and Washington. A density estimate of 0.0003 individuals/km^2 was given for waters off Oregon/Washington, and densities off California ranged from 0.001-0.0033 individuals/km^2 (Barlow 2003).

Southern Hemisphere. Estimates of 4-5% for an average rate of population growth have been proposed (Yochem and Leatherwood 1985). However, a recent estimate of population growth for all blue whales throughout the Antarctic was 8.2% (Branch *et al*. 2007). Branch *et al.* (2007) also included an estimate of 2,280 individuals south of 60º. Stocks remain severely depleted with the 1996 estimate only 0.7% of pre-whaling levels (IWC 2005a).

5. North Atlantic right whale, *Eubalaena glacialis*

a. Species Description, Distribution, and Population Structure

The North Atlantic right whale is a large baleen whale that grows to between 45 and 55 feet in length and can weigh up to 70 tons. Females tend to be larger than males. Right whales are generally black and stocky-bodied, lack a dorsal fin, and have large heads (about 1/4 of the body length) with strongly-bowed lower lips. Callosities, or pale, rough patches of skin frequently serve to differentiate individuals. Two rows of long, dark baleen plates hang from the upper jaw, with about 225 plates on each side. The tail is broad, deeply notched, and all black with a smooth trailing edge.

Right whales (Eubalaena spp.) occur in sub-polar to temperate waters in all major ocean basins of the world, with a clear migratory pattern of high latitudes in the warmer seasons and lower latitudes in the winter seasons (Cummings 1985; Perry *et al*. 1999; Rice 1998). The historical range of North Atlantic right whales extended as far south as Florida and northwestern Africa, and as far north as Labrador, southern Greenland, Iceland, and Norway (Cummings 1985; Reeves *et al*. 1978; Rice 1998). Most sightings in the western North Atlantic are concentrated within five primary habitats or high-use areas: coastal waters off the southeastern United States (SEUS), Cape Cod (CCB) and Massachusetts Bays, the Great South Channel (GSC), the Bay of Fundy, and the Nova Scotian Shelf (Winn *et al*. 1986). In 1994, the SEUS, GSC, and CCB were designated North Atlantic right whale critical habitat.

Genetic studies have revealed similar origins of eastern and western North Atlantic right whales and have shown little genetic variability as compared to their South Atlantic counterparts. The IWC had provisionally divided North Atlantic right whales into an eastern and western "stock." However, preliminary results from DNA analysis suggest that the eastern and western populations were not genetically distinct (Rosenbaum *et al*. 2000). Even so, the extirpation of the eastern stock and its lack of recovery in the last hundred years strongly suggest population subdivision over a protracted time scale. North Atlantic right whales exhibit less genetic variability than South Atlantic right whales, which, in conjunction with behavioral and population data, suggests that North Atlantic right whales may be suffering from reduced fertility, fecundity, and juvenile survivorship (Malik *et. al* 2000; Schaeff *et al*. 1997).

Right whales have been observed from the mid-Atlantic Bight northward through the Gulf of Maine during all months of the year. Individuals of the western North Atlantic right whale population range from wintering and calving grounds in coastal waters of the SEUS to summer feeding and nursery grounds in New England waters and northward to the Bay of Fundy, the Scotian Shelf, and the Gulf of St. Lawrence (Waring *et. al* 2007). In New England, peak abundance of right whales in feeding areas occurs in CCB beginning in late winter. In early spring (May), peak right whale abundance occurs in Wilkinson Basin to the GSC (Kenney *et al*. 1995). In late June and July, right whale distribution gradually shifts to the northern edge of Georges Bank. In late summer (August) and fall, much of the population is found in waters of the Bay of Fundy and around Roseway Basin (Kenney *et al*. 1995; Kenney *et al*. 2001; Winn *et al*. 1986). Variation in the abundance and development of suitable food patches appears to modify the general patterns of movement by reducing peak numbers, stay durations and specific locales (Brown *et al*. 2001; Kenney 2001). In particular, large changes in the typical pattern of food abundance will dramatically change the general pattern of right whale habitat use (Kenny 2001).

During spring, summer and fall, North Atlantic right whales that habituate New England waters occur in dense zooplankton areas - a main characteristic of these waters at that time (Kenney *et al*. 1986, 1995). Modeling suggests an early to mid-March departure to these northern waters from southeastern wintering grounds near Jacksonville, Florida, with a 30-day departure range where mother-calf pairs leave several days behind those without calves (Firestone *et. al* 2008). North Atlantic right whales typically aggregate in CCB during the late winter and early spring (Mayo and Marx 1990). The known concentrations of right whales generally occur in New England's copepod-rich waters in spring and early summers with peak abundance in the GSC (MacAulay *et al*. 1995; Wishner *et al*. 1995) along the 100 m isobath. In summer and fall, known concentrations occur farther north into the Bay of Fundy and Browns and Bacarro Banks, Canada. Approximately 33 percent of the females with calves use summer feeding grounds other than the Bay of Fundy (Waring *et al.* 2007). Seasonal sighting peaks in New England waters are summer for mother-calf pairs and October-December for all age classes (Weinrich *et al.* 2000).

The location of most of the western population is unknown during the winter. Offshore (greater than 30 miles) surveys flown off the coast of northeastern Florida and southeastern Georgia from 1996 to 2001 had three sightings in 1996, one in 1997, 13 in 1998, six in 1999, 11 in 2000, and six in 2001 (within each year, some were repeat sightings of previously recorded individuals). Although there are pregnant females, non-pregnant females and some juveniles congregate on the calving grounds off the Georgia and Florida coasts from November/December to March/April. It has been shown that the warm Gulf Stream waters, generally found south and east of delineated critical habitat, represent the thermal limit for right whales and play an important role in their distribution within the calving grounds (Keller *et al*. 2006). The frequency with which right whales occur in offshore waters in the SEUS remains unclear.

Tagging studies and observations reveal North Atlantic right whales to take far offshore excursions from their habitual waters. There have been a few sightings recorded by Dutch ships showing right whale occurrences across the North Atlantic between 40° and 50°N, in waters influenced by the North Atlantic Current (the broad, eastward-flowing extension of the Gulf

Stream). Tagging studies have recorded these animals to make extensive excursions up to 2000 km from their time spent in the Bay of Fundy (Mate *et al.* 1997). Long distance movements indicate a much more extensive range than that noted above. Knowlton *et al*. (1992) reported movements as far north as Newfoundland, the Labrador Basin, and southeast of Greenland. Waring *et al*. (2007) reported resightings of individuals made off Iceland, arctic Norway and east of Greenland. Observations are occasionally made in other distant locations from the whales' habitual waters, including the Gulf of Mexico, Bermuda, the Gulf of St. Lawrence, Newfoundland, Greenland, Iceland, and northern Norway. The Norwegian sighting (in September 1992) represents one of only two sightings this century of a right whale in Norwegian waters, and the first since 1926. Together, these long-range sightings indicate an extended range for at least some individuals and perhaps the existence of important habitat areas not presently well described.

b. Life History Information

Reproduction. Most known right whale nursery areas are in shallow, coastal waters. In the western North Atlantic, calving takes place between December and March. In both the northern and southern hemisphere, females give birth to their first calf at an average age of nine years (Best *et al*. 1998; Hamilton *et al*. 1998). Calves are 5.5-6.0 meters in length at birth (Best 1994). Gestation lasts from 357 to 396 days in southern right whales (Best 1994), and it is likely to be similar in the northern species. Weaning seems to be variable, and has been reported as eight to 17 months in North Atlantic right whales (Hamilton *et al*. 1995).

Calving interval through the 1997/1998 season suggests that mean calving interval increased since 1992 from 3.67 years to more than five years, a significant trend (Kraus *et al*. 2007). This conclusion is supported by modeling work reviewed by the IWC workshop on status and trends in this population (Best *et al*. 2001a). Calving intervals had indeed increased and, moreover, the reproductive rate was approximately half that reported from studied populations of *E. australis*. An analysis of the age structure of this population suggests that it contains a smaller proportion of juvenile whales than expected (Best *et al*. 2001a; Hamilton *et al*. 1998), which may reflect lowered recruitment and/or high juvenile mortality. In addition, it is possible that the apparently low reproductive rate is due in part to unstable age structure or to reproductive senescence on the part of some females. Data on either factor are poor. However, the most recent sightings reveal more promising numbers for these whales. There have been 39 mother-calf pairs spotted in 2009 so far (as of March 12, 2009) – a record year for these sightings since records have been kept by NMFS (Barb Zoodsma pers. comm. 2009).

The western North Atlantic right whales exhibit migratory patterns, traveling along the eastern seaboard of the U.S. and Canada between calving grounds off of Georgia and Florida to northern feeding areas in March/April and the reverse direction in November/December. Migrations are typically within 30 nautical miles of the coastline and in waters less than 160 feet deep. Although this pattern is well-known, most of the population, particularly the males and non-pregnant females, is not found in the calving area and may not follow this pattern. It has been shown that the warm Gulf Stream waters, generally found south and east of delineated critical habitat, represent the thermal limit for right whales and play an important role in their

distribution within the calving grounds (Keller 2006). It is unknown where the majority of the non-calving population spends the winter.

Feeding. Right whales fast during the winter and feed during the summer, although some may opportunistically feed during migration. Right whales use their baleen to sieve copepods (*Calanus finmarchicus*) from the water. They rely on dense patches of copepods, found in highly variable and spatially unpredictable locations in the Bay of Fundy, Roseway Basin, CCB, the GSC, and other areas off the northeastern United States (NEUS) and Canada. Available evidence from right whale foraging and habitat studies shows that right whales focus foraging activities where physical oceanographic features such as water depth, current, and mixing fronts combine to concentrate copepods (Baumgartner *et al*. 2003; Mayo and Marx 1990; Murison and Gaskin 1989; Wishner *et al*. 1988).

Feeding patterns largely dictate the movement of right whales, which have especially been studied in (spring, summer, fall) New England waters. Right whale dive patterns in the GSC have been closely correlated with the horizontal and vertical distribution and movements of dense patches of zooplankton prey (Winn *et al*. 1995). While some studies show right whales to occur in dense zooplankton areas (Kenney *et al.* 1986, 1995; Winn *et al.* 1995), at least one study suggests these whales seek out aggregations of older zooplankton (copepod) life stages, rather than dense aggregations (Wishner *et al.* 1995). Another study found tagged right whales to visit areas characterized by low bottom temperature, high surface salinity, and high surface stratification with no evidence that the animals associated with oceanic fronts, regions with standing stocks of phytoplankton, or areas where prey abundance was thought to be high (Baumgartner and Mate 2005).

c. Listing Status

Right whales have been listed as endangered under the ESA since its passage in 1973 (35 FR 8495; June 2, 1970). The North Atlantic right whale was originally listed as endangered as a part of the Northern right whale, or *Eubalaena* spp., which has been listed as endangered under the precursor to the ESA and under the ESA since its inception in 1973 (35 FR 8495; June 2, 1970). The original listing included both the North Atlantic and the North Pacific ‘populations’, although subsequent genetic studies conducted by Rosenbaum *et al.* (2000) resulted in strong evidence that the North Atlantic and North Pacific right whales are separate species. Following a comprehensive status review, NMFS concluded that Northern right whales are indeed two separate species. On December 27, 2006, NMFS published two proposed rules to list these species separately as North Atlantic and North Pacific right whales (71 FR 77704 and 71 FR 77694). The final rule published on March 6, 2008 (73 FR 12024).

North Atlantic right whales are also listed as “threatened with extinction,” or Appendix I, of the CITES. Their IUCN Redlist status is “endangered,” or very high risk of extinction.

d. Status and Trends

The western North Atlantic right whale population is the largest right whale population in the Northern Hemisphere. Based on a census of individual whales identified using photo-

identification techniques, combined with the assumption of mortality of whales not seen for seven years, the western North Atlantic stock size was estimated to be 295 individuals in 1992 (Knowlton *et al*. 1994); an updated analysis using the same method gave an estimate of 299 animals in 1998 (Kraus *et al.* 2001). An IWC workshop on status and trends of western North Atlantic right whales gave a minimum direct-count estimate of 263 right whales alive in 1996 and noted that the true population was unlikely to be substantially greater than this (Best *et al.* 2001a). In a review of the photo-identification recapture database for October 2005, 306 individually recognized whales were known to be alive in 2001. Because this was nearly a complete census, it is assumed that this represents a minimum population size, and no estimate of abundance with an associated coefficient of variation has been calculated for this population (Waring *et al*. 2007). The largest population estimate for North Atlantic right whales is 350 individuals (Kraus *et al*. 2005).

The population growth rate reported for the period 1986-1992 by Knowlton *et al*. (1994) was 2.5 percent (CV=0.12), suggesting that the stock was showing signs of slow recovery, but much lower than the six to seven percent per year growth rate noted by Best (1993) for southern right whale populations in Argentina and South Africa. However, work by Caswell *et al.* (1999) has suggested that crude survival probability declined from about 0.99 in the early 1980s to about 0.94 in the late 1990s. The decline was statistically significant. Under current conditions, the population is headed for extinction, and an upper bound on the expected time to extinction is 191 years (NMFS 2005b).

6. North Pacific right whale, *Eubalaena japonica*

a. Species Description, Distribution, and Population Structure

The North Pacific right whale is a large baleen whale that grows to between 45 and 55 feet in length and can weigh up to 70 tons. Females tend to be larger than males. Right whales are generally black (some with white belly patches) and stocky-bodied, lack a dorsal fin, and have large heads (about 1/4 of the body length) with strongly-bowed lower lips. Raised patches of rough skin, or callosities are found around their head, and frequently serve to differentiate individuals. Two rows of long, dark baleen plates hang from the upper jaw, with about 225 plates on each side. The tail is broad, deeply notched, and all black with a smooth trailing edge.

Very little is known of the population size and distribution of right whales in the North Pacific because so few of these animals have been seen in the past 20 years. Klumov (1962) suggested that two populations of right whales existed in the North Pacific: a western population that occurred in the Sea of Okhotsk during summer and the northwestern North Pacific Ocean during the remainder of the year, and an eastern population that occurred in the Bering Sea, Gulf of Alaska, and British Columbia. Brownell *et al.* (2001) concluded that the available evidence supported this hypothesis. Omura (1986) recognized two sub-populations in the western North Pacific right whale population; however, the International Whaling Commission concluded that this was unlikely. Josephson *et al.* (2008) interpreted whaling logs to conclude right whales were not continuous across the Pacific basin, but primarily occupied eastern and western sides. The available evidence is not sufficient to accept or refute Omura's conclusion. While there is no

information on the current population structure, right whales on the eastern and western sides of the Pacific Ocean are considered separate for statistical purposes (Best *et al.* 2001a).

Before right whales in the North Pacific were heavily exploited by commercial whalers, concentrations were found in the Gulf of Alaska, eastern Aleutian Islands, south-central Bering Sea, Sea of Okhotsk, and Sea of Japan (Braham and Rice 1984). Migratory patterns of the North Pacific stock are unknown, although it is thought the whales migrate from high-latitude feeding grounds in summer to more temperate, possibly offshore waters, during winter (Braham and Rice 1984; Scarff 1986; Clapham *et al.* 2004).

Historical whaling records (Maury 1853; Townsend 1935; Scarff 1986, 1991) indicate that right whales ranged across the North Pacific north of 35° N latitude and occasionally as far south as 20° N. They summered in the North Pacific Ocean and southern Bering Sea from April or May to September, with a peak in sightings in coastal waters of Alaska in June and July (Klumov 1962; Maury 1852; Omura 1958; Omura *et al*. 1969; Townsend 1935). Their summer range extended north of the Bering Strait (Omura *et al*. 1969). However, they were particularly abundant in the Gulf of Alaska from 145° to 151°W (Berzin and Rovnin 1966), and apparently concentrated in the Gulf of Alaska, especially south of Kodiak Islands and in the Eastern Aleutian Islands and southern Bering Sea shelf waters (Braham and Rice 1984). These historical concentrations of sightings in the Bering Sea together with some recent sightings indicate that this region and the Gulf of Alaska may represent an important summer habitat for eastern North Pacific right whales (Brownell *et al*. 2001; Clapham *et al.* 2004; Goddard and Rugh 1998; Scarff 1986; Shelden *et al.* 2005). Abundance in the western North Pacific is significantly larger than in the eastern North Pacific.

The winter distribution of right whales in the Pacific is virtually unknown, although some right whales have been sighted as far south as 27° N in the eastern North Pacific (Best *et al*. 2001a). Right whales have also been sighted in Hawaii (Herman *et al*. 1980a), California (Scarff 1986), Washington, and British Columbia. It is presumed that right whales calve during mid-winter, and while there have been speculations on the location of calving grounds, none have been confirmed (Clapham *et al.* 2004).

Current information on the seasonal distribution of right whales is available from dedicated vessel and aerial surveys, bottom-mounted acoustic recorders, and data from marine mammal observers on vessel surveys. In 1996, a group of three to four right whales (which may have included a calf) were observed in the middle shelf of the Bering Sea, west of Bristol Bay and east of the Pribilof Islands (Goddard and Rugh 1998). In June 1998, a lone whale was observed on historic whaling grounds near Albatross Bank off Kodiak Island, Alaska (Waite and Hobbs 1999). Surveys conducted in July of 1997-2000 in Bristol Bay reported observations of lone animals or small groups of right whales in the same area as the 1996 sighting (Hill and DeMaster 1998; Perryman *et al*. 1999). Brownell *et al*. (2001) identified the waters within about 200 miles of the coast of Japan, including outlying islands as accounting for 37.4% of right whale sightings since 1900 in the Pacific. Best *et al.* (2001) suggested the Ryuku Islands, Yellow Sea, and Sea of Japan as important breeding and calving areas for Pacific right whales.

In 2004, a right whale was successfully tagged with a satellite-monitored transmitter for 40 days, during which time the animal moved over a large part of the southeastern Bering Sea including the outer shelf area (Wade *et al.* 2006). In September 2004, information from the tag was used together with acoustic detections to find the largest aggregation of right whales observed in the eastern North Pacific since Soviet whaling. A minimum of 17 individuals were identified by photo-identification and by genotyping from skin biopsies (Angliss and Outlaw 2007)

b. Life History Information

The basic life history parameters and census data, including population abundance, growth rate, age structure, breeding ages, and distribution, remain undetermined for North Pacific right whales. While there are no data for the North Pacific, studies of other right whale populations suggest calving intervals of 3–6 years, life spans of up to 70 years, and growth rates that are likely dependent on feeding success (Kenney 2002; Reynolds *et al.* 2002). Long-lived organisms have limited abilities to respond to chronic increases in juvenile mortality and even lesser abilities to respond to increased mortality through commercial harvest of juveniles and adults (Congdon *et al.* 1993). Life history characteristics such as low reproductive rates, delayed sexual maturity, and reliance on high juvenile survivorship make long-lived species such as whales particularly vulnerable to overexploitation. This likely explains the paucity of sightings in the North Pacific following the illegal kills by Soviet whalers in the 1960s. The effects of past commercial and illegal harvests persist. These removals remain an obstacle to the recovery of the North Pacific right whale, despite the cessation of such whaling.

To date, photogrammetric data in the Bering Sea have been collected primarily for adult animals (LeDuc *et al.* 2001). Of the 12 whales for which lengths were determined (range: 14.7- 17.6 meters [m]), none were smaller than the smallest length estimate for sexually mature right whales (13–16 m: Kenney 2002). Length measurements for two whales observed off California suggest at least one of these whales was not yet sexually mature (12.6 m: Carretta *et al.* 1994). The presence of two calves during the 2004 season in the Bering Sea (Wade *et al.* 2006) is encouraging. However, to date, there is no evidence of reproductive success (i.e., young reared to independence) in the eastern North Pacific. No data are available for the western North Pacific (71 FR 77694).

Feeding. Right whales in the North Pacific prey on zooplankton species including, *Calanus marshallae, Euphausia pacifica, Metridia* spp. and copepods of the genus *Neocalanus* (Omura 1986). Similar to right whales in the North Atlantic, the distribution of North Pacific right whales is likely influenced by the availability of prey in the southeastern Bering Sea and Gulf of Alaska (Shelden *et al.* 2005).

c. Listing Status

Right whales have been listed as endangered under the ESA since its passage in 1973 (35 FR 8495; June 2, 1970). The North Pacific right whale was originally listed as endangered as a part of the Northern right whale, or *Eubalaena* spp., which has been listed as endangered under the precursor to the ESA and under the ESA since its inception in 1973 (35 FR 8495; June 2, 1970). The original listing included both the North Atlantic and the North Pacific ‘populations’,

although subsequent genetic studies conducted by Rosenbaum (2000) resulted in strong evidence that the North Atlantic and North Pacific right whales are separate species. Following a comprehensive status review, NMFS concluded that Northern right whales are indeed two separate species. On December 27, 2006, NMFS published two proposed rules to list these species separately as North Atlantic and North Pacific right whales (71 FR 77704 and 71 FR 77694). The final rule published on March 6, 2008 (73 FR 12024).

North Pacific right whales are also listed as "threatened with extinction," or Appendix I, of the CITES. Their IUCN Redlist status is "endangered," or very high risk of extinction.

d. Status and Trends

Historically, whaling represented the greatest threat to North Pacific right whales, and was ultimately responsible for their endangered status. Whalers began hunting North Pacific right whales in the early 1800s. Between 1839 and 1906, Townsend (1935) recorded 2,118 North Pacific right whales that had been killed north of 40° N by whaling fleets. About 72% of these whales had been killed by 1851 and 97% had been killed by 1875 (Townsend 1935). By 1960, Brownell *et al*. (2001) concluded that North Pacific right whales had started to show signs of recovering from the consequences of whaling. Between 1963 and 1967, however, Soviet whaling vessels killed at least 508 North Pacific right whales, including 251 whales in the Gulf of Alaska and 121 in the southeastern Bering Sea. In 1967, despite the ban on hunting right whales, Soviet whaling vessels killed 126 right whales on the eastern side of Sakhalin Island in the Sea of Okhotsk (Latishev 2007). These additional harvests reversed the recovery of these whales and caused their population to collapse again.

Previous estimates of the size of the right whale population in the Pacific Ocean range from a low of 100-200 (Braham and Rice 1984) to a high of 220-500 (Berzin and Yablokov 1978). Although Hill and DeMaster (1998) argued that it is not possible to reliably estimate the population size or trends of right whales in the North Pacific, Reeves *et al.* (2003) concluded that North Pacific right whales in the eastern Pacific Ocean exist as a small population of individuals while the western population of right whales probably consists of several hundred animals (NMFS 2005b). Brownell *et al.* (2001) reviewed sighting records and also estimated that the abundance of right whales in the western North Pacific was likely in the low hundreds.

Few North Pacific right whales have been seen in the past 20 years. In 1996, a group of three to four right whales (which may have included a calf) were observed in the middle shelf of the Bering Sea, west of Bristol Bay and east of the Pribilof Islands (Goddard and Rugh 1998). In June 1998, a lone whale was observed on historic whaling grounds near Albatross Bank off Kodiak Island, Alaska (Waite and Hobbs 1999). Surveys conducted in July of 1997-2000 in Bristol Bay reported observations of lone animals or small groups of right whales in the same area as the 1996 sighting (Hill and DeMaster 1998; Perryman *et al.* 1999).

At this time, it is not possible to produce a reliable estimate of minimum abundance for this stock, as a current abundance estimate is not available. However, of 13 individual animals photographed during aerial surveys in 1998, 1999, and 2000, two have already been re-photographed (LeDuc *et al*. 2001). Scientists participating in a recent study utilizing acoustic

detection and satellite tracking identified 17 right whales (10 males and 7 females) in the Bering Sea, which is almost threefold the number seen in any previous year in the last four decades (Wade *et al*. 2006). These sightings increased the number of individual North Pacific right whales identified in the genetic catalog for the eastern Bering Sea to 23. Amidst the uncertainty of the eastern North Pacific right whale's future, the discovery of females and calves gives hope that this endangered population may still possess the capacity to recover (Wade *et al*. 2006).

7. Sperm whale, *Physeter macrocephalus*

a. Species description, distribution, and population structure

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 N in the North Atlantic and 70º S in the Southern Ocean (Perry *et al.* 1999; Reeves and Whitehead 1997), whereas mature females and immature individuals of both sexes are seldom found higher than 50º N or S (Reeves and Whitehead 1997). In winter, sperm whales migrate closer to equatorial waters (Kasuya and Miyashita 1988; Waring *et al.* 1993) where adult males join them to breed.

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 1997). The NMFS recognizes six stocks under the Marine Mammal Protection Act - three in the Atlantic/Gulf of Mexico and three in the Pacific (Alaska, California-Oregon-Washington, and Hawaii; (Perry *et al.* 1999; Waring *et al.* 2004). 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 *et al.* 2008).

North Atlantic. In the western North Atlantic, sperm whales range from Greenland south into the Gulf of Mexico and the Caribbean, where they are common, especially in deep basins north of the continental shelf (Romero *et al.* 2001; Wardle *et al.* 2001). The northern distributional limit of female/immature pods is probably around Georges Bank or the Nova Scotian shelf (Whitehead *et al.* 1991). Seasonal aerial surveys confirm that sperm whales are present in the northern Gulf of Mexico in all seasons (Hansen *et al.* 1996; Mullin *et al.* 1994). Sperm whale distribution follows a distinct seasonal cycle, concentrating east-northeast of Cape Hatteras in winter and shifting northward in spring when whales are found throughout the Mid-Atlantic Bight. Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the Mid-Atlantic Bight. In the eastern Atlantic, mature male sperm whales have been recorded as far north as Spitsbergen (Øien 1990). Recent observations of sperm whales and stranding events involving sperm whales from the eastern North Atlantic suggest that solitary and paired mature males predominantly occur in waters off Iceland, the Faroe Islands, and the Norwegian Sea

(Christensen *et al.* 1992a; Christensen *et al.* 1992b; Gunnlaugsson and Sigurjónsson 1990; Øien 1990).

North Pacific. 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° N in winter (Gosho *et al.* 1984; Miyashita *et al.* 1995 as cited in Carretta *et al.* 2005; Rice 1974a). Sperm whales are found year-round in Californian and Hawaiian waters (Barlow 1995; Dohl *et al.* 1983; Forney *et al.* 1995; Lee 1993; Mobley Jr . *et al.* 2000; Rice 1960a; Shallenberger 1981), but they reach peak abundance from April-mid-June and from the end of August-mid-November (Rice 1974a). They are seen in every season except winter (December-February) in Washington and Oregon (Green *et al.* 1992). 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).

Mediterranean. Sperm whales are found from the Alboran Sea to the Levant Basin, primarily over steep slope and deep offshore waters. Sperm whales are rarely sighted in the Sicilian Channel, and are vagrants to the northern Adriatic and Aegean Seas (Notarbartolo di Sciara and Demma 1997). In Italian seas, sperm whales are more frequently associated with the continental slope off western Liguria, western Sardinia, northern and eastern Sicily, and both coasts of Calabria.

Southern Hemisphere. All sperm whales of the Southern Hemisphere are treated as a single stock with nine divisions, although this designation has little biological basis and is more in line with whaling records (Donovan 1991). Sperm whales that occur off the Galapagos Islands, mainland Ecuador, and northern Peru may be distinct from other sperm whales in the Southern Hemisphere (Dufault and Whitehead 1995; Rice 1977; Wade and Gerrodette 1993). Gaskin (1973) found females to be absent in waters south of 50º and decrease in proportion to males south of 46-47º.

b. Life history information

Movement. 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 *et al.* 2008). However, no sperm whale in the Pacific has been known to travel to points over 5,000 km apart and only rarely have been known to move over 4,000 km 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 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.

Habitat. Sperm whales have a strong preference for waters deeper than 1,000 m (Reeves and Whitehead 1997; Watkins 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 40-55 m deep (Scott and Sadove 1997). When they are found relatively close to shore, sperm whales are usually associated with sharp increases in topography where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956). Such areas include oceanic islands and along the outer continental shelf.

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 and Whitehead 1996; Jaquet *et al.* 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.* 2000a; Davis *et al.* 2000b; Davis *et al.* 2000c; Davis *et al.* 2002; Wormuth *et al.* 2000). 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 *et al.* 1996; Waring *et al.* 1993). Sperm whale over George's Bank were associated with surface temperatures of 23.2-24.9°C (Waring *et al.* 2003).

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 (Tynan *et al.* 2005) stranding of 47 individuals in Oregon occurred during June 1979 (Norman *et al.* 2004; Rice *et al.* 1986).

Reproduction. Female sperm whales become sexually mature at an average of 9 years or 8.25-8.8 m (Kasuya 1991). Males reach a length of 10 to 12 m at sexual maturity and take 9-20 years to become sexually mature, but will require another 10 years to become large enough to successfully breed (Kasuya 1991; Würsig *et al.* 2000). Mean age at physical maturity is 45 years for males and 30 years for females (Waring *et al.* 2004). Adult females give birth after roughly 15 months of gestation and nurse their calves for 2-3 years (Waring *et al.* 2004). The calving interval is estimated to be every 4-6 years between the ages of 12 and 40 (Kasuya 1991; Whitehead *et al.* 2008). In the North Pacific, female sperm whales and their calves are usually found in tropical and temperate waters year round, while it is generally understood that males move north in the summer to feed in the Gulf of Alaska, Bering Sea, and waters off of the Aleutian Islands (Kasuya and Miyashita 1988). It has been suggested that some mature males

may not migrate to breeding grounds annually during winter, and instead may remain in higher latitude feeding grounds for more than 1 year at a time (Whitehead and Arnbom 1987). Sperm whale age distribution is unknown, but sperm whales are believed to live at least 60 years (Rice 1978b). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (IWC 1980b). In addition to anthropogenic threats, there is evidence that sperm whale age classes are subject to predation by killer whales (Arnbom *et al.* 1987; Pitman *et al.* 2001).

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 (6-12 individuals) versus the Pacific (25-30 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).

Diving. Sperm whales are probably the deepest and longest diving mammalian species, with dives to 3 km down and durations in excess of 2 hours (Clarke 1976; Watkins *et al.* 1993; Watkins *et al.* 1985). However, dives are generally shorter (25- 45 min) and shallower (400-1,000 m). Dives are separated by 8-11 min rests at the surface (Gordon 1987; Jochens *et al.* 2006; Papastavrou *et al.* 1989; Watwood *et al.* 2006; Würsig *et al.* 2000). Sperm whales typically travel ~3 km horizontally and 0.5 km 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.

Feeding. Sperm whales appear to feed regularly throughout the year (NMFS 2006h). It is estimated they consume about 3-3.5% of their body weight daily (Lockyer 1981). They seem to forage mainly on or near the bottom, often ingesting stones, sand, sponges, and other non-food items (Rice 1989a). A large proportion of a sperm whale's diet consists of low-fat, ammoniacal, or luminescent squids (Clarke 1996; Clarke 1980b; Martin and Clarke 1986). While sperm whales feed primarily on large and medium-sized squids, the list of documented food items is fairly long and diverse. Prey items include other cephalopods, such as octopi, and medium- and large-sized demersal fishes, such as rays, sharks, and many teleosts (Angliss and Lodge 2004; Berzin 1972; Clarke 1977; Clarke 1980a; Rice 1989a). The diet of large males in some areas, especially in high northern latitudes, is dominated by fish (Rice 1989a). In some areas of the North Atlantic, however, males prey heavily on the oil-rich squid *Gonatus fabricii*, a species also frequently eaten by northern bottlenose whales (Clarke 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 (200-236 dB re 1μPa), although lower source level energy has been suggested at around 171 dB re 1 μPa (Goold

and Jones 1995; Møhl *et al.* 2003; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997). Most of the energy in sperm whale clicks is concentrated at around 2-4 kHz and 10-16 kHz (Goold and Jones 1995; NMFS 2006h; Weilgart and Whitehead 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 1997). However, clicks are also used in short patterns (codas) during social behavior and intragroup interactions (Weilgart and Whitehead 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 2.5-60 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 *et al.* 1985; Watkins and Schevill 1975). 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.* 1999b).

c. Listing Status

Sperm whales have been listed as endangered since 1970 under the precursor to the endangered Species Act (ESA) (35 FR 18319; December 2, 1970) and have remained on the list of threatened and endangered species after the passage of the ESA in 1973.

Critical habitat has not been designated for sperm whales.

d. Status and trends

Sperm whales were originally listed as endangered in 1970 (35 FR 18319), and this status remained with the inception of the ESA in 1973. Although population structure of sperm whales is unknown, several studies and estimates of abundance are available. Table 24 contains historic and current estimates of sperm whales by region. 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 2003).

North Atlantic. 190,000 sperm whales were estimated to have been in the entire North Atlantic, but CPUE data from which this estimate is derived are unreliable according to the IWC (Perry *et al.* 1999). The total number of sperm whales in the western North Atlantic is unknown (Waring *et al.* 2008). The best available current abundance estimate for western North Atlantic

sperm whales is 4,804 based on 2004 data. The best available estimate for Northern Gulf of Mexico sperm whales is 1,665, based on 2003-2004 data, which are insufficient data to determine population trends (Waring *et al.* 2008). Sperm whale were widely harvested, from the northeastern Caribbean (Romero *et al.* 2001) and the Gulf of Mexico where sperm whale fishery operated during the late 1700s to the early 1900s (NMFS 2006h; Townsend 1935b).

North Pacific. There are approximately 76,803 sperm whales in the eastern tropical Pacific, eastern North Pacific, Hawaii, and western North Pacific (Whitehead 2002a). Minimum estimates in the eastern North Pacific are 1,719 individuals and 5,531 in the Hawaiian Islands (Carretta *et al.* 2007b). 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 1985-1999 versus 1978-1992 levels, likely due to migration to nearshore waters of South and Central America (Whitehead 2003).

Table 24. Summary of past and present sperm whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% C.I.	Current estimate	95% C.I.	Source
Global	--	--	--	900,000	--	(Würsig et al. 2000)
	--	1,110,000	672,000-1,512,000	360,000	105,984-614,016*	(Whitehead 2002a)
North Atlantic	Basinwide	224,800	--	22,000	--	(Gosho et al. 1984; Würsig et al. 2000)
	Northeast Atlantic, Faroes-Iceland, and U.S. East Coast (combined)	--	--	13,190	--	(Whitehead 2002a)
	NMFS - North Atlantic stock (Western North Atlantic)	--	--	4,804	1,226-8,382*	(NMFS 2008a)
	Eastern North Atlantic - Iceland	--	--	1,234	823-1,645*	(Gunnlaugsson and Sigurjónsson 1990)
	Eastern North Atlantic - Faroe Islands	--	--	308	79-537*	(Gunnlaugsson and Sigurjónsson 1990)
	Eastern North Atlantic - Norwegian Sea	--	--	5,231	2,053-8,409*	(Christensen et al. 1992b)
	Eastern North Atlantic - Northern Norway to Spitsbergen	--	--	2,548	1,200-3,896*	(Øien 1990)
Gulf of Mexico	NMFS - Gulf of Mexico stock	--	--	1,665	CV=0.2	(NMFS 2008a)
	Northern Gulf of Mexico - off the Mississippi River Delta between 86 ^{o} and 91 ^{o}W	--	--	398	253-607	(Jochens et al. 2006)
	North-central and Northwestern Gulf of Mexico	--	--	87	52-146	(Mullin et al. 2004)
North Pacific	Basinwide	620,400	--	472,100	--	(Gosho et al. 1984)
				930,000	--	(Rice 1989a)
	Eastern Tropical Pacific	--	--	26,053	13,797-38,309*	(Whitehead 2003)
	Off Costa Rica	--	--	1,360	823-2,248*	(Gerrodette and Palacios 1996)
	Off Central America north of Costa Rica	--	--	333	125-890*	(Gerrodette and Palacios 1996)
	Eastern Temperate North Pacific	--	--	26,300	0-68,054*	(Barlow and Taylor 2005)
				32,100	9,450-54,750*	(Barlow and Taylor 2005)
	NMFS - North Pacific stock	--	--	--	--	(Angliss and Allen 2007)
	NMFS - California/Oregon/ Washington stock	--	--	2,853	CV=0.25*	(Carretta et al. 2008)
	NMFS - Hawaii stock	--	--	7,082	2,918-11,246*	(Carretta et al. 2008)
Southern Hemisphere	Basinwide	547,600	--	299,400	--	(Gosho et al. 1984; IWC 1988; Perry et al. 1999)
	South of 60 ^{o}S	--	--	14,000	8,786-19,214*	(Butterworth et al. 1995) as cited in (Perry et al. 1999)
	South of 30 ^{o}S	--	--	128,000	17,613-238,387*	(Butterworth et al. 1995) as cited in (Perry et al. 1999)

*Note: Confidence Intervals (C.I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).

Sperm whales are sighted off Oregon in every season except winter (Green *et al.* 1992). However, sperm whales are found off California year-round (Barlow 1995; Dohl *et al.* 1983;

Forney *et al.* 1995), with peak abundance from April to mid-June and from August to mid-November (Rice 1974a). Barlow (2003) reported mean group sizes of 2.0–11.8 during surveys the western U.S. Barlow (2003) estimated that 440 and 52 sperm whales occurred in Oregonian and Washingtonian waters, depending upon year and area, supported by densities of 0.0002 to 0.0019 individuals/km^2.

Hill and DeMaster (1999) concluded that about 258,000 sperm whales were harvested in the North Pacific between 1947-1987. 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 1997). In 2000, the Japanese Whaling Association announced plans to kill 10 sperm whales in the Pacific Ocean for research. Although consequences of these deaths are unclear, the paucity of population data, uncertainly 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.

Southern Hemisphere. Whaling in the Southern Hemisphere averaged roughly 20,000 whales between 1956-1976 (Perry *et al.* 1999). Population size appears to be stable (Whitehead 2003). Whitehead (2002b) estimated 12,069 sperm whales south of 60° S.

8. Gray whale, *Eschrichtius robustus,* Western North Pacific Distinct Population Segment

a. Species Description, Distribution, and Population Structure

Gray whales are recognized by their mottled gray color and lack of a dorsal fin. Instead of the fin, they have a low hump, followed by a series of 10 or 12 knobs along the dorsal ridge of the tail. Adult gray whales are 36-50 feet long and weigh between 16-45 tons (Rice *et al*. 1984).

Gray whales formerly occurred in the North Atlantic Ocean (Fraser 1970, Mead and Mitchell 1984), but this species is currently found only in the North Pacific (Rice *et al*. 1984). Gray whales now occur along the eastern and western coastlines of the North pacific as two geographically isolated populations (Rice and Wolman 1971) and are referred to as the eastern and western populations (Weller *et al*. 2002). In addition to geographic separation, molecular comparisons based on differences in haplotypic frequencies confirm that the eastern and western gray whale populations are genetically differentiated at the population level (LeDuc *et al*. 2002).

Western North Pacific. The Western North Pacific gray whale is presently considered one of the most endangered and little-known whale populations in the world (Berzin *et al*. 1995, Brownell *et al*. 1997, Brownell 1999, Clapham *et al*. 1999). The current population size has been reported as 100-250 whales (Vladimirov 1994, Blokhin 1996).

b. Life History.

Reproduction. Females attain puberty at a mean age of 8 years and a mean body length of 11.7 m (Rice and Wolman 1971). The period of gestation is about 13.5 months (Rice 1983).

Lactation lasts an average of 7 months. Males attain puberty at a mean of 8 years and mean body length of 11.1 m.

The location of the winter breeding grounds for the Western North Pacific gray whale population is unknown, but is thought to be along the coast of southern China (Wang 1984, Omura 1988, Kato and Kasuya 2002, Weller *et al.* 2002). Historically, western gray whales migrated south along the coast of eastern Asia to winter calving grounds off the south coast of Korea, passing Ulsan from late November to late January (Rice *et al*. 1984). Until the turn of this century, another migration route led down the eastern side of Japan to winter grounds in the Seto Inland Sea, Japan (Omura 1974).

In the fall, Eastern North Pacific gray whales migrate from their summer feeding grounds, migrating southward along the coast of North America to spend the winter in their breeding and calving areas off the coast of Baja California, Mexico. Calves are born in shallow lagoons and bays from early January to mid-February. From mid-February to May, the Eastern North Pacific stock of gray whales can be seen migrating northward with newborn calves along the West Coast of the U.S. Photo-identification studies indicate that gray whales in this stock move widely within and between areas on the Pacific coast, are not always observed in the same area each year, and may have several year gaps between re-sightings in studied areas (Calambokidis and Quan 1999, Quan 2000, Calambokidis *et al*. 2002). The major calving areas for the Western North Pacific stock are Laguna Guerrero Negro, Laguna Ojo de Liebre, Laguna San Ignacio, and Estero Soledad (Rice *et al*. 1984). The northbound migration of western gray whales begins mid-February, and by April whales begin showing up in the southern Bering Sea (Rice *et al.* 1984).

Feeding. Gray whales are predominantly bottom feeders that ingest their food by suction (Ray and Schevill 1974). They rarely feed in midwater or at the surface (Rice *et al*. 1984). They feed primarily on benthic amphipods. In some areas, polychaete worms are their main food. Incidentally ingested benthos include gastropods, ascidians, bivalves, priapulids, decapod crustaceans, isopods, sipunculids, hydrozoans, anthozoans, cumaceans, holothurians, sponges, and fish (Zimushko and Lenskaya 1970, Bogoslovskaya *et al*. 1981).

Most of the Eastern North Pacific stock spends the summer feeding in the northern Bering and Chukchi Seas (Rice and Wolman 1971, Berzin 1984, Nerini 1984), but gray whales have also been reported feeding along the Pacific coast during the summer, in waters off of southeast Alaska, British Columbia, Washington, Oregon, and California (Rice and Wolman 1971, Darling 1984, Nerini 1984, Rice *et al.* 1984). Eastern gray whales feed during summer months primarily in the Bering and Chukchi seas after migrating along the western coast of North America from winter breeding grounds off Baja California (Pike 1962).

Western gray whales migrate along the eastern coast of northern Asia to summer feeding grounds in the Okhotsk Sea (Berzin 1990). These whales express site fidelity to feeding grounds off northeastern Sakhalin Island, Russia (Weller *et al*. 1999). Sighting records from aerial and vessel surveys in the Okhotsk Sea between 1979 and 1989 indicated that feeding gray whales aggregated predominately along the shallow-water shelf of northeastern Sakhalin Island, Russia, and were particularly abundant off the southern portion of a coastal lagoon called Zaliv Pil'tun

(Blokhin *et al.* 1985, Berzin *et al.* 1988, 1990, 1991, Blokhin 1996). Pod sizes returning to feed in these waters have reported to range from 1-9 whales (Weller *et al*. 1999).

c. Listing Status

The gray whale was listed as a species on December 2, 1970 (35 FR 18319). On June 16, 1994, the Eastern North Pacific stock of gray whales was removed from the U.S. List of Endangered and Threatened Wildlife, based on evidence that they had recovered to near their estimated original population size and were not in danger of extinction throughout all or a significant portion of their range. Since the entire species of gray whale was no longer listed, the Western North Pacific stock remained listed as a distinct population segment.

d. Status and Trends

Western North Pacific. Not afforded the same degree of international legal protection, the western population has failed to exhibit the successful recovery demonstrated by its eastern counterpart (Clapham *et al.* 1999, Weller *et al.* 2002). Recent mark-recapture abundance estimates indicate the population may currently consist of approximately 100 individuals (Wade *et al.* 2003) and are one of the world's most endangered large whale populations (Clapham *et al.* 1999, VanBlaricom *et al.* 2001). Non-calf and calf (1 year post-weaning) survival rates have been estimated as 0.951 and 0.701, respectively (Bradford *et al*. 2006). This non-calf survival point estimate is similar to mark-recapture estimates for Gulf of Maine humpback whales, but lower than an indirect estimate for the eastern gray whale population.

The population size of the Eastern North Pacific gray whale stock has been increasing over the past several decades. The estimated annual rate of increase, based on shore counts of southward migrating gray whales between 1967 and 1988, is 3.3% with a standard error of 0.44% (Buckland *et al*. 1993). Taking account of the harvest, Wade and DeMaster (1996) estimated an underlying annual rate of increase of 4.4% (95% CI: 3.1%-5.6%) for this same time period. Incorporating the census data through the 1993-94 migration resulted in an annual rate of increase of 2.6% (SE = 0.4%: IWC 1995). Breiwick (1999) estimated the annual rate of increase from 1967-68 to 1997-98 at 2.52% (95% CI: 2.04%-3.12%), and Wade and DeMaster (1996) estimated the annual rate of increase from 1967-68 to 1995-96 at 2.4% (95% CI: 1.6%-3.2%). Rugh *et al*. (2005) estimated the rate of increase from 1967-69 through 2001-02 at 1.9% (SE = 0.32%). They also fit a discrete logistic model to the abundance estimates resulting in an estimate of K (carrying capacity) of 26,290 (CV = 0.059).

9. Steller sea lion, *Eumetopias jubatus*

a. Species description, distribution, and population structure

Steller sea lions are distributed along the rim of the North Pacific Ocean from San Miguel Island (Channel Islands) off Southern California to northern Hokkaido, Japan (Loughlin *et al.* 1984; Nowak 2003). Their centers of abundance and distribution are in Gulf of Alaska and the Aleutian Islands, respectively (NMFS 1992). In the Bering Sea, the northernmost major rookery is on Walrus Island in the Pribilof Island group. The northernmost major haul-out is on Hall

Island off the northwestern tip of St. Matthew Island. Their distribution also extends northward from the western end of the Aleutian chain to sites along the eastern shore of the Kamchatka Peninsula. For management purposes, two stocks have been designated, but which represent a single population. These stocks likely have some taxonomic basis at the sub-species level in both genetics and skull morphology (Phillips *et al.* 2009).

Distribution. The eastern DPS of Steller sea lions includes animals east of Cape Suckling, Alaska (144°W) south to California waters (55 FR 49204). The western DPS of Steller sea lions includes animals west of Cape Suckling, Alaska (144°W; 62 FR 24345). Most adult Steller sea lions occupy rookeries during the pupping and breeding season and exhibit a high level of site fidelity. During the breeding season, some juveniles and non-breeding adults occur at or near the rookeries, but most are on haulouts (sites that provide regular retreat from the water on exposed rocky shoreline, gravel beaches, and wave-cut platforms or ice; (Ban 2005; Call and Loughlin 2005; Rice 1998a). Adult males may disperse widely after the breeding season. Males that breed in California move north after the breeding season and are rarely seen in California or Oregon except from May through August (Mate 1973). During fall and winter many sea lions disperse from rookeries and increase use of haulouts, particularly on terrestrial sites but also on sea ice in the Bering Sea. The rookeries off southern Oregon are located along the coast at Rogue and Orford reefs near 42º25' and 42º45'N and 124º30'W, respectively (Bonnell *et al.* 1992). Counts of adults and juveniles in Oregon have shown a gradual increase from 1486 in 1976 to 3648 in 2001 (Angliss and Outlaw 2005b).

Hearing and Vocalization. Since pinnipeds haul out of the water, studies focus on in water as well as out of water hearing. One study conducted on Steller sea lion aerial hearing sensitivity showed that the subject sea lion had a hearing range (frequencies audible at 60 dB sub(rms) re 20 mu Pa) of about 0.250-30 kHz, and a region of best hearing sensitivity from 5-14.1 kHz (Mulsow and Reichmuth 2010). Underwater hearing sensitivity was tested on a male and female Steller sea lion where hearing thresholds of the male were significantly higher than those of the female (Kastelein *et al*. 2005). The male's maximum sensitivity (77 dB re: 1 mu Pa, rms) occurred at 1 kHz. His range of best hearing (10 dB from the maximum sensitivity) was from 1 to 16 kHz (4 octaves). Higher hearing thresholds (indicating poorer sensitivity) were observed below 1 kHz and above 16 kHz. The maximum sensitivity of the female (73 dB re: 1 mu Pa, rms) occurred at 25 kHz. Her higher hearing thresholds (indicating poorer sensitivity) were observed for signals below 16 kHz and above 25 kHz.

b. Life history information

Reproduction. Female Steller sea lions reach sexual maturity and first breed between three and eight years of age and the average age of reproducing females (generation time) is about 10 years (Calkins and Pitcher 1982; Pitcher and Calkins 1981; York 1994). They give birth to a single pup from May through July and then breed about 11 days after giving birth. Females normally ovulate and breed annually after maturity although there is a high rate of reproductive failures. The gestation period is believed to be about 50 to 51 weeks (Pitcher and Calkins 1981). The available literature indicates an overall reproductive (birth) rate on the order of 55% to 70% or greater (Gentry 1970; Pike and Maxwell 1958; Pitcher and Calkins 1981). Twinning has been reported (Maniscalco and Parker. 2009).

Males reach sexual maturity at about the same time as females (three to seven years of age, reported in (Loughlin *et al.* 1987), but generally do not reach physical maturity and participate in breeding until about eight to ten years of age (Pitcher and Calkins 1981). The sex ratio of pups at birth is assumed to be about 1:1 or biased toward slightly greater production of males, but non-pups are biased towards females (Calkins and Pitcher 1982; NMFS 1992; Pike and Maxwell 1958; Trites and Larkin 1992; York 1994).

Mothers with newborn pups will make their first foraging trip about a week after giving birth, but trips are short in duration and distance at first, then increase as the pup gets older (Maniscalco *et al.* 2006; Merrick and Loughlin 1997; Milette 1999; Milette and Trites 2003; Pitcher *et al.* 2001). Females attending pups tend to stay within 20 nm of the rookery (Calkins 1996; Merrick and Loughlin 1997). Newborn pups are wholly dependent upon their mother for milk during at least their first three months of life, and observations suggest they continue to be highly dependent upon their mother through their first winter (Porter 1997; Scheffer 1945; Trites *et al.* 2006). Generally, female Steller sea lion will nurse their offspring until they are one to two years old (Calkins and Pitcher 1982; Gentry 1970; Pitcher and Calkins 1981; Sandegren 1970; Trites *et al.* 2006).

Habitat. Steller sea lions are not known to make regular migrations but do move considerable distances. Adult males may disperse hundreds of miles after the breeding season (Calkins 1986; Calkins and Pitcher 1982; Loughlin 1997). Adult females may travel far out to sea into water greater than 3,300 feet deep (Merrick and Loughlin 1997). Studies on immature Steller sea lions indicate three types of movements: long-range trips (greater than 9.3 miles and greater than 20 hours), short-range trips (less than 9.3 miles and less than 20 hours), and transits to other sites (NMFS 2007a). Long-range trips started around 9 months of age and likely occur most frequently around the time of weaning, while short-range trips happen almost daily. Young individuals generally remain within 300 miles of rookeries their first year before moving further away in subsequent years (Raum-Suryan *et al.* 2004). Many animals also use traditional rafting sites, which are places where they rest on the ocean surface in a tightly packed group (Bigg 1985)NMFS unpublished data).

Feeding. Steller sea lions are generalist predators that eat various fish (arrowtooth flounder, rockfish, hake, flatfish, Pacific salmon, Pacific herring, Pacific cod, sand lance, skates, cusk eel, lamprey, walleye, Atka mackerel), squids, and octopus and occasionally birds and marine mammals (Brown *et al.* 2002; Calkins and Goodwin 1988; Daniel and Schneeweis 1992; Jones 1981; McKenzie and Wynne 2008; Olesiuk *et al.* 1990b; Pitcher and Fay 1982; Sinclair and Zeppelin 2002). Diet is likely strongly influenced by local and temporal changes in prey distribution and abundance (McKenzie and Wynne 2008; Sigler *et al.* 2009). Haulout selection appears to be driven at least in part by local prey density (Winter *et al.* 2009).

Diving. Diving activity is highly variable in Steller sea lion by sex and season. During the breeding season, when both males and females occupy rookeries, adult breeding males rarely, if ever, leave the beach (Loughlin 2002). However, females tend to feed at night on one to two day trips and return to nurse pups (NRC 2003). Female foraging trips during winter are longer (80 miles) and dives are deeper (frequently greater than 820 feet). Summer foraging dives,

however, are closer to shore (about 10 miles) and shallower (330 to 820 feet; (Loughlin 2002; Merrick and Loughlin 1997). As pups mature and start foraging for themselves, they develop greater diving ability until roughly 10 years of age (Pitcher *et al.* 2005). Juveniles usually make shallow dives to just over 50 feet, but much deeper dives in excess of 1,000 feet are known (Loughlin *et al.* 2003). Young animals also tend to stay in shallower water less than 330 feet deep and within a dozen miles from shore (Fadely *et al.* 2005).

c. Listing status

Steller sea lions were originally listed as threatened under the ESA on November 26, 1990 (55 FR 49204), following a decline in the U.S. of about 64% over previous three decades. In 1997 the Steller sea lion population was split into separate western and eastern stocks based on observed demographic and genetic dissimilarities (Bickham *et al*. 1996, Loughlin 1997). These stocks are now listed under the ESA as the Eastern DPS and Western DPS. Only the Eastern DPS is expected to be affected by the proposed activities. Critical habitat has been designated for Steller sea lions on the major foraging sites, haulouts, and rookeries throughout their range (58 FR 45269).

d. Status and trends

Steller sea lions were originally listed as threatened under the ESA on November 26, 1990 (55 FR 49204), following a decline in the U.S. of about 64% over previous three decades. In 1997, the species was split into two separate populations based on demographic and genetic differences (Bickham *et al.* 1996; Loughlin 1997), and the western population was reclassified to endangered (62 FR 24345) while the eastern population remained threatened (62 FR 30772). The Steller sea lion is also listed as endangered on the 2007 IUCN Red List (Group 1996).

Loughlin *et al.*(1984) estimated the worldwide population of Steller sea lions was between 245,000 and 290,000 animals (including pups) in the late 1970s. Though the genetic differences between the eastern and western DPSs were not known at the time, Loughlin *et al.* (1984) noted that 90% of the worldwide population of Steller sea lions was in the western DPS in the early 1980s (75% in the U.S. and 15% in Russia) and 10% in the eastern DPS. Loughlin *et al.* (1984) concluded that the total worldwide population size (both DPSs) was not significantly different from that estimated by Kenyon and Rice (1961) for the years 1959 and 1960, though the distribution of animals had changed. Steller sea lions collected in the Gulf of Alaska during the early 1980s showed evidence of reproductive failure and reduced rates of body growth that were consistent with nutritional limitation (Calkins *et al.* 1998; Calkins and Goodwin 1988; Pitcher *et al.* 1998). After conducting a range-wide survey in 1989, Loughlin *et al.* (1992) noted that the worldwide Steller sea lion population had declined by over 50% in the 1980s, to approximately 116,000 animals, with the entire decline occurring in the range of the western DPS.

The western stock appears to be in decline. Between late 1970s and the mid-1990s, counts of the western population of sea lions fell from 109,880 animals to 22,167 animals, a decline of 80% (Hauser *et al.* 2007; NMFS 1995). The 1996 count was 27% lower than the count in 1990. Fritz and Stinchcomb (2005) estimate that from 1991 to 2000, the number of adults and juvenile sea lions in the western population declined by about 38%. Surveys by Fritz and Stinchcomb (2005)

indicate that the current number of non-pups in the western population is 29,037. NMFS combined this number with the number of pups in 2004-2005 (9,951) to reach the current minimum population estimate of 38,988 of Steller sea lion in the western U.S. (the western stock); when combined with data on Steller sea lions in Russia the minimum population estimate is 44,780 (Angliss and Outlaw 2007a).

A number of population models have been developed for Steller sea lions (Gerber and VanBlaricom 2001; Goodman 2006; Holmes and York 2003; Pascual and Adkison 1994; Winship and Trites 2006; York *et al.* 1996). According to several population models the western DPS has significant chance of going extinct within the next 100 years (Goodman 2006; Winship and Trites 2006; York *et al.* 1996), while many individual rookeries (breeding aggregations) however, have a much higher risk of extinction (e.g., western Aleutian island rookeries and Gulf of Alaska) (Winship and Trites 2006).

The eastern stock seems to be more stable than the western stock. Trend counts in Oregon were relatively stable in the 1980s, showing a gradual increase in numbers since 1976 (NMFS 2005e). Numbers in California, however, have declined to less than 2,000 non-pups, from counts between 1927 and 1947 that were as high as 7,000 non-pups (NMFS 2005e). The count from Central California in 2000, reached the second lowest count of 349 non-pups (in 1992 the count was as low as 276 non-pups). In Southeast Alaska, counts of non-pups at trend sites increased by 56% from 1979 to 2002 from 6,376 animals to 9,951 (NMFS 2005e; Sease *et al.* 2001). Counts of non-pups at British Columbia trend sites increased nearly 260% between 1982 and 2002 (NMFS 2005e).

NMFS considers this population stable, and multiplies pup counts by a factor of 4.5 (based on (Calkins and Pitcher 1982) or 5.1 (Trites and Larkin 1996) to estimate the total population size (Angliss and Outlaw 2008). Pup count data from 2002 through 2005 from across the range of the eastern population, multiplied by a factor of 4.5 or 5.1 results in a population estimate of 48,519 or 54,989 animals. In 2005, 5,510 pups were counted in Alaska, 3,318 pups were counted in British Columbia in 2002, 1,136 pups were counted in Oregon in 2002, and 818 counted in California in 2004. The current minimum population estimate is 44,584 animals. NMFS calculates this estimate by adding non-pup counts taken in 2002 in Southeast Alaska, to counts of animals in Washington in 2002 as well as counts of pups and non-pups in Canada in 1998, Oregon in 2002, California in 2004, and southeastern Alaska in 2005 (Angliss and Outlaw 2008).

Off Oregon and Washington, nearly 90% of Steller sea lion sightings have occurred within 21 km of shore and none further out than 40 km or in waters greater than 200 m deep (Bonnell *et al.* 1992). In the fall (September and November surveys), mean density was 0.011/km^2 (Bonnell *et al.* 1992).

Estimated annual mortality is 0.22 for ages 0-2, dropping to 0.07 at age 3, then increasing gradually to 0.15 by age 10 and 0.20 by age 20 (York 1994). Population modeling suggested that decreased juvenile survival likely played a major role in the decline of sea lions in the central Gulf of Alaska during 1975-1985 (Holmes and York 2003; Pascual and Adkison 1994; York 1994).

9. Hawaiian monk seal, *Monachus schauinslandi*

a. Species description, distribution, and population structure

Hawaiian monk seals are found primarily in the Northwest Hawaiian Islands (NWHI), which extend more than 2,000 km miles northwest of the Main Hawaiian Islands (MHI). Major breeding subpopulations occur at French Frigate Shoals (FFS), Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll (Carretta *et al.* 2001). Smaller groups are found at Nihoa and Necker Islands, seals have been observed at Gardner Pinnacles, Maro Reef, and Johnston Atoll, and several dozen seals are distributed throughout MHI (Carretta *et al.* 2001, NMFS 2007b). Midway was an important breeding rookery at one time, but is no longer used (Reeves 1992b). However, all Hawaiian monk seals represent a single population. Reported sightings on each of the eight MHI have become increasingly common, and births have been reported on all of the MHI except Lanai and Hawaii.

Hearing and Vocalization. Monk seal hearing peak hearing sensitivity is 10-30 kHz with a functional high limit of 60 kHz (Richardson *et al.* 1995, Wartzok and Ketten 1999). Thomas *et al.* (1990) determined that the Hawaiian monk seal's range of best frequencies (12-28 kHz) is narrower than that of *phocinid* seals. A recent audiogram study involving one male and one female Steller sea lion showed the maximum hearing sensitivity at 1-25 kHz (Kastelein *et al.* 2005). Although these results only represent the responses of two captive individuals, other eared seals exhibit similar responses and display maximum sensitivities of between 2-28 kHz (Schusterman *et al.*, 1972; Moore and Schusterman, 1987; Babushina *et al.*, 1991; Kastak and Schusterman, 1995). The high frequency cutoff for these species was observed to be around 40 kHz (Schusterman, 1981).

b. Life history information

Reproduction. Hawaiian monk seals do not form breeding colonies or harems (Johanos *et al.* 1994; Kenyon and Rice 1959). Mating, which occurs in water and is rarely observed, is inferred from male-female association patterns and from mounting injuries (Johanos *et al.* 1994). Breeding is asynchronous, lasting from February through September (Johanos *et al.* 1994). In recent years, fewer than 200 individuals are born annually (NMFS 2007b).

Females typically give birth for the first time between ages of 5 and 10 (Antonelis *et al.* 2006). Pupping patterns vary greatly and not all females give birth in consecutive years (Johanos *et al.* 1994; Kenyon and Rice 1959). Females that do give birth in consecutive years pup later each season, while females that skip a year or more give birth earlier the next season. The mean interval for births in consecutive years was found to be 381 days (Johanos *et al.* 1994). Birth rates vary depending on breeding location and year, with approximately 30-70% of all adult females giving birth in any given year (Harting *et al.* 2007)(Johanos *et al.* 1994; Ragen and Lavigne 1999). Females give birth from February to August, peaking in late March/early April (Johanos *et al.* 1994), although pupping has been recorded year round. They prefer to give birth on beaches near shallow water and coral reefs surrounding the area, apparently to afford protection to the pup (Westlake and Gilmartin 1990).

Newborn pups weigh 16-17 kg and measure 95-100 cm long (Kenyon and Rice 1959). Pups are black at birth and undergo a post-natal molt late in the nursing period. Nursing lasts, on average, 39 days (Johanos *et al.* 1994), during which time the mother remains constantly near her pup in and out of

water (Kenyon and Rice 1959). The mother does not eat during nursing and rapidly loses weight (Gerrodette and Gilmartin 1990). After weaning, the pup is abandoned to live off of fat stores until it learns to feed on its own, while the mother swims offshore to feed (Gerrodette and Gilmartin 1990; Johnson and Johnson 1978; Kenyon and Rice 1959; Wirtz 1968). At weaning, pups normally weigh between 43-73 kg (Kenyon and Rice 1959). Rice (1964) suggested that adult females weigh approximately 205 kg and are about 2.3 m long, and the average adult male is smaller, at about 170 kg and 2.1 m.

Although nursing monk seal mothers generally avoid other adult seals, occasional pup switches do occur (Johnson and Johnson 1978, Boness 1990), and mothers sometimes foster a pup if her own is lost (Alcorn and Henderson 1984, Gerrodette *et al.* 1992). If switched pups are of similar size, survival for the first year is minimally affected; however if a larger pup switches with a small one, the larger pup will have a longer nursing period and the smaller pup's probability of survival will be reduced (NMFS 2007b).

Habitat and Feeding. Virtually all terrestrial substrates, including emergent reefs and shipwrecks, are used by monk seals. Sandy beaches with shallow protected water near shore are the primary haul-out areas, for pupping, nursing, and resting, although pups are born on a variety of substrates (Gilmartin 1983). Seals use vegetation behind beaches as shelter from wind and rain.

Pinniped movements are generally based on foraging. Oceanographic features, such as thermal changes that might concentrate prey densities, can affect individual seal foraging behavior (Field *et al.* 2001). Hawaiian monk seal distribution, destinations, routes, food sources, and causes of movements when not traveling between islands are not well known. Approximately 10-15% of Hawaiian monk seals migrate among the breeding populations (Johnson and Kridler 1983). Inter-island movement appears to be more likely when the islands are close together. For example, movement between Kure Atoll, Midway Atoll, Pearl and Hermes Reef appear to be fairly common, while movement between FFS and Kure Atoll (a distance of 2,000 km) is not known to occur. The western subpopulations (Pearl and Hermes Reef, Midway Islands, and Kure Atoll) exhibit a higher degree of migration compared to the more isolated subpopulations at Laysan, Lisianski, and FFS (NMFS 2007b; Table 25).

Table 25. Migration rates per Hawaiian monk seal among subpopulations per year. Data are from 1995-2008, excluding translocations.

From/To	Nihoa	Necker	FFS	Laysan	Lisianski	PHR	Midway	Kure
Nihoa	0.7727	0	0.2273	0	0	0	0	0
Necker	0	0.4259	0.5741	0	0	0	0	0
FFS	0.0027	0.0065	0.9888	0.0019	0	0	0	0
Laysan	0	0	0.0043	0.9610	0.0334	0.0013	0	0
Lisianski	0	0	0.0011	0.0484	0.9434	0.0057	0.0007	0.0007
PHR	0	0	0.0004	0.003	0.0082	0.9450	0.0305	0.0130
Midway	0	0	0	0.0013	0	0.0707	0.7639	0.1641
Kure	0	0	0	0	0.0011	0.0168	0.0786	0.9035

At the breeding islands, monk seals feed on octopus, spiny lobster, eels, and bottom-dwelling and reef fish (Gilmartin 1983; Goodman-Lowe 1998; Rice 1960b). Considered foraging generalists, monk seals exhibit significant differences in diet between islands, age, and sex groups (NMFS 2007b). No research or monitoring effort has been identified that will effectively measure or index monk seal prey abundance at the major breeding atolls (NMFS 2007b).

Seals forage within the barrier reefs of the atolls and on the leeward slopes of reefs and islands, as well as nearby seamounts and submerged reefs and banks (Pullin and Stewart 2006). Several recent studies of the foraging patterns of Hawaiian monk seals near rookeries in the NWHI provide insight into their diving behavior. Dive depths appear to differ slightly between rookeries as well as between age and sex classes. Stewart *et al.* (2006) found that throughout the six NWHI breeding colonies, most dives were less than 150 meters, but found some dives exceeding 550 meters. At Pearl and Hermes Reef, most dives reach 8-40 meters, with some dives to three- to four-fold greater depths (Harington *et al.* 2004). At Kure Atoll, males tended to dive deeper than females (Harington *et al.* 2004). However, at Laysan Island, this trend was reversed and dives were much deeper (800 to 1`,150 feet`; Harington *et al.* 2004). Most dives at FFS were to depths of 4-40 meters, but some dives exceeded 500 meters (Abernathy 1999). Parrish *et al.* (2002) noted a tendency towards night diving at FFS.

Hawaiian monk seals tend to dive within the water column, rather than to the sea floor, regardless of site (Pullin and Stewart 2006). Some work using Crittercams on seals at FFS indicates that most time spent underwater was for resting and socializing, not feeding. Despite the reef fishes of the coral shallows, adult seals forage on the slopes of the atoll and neighboring banks (Parrish *et al.* 2000). This is corroborated by the comparison between the diet composition of tagged seals and the composition of fish in each of four ecological zones (defined by depth) (Parrish and Abernathy 2006). Foraging has been shown to vary by age, with older juveniles (years 2 and 3) focusing on shallow atoll depths (10-30 meters) and yearlings feeding in sand fields at 50-100 meters. It is

possible that the shift in foraging behavior with age is dependent on the physical strength to flip small rocks to find prey, rather than increasing dive duration or depth (Parrish *et al.* 2005).

c. Listing status

Hawaiian monk seals were listed as endangered on November 23, 1976 (41 FR 51611).

d. Status and trends

The Hawaiian monk seal was listed as endangered under the ESA on November 23, 1976 (41 FR 51611). Hawaiian monk seals are considered one of the most endangered groups of pinnipeds on the planet because all of their populations are either extinct (Caribbean monk seal) or close to extinction (Mediterranean and Hawaiian monk seals). Two periods of anthropogenic decline have been reported; the first decline occurred in the 1800s when sealers, crews of wrecked vessels, and guano and feather hunters nearly hunted monk seals to extinction (Dill and Bryan 1912, Kenyon and Rice 1959).

Following the initial collapse, expeditions to the NWHI reported increasing seal numbers and partial recovery to slightly more than 1,000 individuals (Bailey 1952, Rice 1960b). However, a second decline occurred from the late 1950s to the mid-1970s; the population declined by roughly 50% by

the 1980s (NMFS 1991). The total population in the FFS, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Kure Atoll, and Midway, Necker, and Nihoa was estimated to be 1,501 in 1984, 1,976 seals in 1986, and 1,580 in 1992 (Ragen 1993). For the years 1985 to 1993 the mean beach counts declined by approximately 5% per year. This downward trend is expected to continue, mainly because of poor pup and juvenile survival in recent years.

The best estimate of the total population of the species is 1,202 seals and the minimum population size estimate for the Hawaiian monk seal is 1,176 seals (NMFS 2007b). Data collected in 2008 suggest that the species population is now 1,146 (NMFS 2009). A log-linear regression of estimated abundance from 1998 to 2006 suggests the population has declined on average -3.9% per year, and models predict that the total population of the species will fall below 1,000 monk seals within 5 years (NMFS 2007b). Trends in abundance vary considerably among the six main subpopulations.

A recent five-year status review conducted by NMFS recommends that the Hawaiian monk seals' endangered status should remain the same (72 FR 46966, August 2007). The population dynamics at the different subpopulations have varied considerably, and current demographic variability among the island populations probably reflects a combination of different histories of human disturbance and management (Gerrodette and DeMaster 1990, Craig and Ragen 1999), and varying environmental conditions (Baker *et al.* 2007; Baker and Thompson 2006; Craig and Ragen 1999; Polovina *et al.* 1994). The current status of the Hawaiian monk seal is dire, due to low juvenile survival and the number of aging breeding females in the population. Consequently, NMFS is currently exploring development of a captive care program for juvenile Hawaiian monk seals to enhance their potential for survival and recovery (NMFS 2007b).

The total of mean, non-pup, beach counts at the main reproductive subpopulations in 2005 was approximately 67% lower than in 1958 (Benson *et al.* 2007). A log-linear regression of estimated abundance from 1998 (the first year for which a reliable total abundance estimate was obtained) to 2006 estimates that abundance declined by 3.9% annually (Figure 2)(NMFS 2007b).

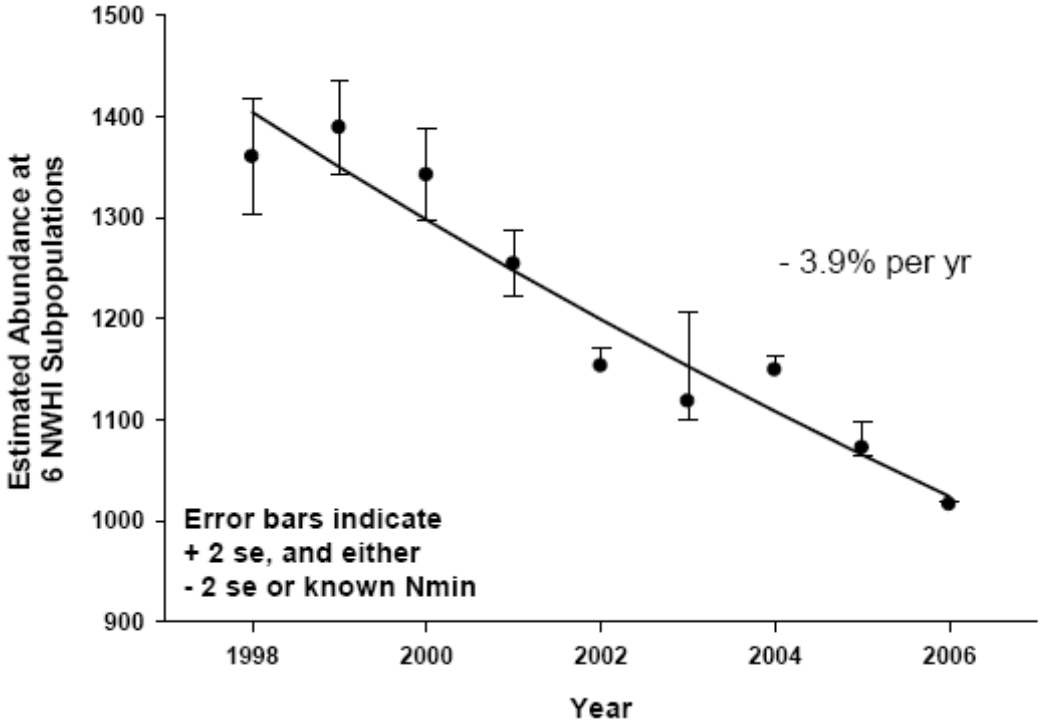

Figure 2. Trends in abundance of Hawaiian monk seals at the six main NWHI subpopulations combined, 1998-2006. This graph does not include abundance estimates for Necker, Nihoa, or the MHI. Error bars indicate ±2 standard errors or known minimum abundance. The fitted trend line reveals an estimated decline of 3.9% (NMFS 2007b).

Trends vary among the six main subpopulations. Non-pup beach counts at FFS have decreased by 73% from 1989 to 2005 (Benson *et al.* 2007). At one time, FFS accounted for over 50% of the total non-pup beach counts among the NWHI subpopulations; however, that proportion has dropped to 25%, although FFS still maintains the single largest subpopulation (NMFS 2007b). The annual number of births has dropped from a high of 127 in 1988 to 39 in 2006, and survival from weaning to age two has declined from a high near 90% in the mid-1980s to a low of 8% in 1997 (NMFS 2007b). Shark predation and prey availability are two potentially responsible factors.

Populations at Laysan and Lisianski Islands declined sharply after the late 1950s. In 1994, 21 adult male Hawaiian monk seals were relocated from Laysan Island to the MHI in an attempt to equalize the sex ratio at Laysan Island, and beach counts increased from 1995 to 2000, but have declined in the following years, while the Lisianski subpopulation has remained relatively stable, yet low, since the 1970s. Marine debris and low fecundity are factors that might contribute to the lack of subpopulation growth at Lisianski Island. And while the decline in abundance in Laysan may be related to female mortality caused by male aggression, juvenile survival is relatively good for most cohorts, and the lack of recovery on Laysan is not understood (NMFS 2007b).

Until recently, the three westernmost subpopulations, Kure, Midway and Pearl and Hermes Reef exhibited substantial growth. Beach counts on Kure increased 5% per year from 1983 to 2000, declined in 2000-2001, and are now slowly increasing. At Midway, beach counts increased from 1995 to 2000, and have since declined. The subpopulation at Pearl and Hermes Reef increased after

the mid-1970s. Prior to 1999, beach count increases of up to 7% per year were observed. This is the highest estimate of the maximum net productivity rate observed for this species. Since 2000, low juvenile survival, thought to be due largely to food limitation, has been widespread with rare exceptions in the NWHI, resulting in the population decline (Benson *et al.* 2007), and several recent cohorts at the three westernmost sites indicate a drop in juvenile survival (NMFS 2007b).

Sightings of Hawaiian monk seals have occurred on at least three occasions at the remote Pacific location of Johnston Atoll (excluding nine adult males relocated there from Laysan Island in 1984). The decrease in survival rates of immature animals, including a decline in survival from birth to weaning, and survival from weaning to age 2 years has contributed to a dramatically imbalanced age structure for all six of the main NWHI subpopulations (Fig. 12) (NMFS 2007b, 2009a). Although studies show that the relationship between size of pups and first year survival vary between subpopulations and over time, site-specific analyses do support girth and year as predictors of first-year survival at each location. When conditions for survival are worse, the relationship between size and survival strengthens. The simplest explanation for this is food limitation (Baker 2008).

Sightings and births are increasing in the MHI, although systematic surveys were not conducted before 2000, and counts do not represent total abundance, as they do not account for seals in the water, and not every seal on land is detected. In 2000, the count in the MHI was 45 seals, and in 2001, 52 were counted. In 2005, the total number of unique seals identified was 77, based on non-systematic sightings. Annual births have increased since the mid-1990s. Although this could be a positive indication for the survival of the species, the increased chance of contraction of diseases such as leptospirosis and toxoplasmosis from wild and domestic animals, and increased interactions with humans, including fishermen, boaters, and divers raise conservation concerns which do not apply to the NWHI (NMFS 2007b).

Hawaiian monk seal pups weaned in the MHI exhibit higher girths and lengths compared to pups from the NWHI, as a result of pre- and post-partum maternal investment – a partial reflection of prey availability – contradicting the studies that indicate better foraging conditions in the NWHI. Suggested explanations for this include a higher per capita availability of prey in the MHI, similar absolute preferred prey densities when apex predators are not included in the biomass, and increased prey availability due to reduced competition from apex predators (Baker and Johanos 2004).

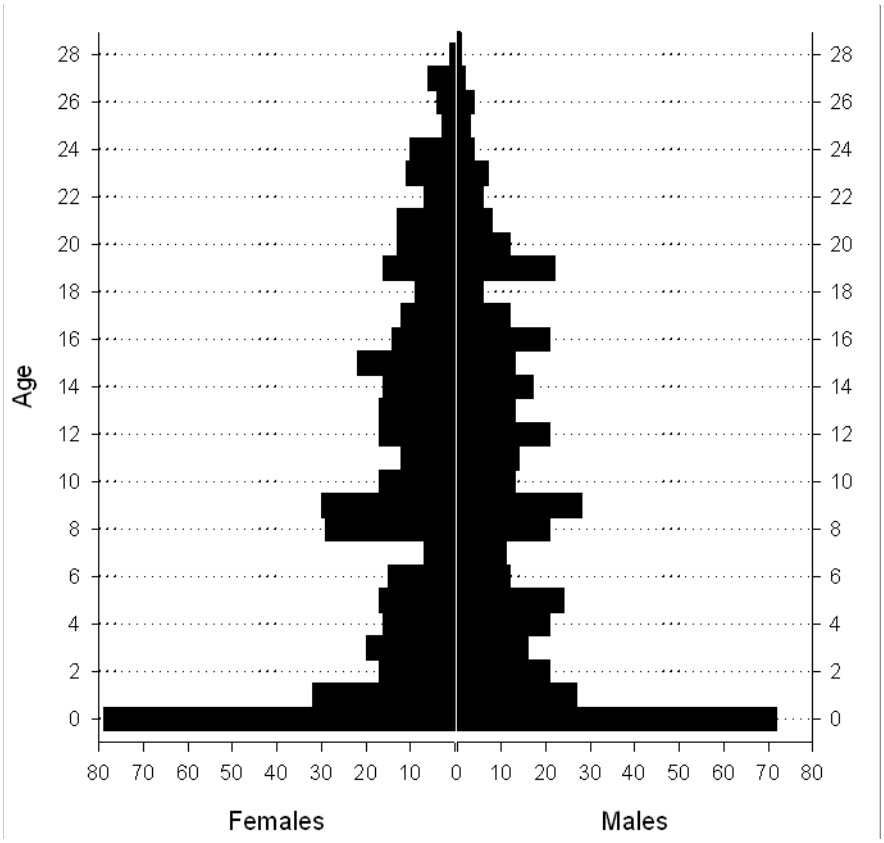

Figure 3. Age distribution for the Hawaiian monk seal population in the NWHI (MMRP unpublished data in NMFS 2009).

VI. ENVIRONMENTAL BASELINE

A. Natural Mortality

Natural Mortality Rates

Cetaceans

Natural sources and rates of mortality for whales are largely unknown. Rates of natural mortality in fin whales generally are thought to range between 0.04 and 0.06 (Aguilar and Lockyer 1987). Natural mortality rates are difficult to estimate for sei whales, but appear to be about 7.5 percent per year in adults, perhaps somewhat greater in immature animals (Allen 1980). The total level of natural mortality for blue whales in the Atlantic is unknown, but the total level of human-caused mortality (from U.S. fisheries interactions or U.S. ship strikes) is believed to be insignificant and approaching a zero mortality and serious injury rate (NMFS 2002). Rates of natural mortality for humpbacks are unknown, but reported levels of U.S. fishery-caused mortality is more than 10% of the calculated potential biological removal (NMFS 2008a,b).

Natural mortality rates are scarce for right whales, although more is known about causes of death for North Atlantic than for North Pacific right whales. Deaths resulting from human activities account for at least one-third of all known mortalities in the western North Atlantic right whale population (Kraus 1990), however, the extent to which natural factors, such as disease and

predation, affect mortality rates is not known. Kraus (1990) used photo-identification data from the western North Atlantic population to calculate an average mortality rate of 17 percent per year in first-year right whales, while second- through fourth-year whales had an average mortality rate of 3 percent per year. Including all sources of mortality, both natural and anthropogenic, 27 percent of all western North Atlantic right whales die before reaching four years of age (Kraus 1990). Very little is known about natural mortality in North Pacific right whales.

Ice Entrapment

Cetaceans
Whales may become trapped by winter ice settling around them. They face starvation if they cannot escape. The essential factor is that they need holes in the ice in order to surface and breathe as they escape to the floe edge. Ice entrapment is known to injure and kill some fin whales, particularly in the Gulf of St. Lawrence (Sergeant *et al*. 1970). Ice entrapment is known to injure and kill some blue whales in the North Atlantic, particularly along the southwest coast of Newfoundland during late winter and early spring (Beamish 1979; Sergeant 1982). Scarring on the dorsal surface of some blue whales in the St. Lawrence is thought to be from contact with ice (Sears *et al*. 1987, 1990). Unlike in the western North Atlantic, injury or suffocation from ice entrapment is not known to be a factor in the natural mortality of blue whales in the North Pacific.

Predation

Killer whales, *Orcinus orca*, and sharks prey on every species of whale and pinniped affected under this action, although attacks on right, sei, and blue whales appear to be more rare than for the other species.

Cetaceans
Predation has frequently been observed on humpbacks by killer whales with juveniles being the primary age group targeted of this species. 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). 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).

Predation by killer whales has also frequently been observed on fin whales. Adult fin whales engage in a 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 individual fin whales (Perry *et al*. 1999). Mitchell and Reeves (1988) reported evidence, most of it anecdotal, indicating that killer whales attack fin whales in the western North Atlantic. Shark attacks on weak or young individuals are probably common, but have not been documented.

Sperm whales are known to be occasionally predated upon by killer whales (Jefferson and Baird 1991; Pitman *et al.* 2001) and large sharks (Best *et al.* 1984) and harassed by pilot whales (Arnbom *et al.* 1987; Palacios and Mate 1996; Rice 1989b; Weller *et al.* 1996; Whitehead 1995).

Evidence of attacks on right, sei, and blue whales is less common. Various species of large sharks and killer whales may be predators of right whales, particularly for young or sick individuals, but no such attacks have actually been observed in North Atlantic right whales. Scars from killer whale attacks have been photographed on North Atlantic right whales (Kraus 1990), although the level of killer whale attacks and the extent to which they result in death is not known. Andrews (1916) suggested that killer whales attacked sei whales less frequently than fin and blue whales in the same geographical 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).

As the world's largest animals, blue whales are only occasionally known to be taken by killer whales (Sears *et al*. 1990; Tarpy 1979). A well-documented observation of killer whales attacking a blue whale off Baja California proves that blue whales are at least occasionally vulnerable to these predators (Tarpy 1979). Blue whales also engage in a flight response to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). A high proportion of the blue whales in the Gulf of California bear injuries or rake-like scars that are the result of encounters with killer whales (Sears 1990), although the extent to which such attacks are fatal is unknown. In the Atlantic, two blue whales in the Gulf of St. Lawrence bore rake-like markings assumed to be from the teeth of killer whales (*Orcinus orca*) (Sears *et al*. 1990), but no direct evidence of predation on blue whales has been reported from this area.

Pinnipeds

Killer whale predation on pinnipeds, particularly on the Western Steller sea lion DPS under reduced population size, may cause significant reductions in the stock (NMFS 2008c). Sleeper sharks are also significant predators of Steller sea lions. Frid *et al.* (2009) suggested that risk of predation in nearshore waters by killer whales and offshore predation risk by sleeper sharks limited the use of Pacific herring in deep water and walleye Pollock in shallow water.

Shark predation is considered a threat to Hawaiian monk seals because of the small number of remaining and previous declines in monk seal numbers. Sharks prey upon pups and subadults primarily, but may injure or kill individuals of any age (Alcorn and Kam 1986; Bertilsson-Friedman 2006). Injuries and scars from old shark bites can be seen on many monk seals and predation has been occasionally observed (Alcorn and Kam 1986; Balazs and Whittow 1979; Bertilsson-Friedman 2002; Hiruki *et al.* 1993; Johanos and Kam 1986; Taylor and Naftel 1978; Wirtz 1968). Historically, attacks were believed to be from tiger sharks, but recent observation support Galapagos sharks to also be significant predators, particularly at FFS (Bertilsson-Friedman 2006). Female pups appear to be preyed upon more frequently than male pups (Bertilsson-Friedman 2006). Male juveniles are more frequently attacked than females of this age class (Bertilsson-Friedman 2006). Pups tend to sustain more severe injuries than other age classes (Bertilsson-Friedman 2006). There has been a significant increase in shark predation on Hawaiian monk seal pups born at FFS, where shark related injury and mortality of pre-weaned pups have

been conspicuously higher than at other sites (NMFS 2007b). Based on field observations, shark predation may also be compromising recovery at Midway and Kure (NMFS 2007b).

Disease

Cetaceans
Many baleen whale species have been observed to carry parasites, become infected with biotoxins, and succumb to bacterial and viral infections.

Crassicaudosis is a systemic disease caused by the nematode, *Crassicauda boopis*, occurring in blue whales, fin whales, and humpback whales (Lambertsen 1992). Infections with this giant nematode characteristically incite a chronic inflammatory reaction of the blood vessels which drain the kidneys and cause renal failure (Lambertsen 1992). This disease plays a major role in the natural mortality in fin whales and the occurrence of this nematode may be preventing some fin whale populations from recovering (Lambertsen 1992). In fact, Lambertsen (1986) contended that crassicaudosis in the urinary tract was the primary cause of natural mortality in North Atlantic fin whales.

Chronic exposure to the neurotoxins associated with paralytic shellfish poisoning (PSP) via zooplankton prey has also been shown to have detrimental effects on marine mammals. Estimated ingestion rates are sufficiently high to suggest that the PSP toxins may be affecting marine mammals, possibly resulting in lower respiratory function, changes in feeding behavior, and diminished reproduction (Durbin *et al.* 2002).

Parasites and biotoxins from red-tide blooms are potential causes of mortality (Perry *et al*. 1999) for humpback whales. 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. Between November 1987 and January 1988, at least 14 humpback whales died after consuming Atlantic mackerel containing a dinoflagellate saxitoxin (Geraci *et al*. 1989). The whales subsequently stranded or were recovered in the vicinity of Cape Cod Bay and Nantucket Sound, and it is highly likely that other unrecorded mortalities occurred during this event. During the first six months of 1990, seven dead juvenile (7.6 to 9.1 m long) humpback whales stranded between North Carolina and New Jersey. The significance of these strandings is unknown, but is a cause for concern. In July 2003, an Unusual Mortality Event was recorded in offshore waters when an estimated minimum of 12-15 humpback whales died in the vicinity of the Northeast Peak of Georges Bank. Preliminary tests of samples taken from some of these whales were positive for domoic acid at low levels, but it is currently unknown what levels would affect the whales and therefore no definitive conclusions can yet be drawn regarding the cause of this event or its effect on the status of the Gulf of Maine humpback whale population.

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). Sei whales are usually relatively free of ectoparasites, but are very often heavily infected with endoparasitic helminths; presumably this is because its diet is more catholic than that of the fin or blue whale (Rice 1977). Some of the seen endoparasitic worms are frequently pathogenic, affecting especially the liver and kidneys. A disease of unknown origin affects seven percent of the sei whales off California

and causes them to shed their baleen plates, which greatly impairs their feeding ability (Mizroch *et al.* 1984b).

Calcivirus and papillomavirus are known pathogens of sperm whales (Lambertsen *et al.* 1987; Smith and Latham 1978). Strandings are also relatively common events for sperm whales, 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.

At this time, there are no data indicating that disease is limiting right whale recovery. However, results of body condition analysis and the occurrence of skin lesions on North Atlantic right whales maybe indicative of health issues within the population (NMFS 2005b).

Pinnipeds
Steller sea lions have tested positive for several pathogens, but disease levels are unknown (FOC 2008). Similarly, parasites in this species are common, but mortality resulting from infestation is unknown. However, significant negative effects of these factors may occur in combination with stress, which reduces immune capability to resist infections and infestations. If other factors, such as disturbance, injury, or difficulty feeding occur, it is more likely that disease and parasitism can play a greater role in population reduction.

Hawaiian monk seals, like other marine mammals, can become ill or die from several diseases (Aguirre *et al*. 2007a). Epidemiological studies have not shown significant differences in presence of diseases and infectious disease is not currently a significant cause of overall mortality (Aguirre 2000; Aguirre *et al.* 2007; Banish and Gilmartin 1992; Reif *et al.* 2004). However, toxoplasmosis has been identified as the cause of death in two adult seals (Dubey *et al.* 2004; Honnold *et al.* 2005; NMFS 2007b). A novel herpesvirus isolate has been identified from captive and wild monk seals as a possible cause of eye disease in rehabilitated seals *(*Goldstein *et al.* 2006).

To date no epidemics of infectious diseases have been identified. However, there have been three events during which mortality or reproductive failure raised concern over the potential role of disease. These include a die-off of at least 50 seals on Laysan Island in 1978, a cluster of four aborted fetuses on Laysan Island in 2000, and a die-off of at least 11 seals throughout the NWHI in 2001 (Gilmartin *et al.* 1980, Antonelis *et al*. 2001). In 2001, the discovery of four dead seals on Laysan Island within one week led to the declaration of an unusual mortality event.

Interspecific Competition

Cetaceans
There has been considerable discussion of interspecific competition among mysticete whales, but no conclusive evidence has been adduced to demonstrate that it occurs (Clapham and Brownell 1996). The substantial dietary overlap among the balaenopterids (Kawamura 1980; Nemoto 1970) establishes the potential for interference competition.

It has been suggested that interspecific competition with either sei whales or planktivorous fish may limit Northern right whale prey consumption (Kraus *et al*. 1988; Mitchell 1975; Payne *et al*. 1990). In the North Atlantic, sei whales are sympatric with the right whales, and because both species feed on small zooplankton species, they may compete (Mitchell 1975). There is also speculation about competition with certain species of fish in the Gulf of Maine, including sand lance (*Ammodytes* spp.), herring (*Clupea* spp.), Atlantic mackerel (*Scomber scombrus*), river herrings (shad, blueback; *Alosa* spp.), menhaden (*Brevoortia tyrannus*), and basking sharks (*Cetorhinus maximus*). However, as noted by Clapham and Brownell (1996), assertions regarding interspecific competition are rarely well defined or ecologically based; while the potential for interference competition exists for right whales with other species, direct evidence is essentially absent.

Nothing is known about possible competition between North Pacific right whales and sympatric species. Bowhead whales are similar in anatomy and could conceivably be competitors. Since most bowheads migrate out of the Bering Sea each spring and spend the summer in the Beaufort Sea (Moore and Reeves 1993) at the time when right whales might be in the Bering Sea, there is unlikely to be much overlap in range. Bowhead prey consists of copepods (e.g., *C. glacialis*) and euphausiids (e.g., *Thysanoessa raschii*) (Lowry 1993), although more than 60 species of invertebrates have been recorded in their diet.

Other baleen whales whose range overlaps with the range of blue whales could potentially compete with blue whales for food (Nemoto 1970). Nevertheless, there is no evidence of competition among these whales and the highly migratory behavior of blue whales may help them avoid competition with other baleen whales (Clapham and Brownell 1996), and it seems unlikely that resource competition would be an important factor in preventing the recovery of blue whale stocks.

Pinnipeds

The primary identified cause of adult and immature female mortality affecting the recovery potential in the Hawaiian monk seal population during the 1980s and early 1990s, was injury and often death caused by multiple male aggression (especially at Laysan and Lisianski Islands). Attacks by single adult males have also resulted in several monk seal mortalities, occurring at most or all locations and involving behavior which ranges from normal pinniped male harassment of younger animals to an aberrant level of focused aggression, especially directed toward weaned pups. Most recently, this emerged as a serious issue at FFS in the late 1990s. While this threat tends to be episodic, it is usually limited in geographic area at any given time, and the methods for mitigating it have been successful, this is still considered a serious threat.

B. Vessel Interactions

Vessel interactions by way of ship collisions are a major human-induced mortality factor affecting marine mammals today. Quantification of ship strikes and the effect on large whales in the proposed action area is difficult. Collisions with ships are an increasing threat to many large whale species, particularly as commercial shipping lanes cross important large whale breeding and feeding habitats or migratory routes. Ship strikes are known to affect large whales especially in the western North Atlantic portion of the action area, where several high-use shipping corridors occur.

Current studies show the North Atlantic right whale to be the most vulnerable large whale species to ship strikes. However, past studies have also placed the fin and humpback whales in first place. Sei whales, and blue whales are also commonly struck and strikes are least common for bowhead whales. Ship strike reports or occurrences are not well known and documented for North Pacific right whales. 17 sperm whale individuals were known to have been struck by vessels in 2004 (Jensen and Silber 2004). Whale-watching vessels are known to influence sperm whale behavior (Richter *et al.* 2006).

Historical records demonstrate that the most numerous, per capita, ocean-going-vessel strikes recorded among large whale species accrue to the North Atlantic right whale (Vanderlaan and Taggart 2007). Very little is known about ship strike mortality statistics of North Pacific right whales (NMFS 2006e). Right whales may be more vulnerable to ship strikes than any other species because of behaviors, such as skim feeding, nursing, and mating, which occur at the surface and may make whales less attentive to surrounding activity and noise (Laist *et al*. 2001). Records from Knowlton and Kraus' (2001) account for right whale deaths due to ship strikes and report that, of 15 confirmed right whale ship strikes in the western North Atlantic (including Canada) from 1970 to 1999, nine (60 percent) occurred in the Northeast, and three (20 percent) occurred in both the mid-Atlantic and Southeast. Records of deaths from 1970 to 1999 indicate that ship strikes were responsible for over one-third (16 out of 45, or 35.5 percent) of all "confirmed" right whale mortalities (a "confirmed" mortality is one observed under specific conditions defined by NMFS) (Knowlton and Kraus 2001). Based on criteria developed by Knowlton and Kraus (2001), 56 additional ("unconfirmed") serious injuries and mortalities from entanglement or ship strikes were found to have occurred between 1970 and 1999, of which 25 (44.6 percent) were from ship strikes. Of these, 16 were fatal interactions; two possibly fatal; and seven nonfatal (Knowlton and Kraus 2001). Because of ship strike frequency and gravity, mortalities due to ship strikes have been a cause for concern and threaten to accelerate the declining trend in growth rates in North Atlantic right whales. Annual mortality rate (Kraus *et al.* 2005), and calculations based on demographic data through 1999 (Fujiwara and Caswell 2001) indicate that this mortality rate increase would reduce population growth by approximately ten percent per year (Kraus *et al*. 2005). In 2005 mortalities included six adult females, three of which were carrying near-term fetuses. Furthermore, four of these females were just starting to bear calves, and since the average lifetime calf production is 5.25 calves (Fujiwara and Caswell 2001), the deaths of these females represent a lost reproductive potential of as many as 21 animals.

In 2004, a review of the NMFS' ship strike database had revealed fin whales to be the most frequently confirmed victims of ship strikes at that time (26% of the recorded ship strikes where n = 75/292 records), with most collisions occurring off the east coast, followed by the west coast of the U.S. and Alaska/Hawaii (Jensen and Silber 2004). According to Waring *et al*. (2007), five fin whales were killed or injured as a result of ship strikes between January 2000 and December 2004. Between 1999-2005, there were 15 reports of fin whales strikes by vessels along the U.S. and Canadian Atlantic coasts (Cole *et al.* 2005a; Nelson *et al*. 2007a). 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% of living fin whales from the Mediterranean show

ship strike injury and 16% 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).

A 2003 study had found that more humpback whales were killed in collisions with ships than any other whale species except for fin whales at that time (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*. 1997). Of 123 humpback whales that stranded along the Atlantic coast of the U.S. between 1975 and 1996, 10 (8.1%) 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*. 2005b; Nelson *et al.* 2007b). 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%.

Sei whales are occasionally killed in collisions with vessels. Of three sei whales that stranded along the U.S. Atlantic coast between 1975-1996, 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*. 2005b; Nelson *et al*. 2007b). 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*. 2008). 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%.

Ship strike is also a concern for blue whale species. Ship strikes have recently averaged roughly one every other year (eight ship strike incidents are known Jensen and Silber (2004), but in September 2007, ships struck five blue whales within a few-day period off southern California (Calambokidis pers. comm. 2008). Dive data support a surface-oriented behavior during nighttime that would make blue whales particularly vulnerable to ship strikes. There are concerns that, like right whales, blue whales may surface when approached by large vessels; a behavior that would increase their likelihood of being struck. In the California/Mexico stock, annual incidental mortality due to ship strikes averaged one whale every 5 years, but we cannot determine if this reflects the actual number of blue whales struck and killed by ships (i.e., individuals not observed when struck and those who do not strand; Barlow *et al*. (1997). As with other whale species, it is believed that the vast majority of ship strike mortalities of blue whales are never identified, and that actual mortality is higher than currently documented.

Pinnipeds

At present, ship strikes of Hawaiian monk seals is believed to be extremely low or non-existent, primarily because most monk seal subpopulations are located in restricted waters far from heavily traveled waters. Although there is no published evidence that monk seals were struck by

vessels, one seal was found in 1986 with a broken jaw and presumed propeller cuts on its belly. Another seal was found off Kona with an injured back and broken vertebrae. With the growth of the MHI subpopulation, the probability of ship strike is likely to increase.

C. Fishery Interactions

Cetaceans

Entrapment and entanglement in fishing gear is a frequently documented source of human-caused mortality in large whale species. Entrapment and entanglement in fishing gear may also make whales more vulnerable to additional dangers (e.g., predation and ship strikes) by restricting agility and swimming speed. Injuries and entanglements that are not initially lethal may result in a gradual weakening of entangled individuals, making them more vulnerable to some other direct cause of mortality (Kenney and Kraus 1993). For example, entanglement may reduce a whale's ability to maneuver, making it more susceptible to ship strikes. Entanglement-related stress may decrease an individual's reproductive success or reduce its life span, which may in turn depress population growth. Furthermore, tissue damage caused by gear causes the whale to physiologically respond with an increase in glucocorticoids which suppresses lymphocytes and, if sustained (due to chronic destruction of tissue by gear), compromises the ability of the whale to fight other infections (Cole *et al*. 2006). 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 frequency of eventual mortalities. Numerous fisheries operate within the action area, and entanglement in fishing gear is a concern for whales in these ocean basins. The incidence of entanglement for each species is discussed below.

For fin whales in the North Atlantic, incidental capture, injury, and mortality do occur, but appear to be relatively rare. However, these interactions are difficult to assess due to the size, strength, and distribution of fin whales, and it is possible that injuries or mortalities from entanglement are affecting fin whales. No fishery-related mortality or serious injury to fin whales was observed by NMFS fishery observers during 2002 through 2006 (NMFS 2008a,b). Also for the period of 2002 through 2006, the minimum rate of human-caused mortality and serious injury to fin whales in the U.S. and Canadian Atlantic was 2.0 per year, with 0.8 being from fishery interactions. Anecdotal accounts from fishermen have suggested that large whales swim through their nets rather than get caught in them (Barlow *et al.* 1997), and NMFS has no observer records of fin whales being killed or seriously injured in commercial fisheries observed from 1997 to 2001 in the U.S. North Atlantic (Waring *et al.* 2004). However, NMFS stranding and entanglement records during the same time period yield an average of 0.2 fin whale mortalities per year from fishery interactions or entanglements in U.S. Atlantic waters (Waring *et al.* 2004). Also, according to a later study by Waring *et al*. (2007), four fin whales in the western North Atlantic died or were seriously injured in fishing gear. These stranding and entanglement reports are not statistically quantifiable in the same manner as fishery observer records, but they help to provide a minimum estimate of entanglements. More recently from 2001 to 2005, Nelson *et al*. (2007a) report four confirmed entanglements of fin whales in the western North Atlantic off the U.S. east coast, three of which were fatal and one resulted in serious injury.

Humpback whales have been affected by interactions with fishing gear in the North Atlantic. For the period 2002 through 2006, the minimum annual rate of human-caused mortality and serious injury to the Gulf of Maine humpback stock averaged 4.4 animals per year (includes U.S. and Canadian waters), with 3.0 of that value being from fishery interactions (U.S. waters 2.6; Canadian waters 0.4) (Glass *et al*. 2008). From 1990 to 1994, NMFS records indicate that 11 humpback whales were entangled in lobster gear in the Gulf of Maine, and from 1997–2001, 11 humpbacks from the Gulf of Maine stock were killed or seriously injured as a result of interactions with fishing gear (Waring *et al.* 2004). From 1999 to 2003, at least five humpback whale mortalities and nine serious injuries occurred in the Gulf of Maine due to fishery interactions (Waring *et al.* 2006); and from 2001-2005, Nelson *et al.* (2007a) report seven mortalities and five serious injuries of humpbacks in U.S. Atlantic waters due to entanglement. Robbins and Mattila (2001) studied entanglement-related scarring on 134 individual humpback whales in the Gulf of Maine and concluded that between 48 and 65 percent had experienced entanglements. The authors also found that female humpbacks showing evidence of prior entanglements produced significantly fewer calves, suggesting entanglement may significantly reduce reproductive success (Robbins and Mattila 2001).

Entanglements in commercial fishing gear appear unlikely to threaten the status or trend of sei whales. There are no confirmed fishery-related mortalities or serious injuries of sei whales reported in the NMFS Sea Sampling bycatch database (NMFS 2008a,b). There was one serious injury entanglement reported on Jeffreys Ledge in 2006 (NMFS 2008a,b), no reported fishery-related mortalities or serious injuries of sei whales in western North Atlantic fisheries from 1999–2005 (Nelson *et al*. 2007; Waring *et al.* 2006a), from 1997–2001 (Waring *et al.* 2004), nor from 1989–1995 (Barlow *et al.* 1997). However, it is possible that some mortalities go unobserved. Perry *et al*. (1999) note that injuries and mortalities from fisheries-related incidents are considered biologically insignificant for sei whales, but that a comprehensive review of all fisheries has not been conducted.

Most North Atlantic right whale entanglements appear to be with gillnets, lobster pots, crab pots, seines, fish weirs, and aquaculture equipment (NMFS 2005b). According to the 2006 Stock Assessment Report, 57 percent of right whale mortalities or serious injuries reported from 2000 through 2004 resulted from entanglements or fishery interactions (Waring *et al*. 2007). From 2002 through 2006, 7 of 19 records of mortality or serious injury in U.S. and Canadian waters involved entanglement or other fishery interactions (NMFS 2008a,b). The only bycatch of a right whale was observed by the Northeast Fisheries Observer Program in the pelagic drift gillnet fishery in 1993, but no bycatch mortalities or serious injuries have been documented in any of the other fisheries monitored by NMFS (NMFS 2008a,b). Entanglement records from 1990 through 2006 maintained by NMFS Northeast Regional Office include 45 confirmed right whale entanglements, including right whales in weirs, in gillnets, and in trailing line and buoys. Because whales often free themselves of gear following an entanglement event, scarring may be a better indicator of fisheries interaction than entanglement records. In an analysis of the scarification of right whales, 338 of 447 (75.6%) whales examined during 1980-2002 were scarred at least once by fishing gear (Knowlton *et al*. 2005). Further research using the North Atlantic Right Whale Catalogue has indicated that, annually, between 14% and 51% of right whales are involved in entanglements (Knowlton *et al*. 2005). Although entanglements do not always result in death or serious injury, they pose a serious threat to North Atlantic right whales.

There are several more statistics on North Atlantic right whale entanglement injury or death. Records of deaths from 1970 to 1999 indicate that three out of 45 (6.7 percent) were due to entanglement in fishing gear (Knowlton and Kraus 2001). Based on criteria developed by Knowlton and Kraus (2001), 31 (55.4 percent) additional ("unconfirmed") serious injuries and mortalities from entanglement were found to have occurred between 1970 and 1999. Of these, three were fatal interactions; eight possibly fatal; and 20 nonfatal (Knowlton and Kraus 2001). Entanglement records from 1970 through 2004 (Waring *et al*. 2007) included at least 92 right whale entanglements or possible entanglements. Records of right whales from 2000 to 2004 confirm that 8 of the 14 right whales found dead or seriously injured involved entanglements or other fishery interactions. Also during 2000 to 2004, there were at least five documented cases of entanglements for which the intervention of disentanglement teams averted a likely serious injury determination (Waring *et al*. 2007). A NMFS reference document on mortality and serious injury determinations for large whales contains 50 reports of right whale events from 1999 to 2003 (Cole *et al*. 2005). During this period, entanglements resulted in three right whale mortalities and seven reports of serious injury. Between 1999 and 2003, there were 18 verified right whale mortalities, of which 16.7 percent resulted from entanglement (Cole *et al*. 2005).

There are no NMFS records of fisheries mortalities of North Pacific right whales (Angliss and Allen 2007). Thus, the estimated annual mortality rate incidental to U.S. commercial fisheries approaches zero whales per year from this stock (Angliss and Allen 2007). Therefore, the annual human-caused mortality level is considered to be insignificant and approaching zero mortality and serious injury rate (Angliss and Allen 2007). However, studies reveal entanglement issues in non-U.S. waters with North Pacific right whales. Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989 (Kornev 1994). An analysis of right whale photographs to estimate entanglement rate from scarring data is currently under way. Perry *et al*. (1999) reported two fishery-related mortalities due to fishing gear entanglement from Russian waters (Kornev 1994). On review of the original records in the Platforms of Opportunity Program database, one of the encounters was actually a sighting and not an entanglement. Therefore, only one case of entanglement is known from the western North Pacific (Brownell *et al*. 2001), though the occurrence of right whales near trap fisheries in the Bering Sea creates a potential for interactions.

There are no confirmed records of mortality or serious injury to blue whales in the U.S. North Atlantic EEZ (NMFS 2002). However, in March 1998 a dead 20 meter male blue whale was brought into Rhode Island waters on the bow of a tanker (NMFS 2002). The cause of death was determined to be a ship strike, but the necropsy revealed some injuries that were difficult to explain in that context (NMFS 2002). There have been no observed fishery-related mortalities or serious injury to blue whales in the North Atlantic (NMFS 2002). In Canadian waters, at least one blue whale found dead in the Gulf of St. Lawrence in recent years apparently died from the effects of entanglement in fishing gear (R. Sears, pers. comm., August 1995). A blue whale was observed on Stellwagen Bank, north of Cape Cod, Massachusetts in August 1987 trailing fishing gear, including what appeared to be a lobster pot buoy, from one pectoral fin (D.K. Mattila, pers. comm., February 1998). The lack of more evidence that blue whales become entrapped or entangled in fishing gear in the western North Atlantic may be due to incomplete reporting. In addition, the large size of the animals makes it more likely that blue whales will break through

nets, or carry gear away with them. In the latter case, undetected mortality may result from starvation due to interference with feeding, as sometimes occurs in humpback and northern right whales.

No definite evidence of blue whales being taken in fishing gear in the North Pacific is available. Heyning and Lewis (1990) made a crude estimate that about 73 rorquals were killed annually in the offshore southern California drift gillnet fishery during the 1980s, and at least some of these could have been blue whales. Heyning and Lewis 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 occurs. Thus, the lack of documentation of blue whale entanglements should not be interpreted to mean that none occur. The drift gillnet fisheries for swordfish and sharks off California and Baja California represent a potential threat to blue whales of the Mexico/California stock. Observer coverage in such fisheries was relatively low in the past (Barlow *et al*. 1995) but increased to 10-18 percent in 1991-1995 (Barlow *et al*. 1997). In the observed fisheries, no blue whale mortalities were documented. However, entanglement rates may be underestimated inasmuch as blue whales may break through or carry away fishing gear, perhaps suffering unrecorded subsequent mortalities.

Sperm whales are known to have become entangled in commercial fishing gear. Sperm whales are also killed incidentally by gill nets at a rate of roughly nine per year (data from 1991 to 1995) in U.S. Pacific waters (Barlow *et al.* 1997). Sperm whales are known to interact (remove fish from) longline fisheries in the Gulf of Alaska and entanglement has rarely been recorded (Hill and DeMaster 1999; Rice 1989a; Sigler *et al.* 2008).

There is concern that many marine mammals that die from entanglement in commercial fishing gear tend to sink or drift out to sea rather than strand ashore, thus making it difficult to accurately determine the frequency and number of whales involved. In addition, it is likely that entanglements and resulting injuries to some members of these whale populations go undetected and unreported. Since factors such as sinking make it hard to ascertain exact statistics of entanglements, effects of this threat on the large whale species in this Opinion remains unknown.

Pinnipeds

Several dozen Steller sea lion individuals may become entangled and drown in commercial fishing gear (Atkinson *et al.* 2008; NMFS 2008c). Significant concern also exists regarding competition between commercial fisheries and Steller sea lions for the same resource: stocks of pollock, Pacific cod, and Atka mackerel. Significant evidence exists that supports the western DPS declining as a result of change in diet and resulting declines in growth, birth rates, and survival (Atkinson *et al.* 2008; Calkins *et al.* 1998; Calkins and Goodwin 1988; Pitcher *et al.* 1998; Trites and Donnelly 2003). As a result, limitations on fishing grounds, duration of fishing season, and monitoring have been established to prevent Steller sea lion nutritional deficiencies as a result of inadequate prey availability.

From 1982-2006, there were 12 recorded instances of seals interacting with active fishery equipment in the NWHI and 43 seals have been documented in fishery interactions in the MHI from 1982-2006 (Carretta *et al.* 2006, NMFS 2007b). Five of the MHI interactions involved gillnets, and four of these occurred in the past 7 years. The remaining 38 interactions have

involved embedded hooks, with one mortality (Carretta *et al.* 2006); NMFS unpub. data). Two monk seals drowned in recreational gillnets on Oahu within the past 3 years (NMFS 2007b). It is expected that a seal is hooked at least every 2.9 years, resulting in serious injury or mortality at least every 6.7 years (NMFS 2003). Data from 1991-1992 support a Hawaiian monk seal stealing bait or caught fish once every 34.4 hours of fishing effort (Nitta and Henderson 1993). Data accumulated since 1990 indicate a total of 3 seals hooked by longlines, with another 13 possibly attributable to the fishery. At least three seals are known to have been hooked as a result of recreational fishing on Kure while the USCG operated a station there (Forney *et al.* 2000). While monk seals have been observed near fishing boats, there have been no reported interactions between monk seals and the bottomfishing fishery in the MHI. Although the NWHI are closed to most fisheries and all remaining fisheries will cease operations within one year, fisheries interactions are expected to become more numerous in the MHI as more seals inhabit the islands. Although de-hooking has been more successful in recent years, this does not alleviate the problem or the potential for future interaction.

Entanglement in fishing gear is a major threat to marine mammals in general and Hawaiian monk seals specifically. It has been estimated that nearly 100,000 marine mammals die each year due to marine debris ingestion or entanglement (Wallace 1985). The increased use of plastics, polypropylene, nylon nets and line has resulted in a corresponding increase of derelict debris on beaches in the NWHI (Donohue *et al.* 2001; Henderson 2001). Derelict fishing gear is a chronic pollutant affecting the NWHI (Donohue *et al.* 2001). Most fishing debris appears to be trawl webbing, comprising 84-88% of debris encountered (Boland and Donohue 2003; Donohue *et al.* 2001). Although MMRP staff have routinely removed debris from study sites, the Pacific Islands Fisheries Science Center began a concerted marine debris removal program that, in its first year (1996-1997), recovered 4,368 kg of derelict fishing gear from the NWHI. Over the next decade, at least 510,675 kg (511 metric tonnes) of derelict net gear was removed from the coral reef ecosystems of the NWHI (NMFS 2007b). Derelict fishing gear continues to accumulate at a rate of roughly 52 metric tonnes per year (Dameron *et al.* 2007). The NMFS continues to remove accumulating marine debris from the NWHI on an annual basis. Pearl and Hermes Reef accumulates over half of the annual marine debris deposition in the NWHI, although Lisianski Island also accumulates debris at very high rates (Dameron *et al.* 2007; Donohue *et al.* 2001). Accumulation is highest in lagoon areas, where Hawaiian monk seals frequently occur (Dameron *et al.* 2007). Debris accumulation is related to oceanography, with more debris accumulating when the subtropical convergence zone shifts southward and marine debris accumulated within the North Pacific Central Gyre is deposited or snags on reefs in the NWHI (Dameron *et al.* 2007; Pichel *et al.* 2007). For this reason, accumulation in the NWHI is heavier during El Niño events than during normal periods or La Niña events, resulting in higher Hawaiian monk seal entanglement rates (Dameron *et al.* 2007; Morishige *et al.* 2007).

Marine debris and derelict fishing gear have been well documented to entangle monk seals, who have one of the highest entanglement rates of any pinniped (Henderson 1984; Henderson 1985; Henderson 1990; Henderson 2001). Monk seals have become entangled in net, line, net/line combinations, straps, rings, and other random items such as discarded lifejackets, buckets, bicycle tires, and rubber hoses (Henderson 1990). Once entangled, unless a seal can free itself or is freed by researchers, the animal may suffer from:

- increased hydrodynamic drag while swimming and pursuing prey
- severe wounds that may become infected and lead to secondary complications and death
- severance of vital tissues, particularly in the neck and head region
- death by strangulation, drowning, starvation, or shark attack.

A total of 268 monk seals entanglements are known from 1982-2006 (11.2 entanglement annually), including 118 in fishing gear. Of these, 183 were released, 69 escaped unaided, 8 died, and 8 were not released, with their fate unknown. There were 57 serious injuries (32 from fishing gear) and 8 mortalities (7 from fishery items). From 1982 – 2000, an average of 2.3 seals were seriously injured or died as a result of fishery related marine debris (NMFS 2007b).

D. Subsistence and Historical Hunting

U.S. Commercial harvest of these large whale species no longer occurs in the action area for the proposed studies, and the IWC has moratoriums in place to protect these species from commercial whaling internationally. Nonetheless, historical whaling significantly reduced large whale abundance, and the effects of these reductions likely still persist. Subsistence hunting in U.S. waters currently occurs for some whales.

Fin whales have undergone significant exploitation throughout the world, but are currently protected under the IWC. The existing moratorium on the commercial hunting of fin whales in most of their range has been in force for two decades, and it has almost certainly had a positive effect on the species recovery. There is currently no legal whaling for fin whales in the Northern Hemisphere, apart from the annual take of up to about 20 fin whales in Greenland, which is sanctioned and managed under an IWC quota scheme. Iceland has consistently expressed a strong interest in resuming its whaling industry targeting fin, sei, and minke whales (Sigurjónsson 1989) and has recently re-joined the IWC. Iceland and Norway are not bound by IWC's moratorium on commercial whaling because both countries filed objections to that moratorium. Well-documented pirate whaling in the northeastern Atlantic occurred as recently as 1979 (Best 1992; Sanpera and Aguilar 1992), and attempted illegal trade in baleen whale meat has been documented several times during the 1990s (Baker and Palumbi 1994). Since the mid-1970s, there has been a strong demand in world markets (most of it centered in Japan) for baleen whale meat (Aguilar and Sanpera 1982). Therefore, it cannot be assumed that fin whales have been fully protected from commercial whaling since 1986 or that their current legal protection from commercial whaling will continue into the future.

Humpback whales were the target of commercial whaling operations in the western North Atlantic, being an early target of the whaling industry and one of the predominant species harvested between the 1860s and the early decades of the 1900s (Stevick *et al.* 2003a). Humpbacks were hunted in all areas where substantial concentrations would occur, including on summer feeding grounds located in the Gulf of Maine (Stevick *et al.* 2003b). Humpback commercial whale hunting then ceased in the North Atlantic in 1955 and in all other oceans in 1966. The last remaining hunt was carried out from the Island of Bequia, St. Vincent and the Grenadines, Lesser Antilles, using small boats and methods employed by 19th century Yankee whalers (Ward 1987). In 1987, the IWC set a quota of 3 humpback whales per year for each of the years 1987 through 1989 for the Bequia subsistence harvest, but only one whale was killed in

1987. The Bequia hunt probably did not adversely affect the overall population of humpback whales within the Western North Atlantic, but it probably slowed recovery of the species in the Lesser Antilles region since it focused on reproductively mature females (Winn and Scott 1981). Humpback hunting at Bequia has probably terminated, since the men who organized the tradition are now aged or dead.

Sei whales were also harvested in the western North Atlantic, with 14,295 caught in the North Atlantic between 1885 and 1984 (Horwood 1987). Whaling occurred at the Blandford, Nova Scotia, whaling station, where 825 sei whales were taken between 1965 and 1972 (Mitchell 1975). When modern whaling began in Norway in the late 1800's, blue whales and then fin whales were the preferred species, although a few sei whales were taken late each season after the larger rorquals had migrated out of the area. As blue and fin whale stocks declined, however, sei whale catches gained in importance. In the early years, most sei whale catches occurred in waters off Norway and Iceland, although substantial catches were taken off Nova Scotia from 1967 to 1972. Currently, the Icelandic stock is the only one harvested in the North Atlantic.

Deliberate killing has had a severe effect on the status of blue whales in the North Atlantic (Jonsgård 1955). At least 11,000 were taken (all whaling areas, combined) from the late 19th to mid 20th centuries (Sigurjónsson and Gunnlaugsson 1990a). Blue whales are not known to have been subjected to hunting anywhere in the western North Atlantic since the 1960s. Whalers who hunt humpback whales in the Lesser Antilles under the aboriginal exemption in the IWC Schedule (and other cetaceans, including sperm whales and pilot whales) apparently do not see or attempt to take blue whales (Price 1985). Similarly, the aboriginal subsistence whaling off the coasts of Greenland legally involves only fin and minke whales at present, and only humpback whales have been reported as having been taken illegally in recent years (e.g., see Anon. 1993). Blue whales were not reported as taken from Icelandic shore stations after 1960, but at least three "fin" whales landed in Iceland during the 1980s were fin-blue whale hybrids (Árnason *et al*. 1991; Spilliaert *et al*. 1991). Another fin-blue whale hybrid was killed by a Spanish whaling operation in 1984 (Bérubé and Aguilar 1998). Currently, Norwegian whaling operations target only minke whales, and the commercial whaling stations in Iceland, Spain, and the Portugese islands of the Azores and Madeira remain officially closed.

Hunting also has had a severe impact on blue whales in the North Pacific. Areas of former abundance, notably off Japan and the Aleutian Islands, are currently host to very few blue whales (Miyashita *et al*. 1995; Stewart *et al*. 1987), strongly suggesting that whaling gravely depleted the populations concerned. According to Yablokov (1994), citing Zemsky and Shazhinov (1982), "It was ... well known in the Soviet Union that blue whales continued to be killed [in the Southern Hemisphere] after they were protected by the IWC." Details of these illegal kills have been reported recently (Zemsky *et al.* 1995a, 1995b). Although Yablokov (1994) stated that Russia also made illegal catches in the North Pacific from both land stations and pelagic operations, no information on these takes has been published. If these unreported catches included large numbers of blue whales, they would almost certainly have had a significant negative impact on the recovery of the species in this region.

Although initially the single major cause of decline in North Atlantic Right Whales, there has been little hunting of right whales this century; the last known catch occurred in 1951 at Trinity

Bay, Newfoundland (Mead 1986). Catches in the eastern North Atlantic in the late 19th and early 20th centuries were made off Iceland, Scotland and Ireland (Brown 1976; Collet 1909); these catches were made largely by Norwegian whaling operations, and it is likely that they irreversibly damaged or extirpated this stock. Basque whalers may have taken substantial numbers of right whales at times during the 1500s in the Strait of Belle Isle region (Aguilar 1986), and the North Atlantic stock of right whales may have already been substantially reduced by the time whaling by colonists began in the Plymouth, Massachusetts area in the 1600s (Reeves and Mitchell 1987). A modest but persistent whaling effort along the coast of the eastern United States lasted three centuries, and the records include one report of 29 whales killed in Cape Cod Bay in a single day during January 1700. Based on incomplete historical whaling data, Reeves and Mitchell (1987) could conclude only that there were at least some hundreds of right whales present in the western North Atlantic during the late 1600s. In a later study (Reeves *et al.* 1992a), a series of population trajectories using historical data and an estimated present population size of 350 were plotted. The results suggest that there may have been at least 1,000 right whales in this population during the early to mid-1600s, with the greatest population decline occurring in the early 1700s. The authors cautioned, however, that the record of removals was incomplete, the results were preliminary, and refinements were required. Based on back calculations using the present population size and growth rate, the population may have numbered fewer than 100 individuals by the time international protection for right whales can into effect in 1935 (Hain 1975; Kenney *et al.* 1995; Reeves *et al.* 1992a). However, too little is known about the population dynamics of right whales in the intervening years to state anything with confidence. There is no evidence that illegal whaling operations occurred in the North Atlantic, however these may occur for right whales in the North Pacific. Currently, subsistence hunters in Alaska and Russia are not reported to take animals from the North Pacific right whale stock.

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 1959-1983). However, other estimates have included 436,000 individuals killed between 1800-1987 (Carretta *et al.* 2005b). However, all of these estimates are likely underestimates due to illegal and inaccurate killings by Soviet whaling fleets between 1947-1973. In the Southern Hemisphere, these whalers killed an estimated 100,000 whales that they did not report to the IWC (Yablokov *et al.* 1998), with smaller harvests in the Northern Hemisphere, primarily the North Pacific, that extirpated sperm whales from large areas (Yablokov and Zemsky 2000). Additionally, Soviet whalers disproportionately killed adult females in any reproductive condition (pregnant or lactating) as well as immature sperm whales of either gender. Following a moratorium on whaling by the IWC, significant whaling pressures on sperm whales were eliminated.

Pinnipeds

Steller sea lions were historically and recently subjected to substantial mortality by humans, primarily due to commercial exploitation and both sanctioned and unsanctioned predator control, (Atkinson *et al.* 2008; Bigg 1988; Bonnot 1928; Bonnot and Ripley 1948; NMFS 2008c; Pearson and Verts 1970; Rowley 1929; Scheffer 1945; Scheffer 1950). Several hundred individuals are removed by subsistence hunters annually in controlled and authorized harvests. Occasional harvest occur in Canada (FOC 2008). Additional mortality (362 from 1990 to 2003) has

occurred from shooting of sea lions interfering in aquaculture operations along British Columbia (FOC 2008). Marine debris is also concerning for the health of Steller sea lion populations. It is estimated that 0.26% of Steller sea lions have marine debris around their necks or are hooked by fishing gear (0.07%) (FOC 2008; Raum-Suryan *et al.* 2009).

Seal hunters, crews of wrecked vessels, and guano and feather hunters hunted Hawaiian monk seals to near extinction in the late 1880s (Dill and Bryan 1912; Kenyon and Rice 1959; Ragen and Lavigne 1999). There is virtually no empirical information on the effect of this unregulated hunting pressure on Hawaiian monk seals, so the declines in their population has been inferred primarily from reports on where monk seals were not observed for several years (Ragen and Lavigne 1999). See *Status of Listed Resources* for available island-specific data. Hawaiian monk seals appear to have increased in population size after hunting pressure reduced their densities to levels below thresholds where human disturbance and commercial exploitation were significant factors (Ragen and Lavigne 1999).

E. Habitat Degradation

A number of human activities may be directly or indirectly affecting these listed species in the action area by degrading habitat. Anthropogenic activities such as discharges from wastewater systems, dredging, ocean dumping and disposal, aquaculture and additional impacts from coastal development are also known to affect marine mammals and their habitat. Undersea exploitation and development of mineral deposits, as well as dredging of major shipping channels pose a continued threat to the coastal habitat of listed species considered in this action. Point-source pollutants from coastal runoff, offshore mineral and gravel mining, at-sea disposal of dredged materials and sewage effluent, oil spills, as well as substantial commercial vessel traffic, and the impact of trawling and other fishing gear on the ocean floor are continued threats to marine mammals in the proposed action area. The effects of these activities are difficult to measure and remain largely unknown. Specific offshore industrial projects having deleterious effects on listed species are discussed in the *Offshore Industrial Activities* section below.

Cetaceans

Water-dependent construction activities frequently involve blasting, dredging, and filling which could result in displacement, injury, or mortality of listed whales. These adverse effects can and should be mitigated or eliminated through seasonal timing or construction design modifications. While the actual physical loss of habitat may be small in comparison to the total habitat available, secondary effects associated with the initial habitat modification may have negative consequences on the distribution and reproductive success of listed whales. Examples of such impacts might include increased vessel traffic associated with harbors, ramps, moorings, and hotels; development of tourism focusing on watching whales or diving with them; degradation of water quality resulting from increased surface runoff (agricultural, industrial, and residential); and sewage effluent from land and vessels. For example, only one Hawaiian marina has a sewage pumping station. Consequently, boats dump sewage directly into the water and sewage slicks can be seen at the surface (Glockner-Ferrari and Ferrari 1985).

One of the most direct potential sources of habitat degradation for listed whales is oil pollution. General concerns with regard to oil pollution are ingestion of contaminated prey, potential

irritation of skin and eyes, inhalation of toxic fumes, and abandonment of polluted feeding habitat (Geraci 1990). However, data on the effects of oil pollution on cetaceans are inconclusive, and the large baleen whales appear to be generally unaffected by oil *per se* (Geraci 1990).

Some studies suggest increased recreational boat traffic can disrupt behavior (e.g., in humpback whales (Glockner-Ferrari and Ferrari 1990)). For example, fast power boats, jet skis and parasails may disrupt and disturb right whales and pose a threat to whales even if their operators are not intentionally observing the animal itself. Pleasure boat traffic exists in various coastal areas with little regulation or enforcement; however, its impact on these whales is unknown.

Pinnipeds

Several factors currently threaten to curtail the quality or quantity of Hawaiian monk seal habitat, including human disturbance, toxins, contaminants, reef deterioration, and overfishing.

Hawaiian monk seals exhibit a "critical intolerance of humans" (Kenyon 1972). Human interactions with monk seals have ranged from unintentional disturbances at haul-out sites, to inflicting deliberate injuries on seals and killing them. Human disturbance can affect haul-out behavior, including causing seals to return to the water or decreasing attendance and nursing in mother and pup seals (Schneider and Payne 1983). Following an initial period of decline from expeditions to the NWHI, a second period occurred from the late 1950s to the mid-1970s when beach counts declined 50% where military and U.S. Coast Guard operations occurred. Here, pregnant females abandoned preferred pupping sites and nursing females abandoned their pups (Kenyon 1972, Gerrodette and Gilmartin 1990). Even today, Hawaiian monk seals in the NWHI avoid beaches where people have often disturbed them.

In the MHI, Hawaiian monk seals tend to distribute themselves in more remote areas where human disturbance is less likely (Baker and Johanos 2004). However, individual seals have become habituated to human presence and frequent beaches and other areas heavily used by humans. Recent successful monk seal pupping events have occurred on popular MHI beaches, in spite of documented instances of residents throwing coconuts at a resting seal and dogs biting beached monk seals.

F. Anthropogenic Noise

The effects of noise pollution are a growing concern. In addition to natural sources of noise (e.g., lightning, rain, sub-sea earthquakes, and animal vocalizations), noise generated by human activity occurs within the action area – this includes noise from vessel traffic, aircraft, sonar, coastal and marine construction, mineral extraction, explosives, and seismic activities. This noise may affect listed species; of particular concern is how it may affect their communication at low frequencies (Carretta *et al.* 2007). Effects of noise influence could include tolerance, habituation, sensitization, masking, behavioral disruption, social disruption, or displacement. Long-term effects of noise influence could include mortality, injury, long-term displacement, energetic consequences, or tolerance and stress for the whales. Listed species in the proposed action area are regularly exposed to these types of natural and anthropogenic sounds; however, the extent of any effects from this exposure remains unknown.

Some responses of listed species to noise are documented, and we assume those findings apply to whales within the action area. Sound from aircraft could cause short-term behavioral reactions or other effects to whales in the action area. Right whales and humpbacks react to aircraft at low altitudes by startling, diving, turning, or swimming away (Herman *et al*. 1980a,b; Payne *et al*. 1983; Shallenberger 1978; Watkins and Moore 1983). Whales actively feeding, socializing, or mating seem less likely to respond to aircraft noise (Payne *et al*. 1983; Richardson and Malme 1993). There is no indication that single or occasional aircraft overflights cause long-term displacement of whales (Richardson *et al*. 1995).

Sound from ships and boats can also cause behavioral reactions and other avoidance or startle responses to the listed species in the action area. For fin whales, response to vessel noise also depends on the behavior of the animal at the time of vessel approach, as well as the speed and direction of the vessel (Perry *et al.* 1999) and this is likely the case for other listed whale species (Perry *et al.* 1999; Richardson *et al*. 1995). While feeding, fin whales react less rapidly and with less obvious avoidance behaviors (Richardson *et al.* 1995). Sei whales are reported to respond to approaching vessel traffic in a similar manner as fin whales (Perry *et al.* 1999). Humpback reactions to boat approaches are variable, ranging from approach to avoidance (Salden 1993). Overall, humpbacks attempt to avoid vessels with increased frequencies of surfacings without blows and dives initiated without raised flukes (Bauer 1986); additional responses include reduced time at the surface, longer dives, altered directions of travel, and reduced speeds after the boat departs (Green and Green 1990). Feeding humpbacks can be displaced temporarily by vessels (Richardson *et al.* 1995). Right whales are more approachable by slow-moving boats, but move away from vessels that approach rapidly (Brown *et al*. 1991; Goodyear 1989; 1993; Watkins 1986).

Sound from explosives used during maritime construction and demolition have pressure pulses with high peak and very rapid rise times. They produce shock waves at close distances, which propagate in a different manner than acoustical energy (Richardson *et al.* 1995). Few specific data are available regarding disturbance or blast injury effects from underwater explosions on marine mammals. Some pinnipeds and toothed whales exhibit short-term avoidance reactions and nearby blasts can injure or kill marine mammals (Richardson *et al*. 1995).

Animals could become habituated to sound and tolerate the noise over time which could expose them to other dangers. For example, baleen whales use shipping lanes in the St. Lawrence estuary and off Cape Cod each year despite frequent exposure to vessel noise (Beach and Weinrich 1989; Mitchell and Ghanime 1982). This exposes these whales to ship strikes. Baleen whales also feed consistently in rich fishing grounds where large numbers of trawlers operate (Brodie 1981 a, b). Watkins (1986) suggested that, near Cape Cod, reactions of various species changed over the years as whale watching became popular.

G. U.S. Navy Activities

Southern California Range Complex

The U.S. Navy has been conducting training and other activities in their Southern California Range Complex 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 8 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 2008a).

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 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 mid-frequency active sonar, 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 mid-frequency active sonar, 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 the Southern California Range Complex 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.

Hawaii Range Complex

Since 1971[10], the U.S. Navy has conducted the biennial Rim of the Pacific (RIMPAC) exercises. These exercises have historically lasted for approximately one month and have involved forces from various nations on the Pacific Rim including Australia, Canada, Chile, Japan, and the Republic of Korea. We have limited information on the timing and nature of RIMPAC Exercises prior to 2002 and we have no information on their potential effects on endangered and threatened marine animals in the Hawaii Range Complex prior to 2006, when NMFS started to consult with the U.S. Navy on the exercises.

[10] Previous biological opinions on the 2006 Rim of the Pacific Exercises and the Undersea Warfare Exercises reported that Rim of the Pacific Exercises had occurred in the Hawaii Range Complex since 1968. U.S. Navy historians have since verified that these exercises began in 1971.

Between June and July 2006, the U.S. Navy conducted RIMPAC exercises in the Hawaii Range Complex. Based on the U.S. Navy's 7 December 2006 After Action Report, over the 15 calendar days of the 2006 RIMPAC (U.S. Navy 2006), mid-frequency sonars were employed for a total of 472 hours. Active and passive sonobuoys were also deployed for 115 hours during these exercises but not all sonobuoys were transmitting noise.

During the 2006 RIMPAC exercises, U.S. Navy observers reported marine mammals on 29 occasions. On 12 of those 29 occasions, mid-frequency sonar was shut down for a total of eight hours. On two other occasions, marine mammals were observed more than 1,000 yards from a vessel while mid-frequency sonar was active.

The After Action Report for the 2006 RIMPAC concluded that (a) there was no evidence of any behavioral effects on marine mammals throughout the exercise; and (b) there were no reported stranding events or observations of behavioral disturbance of marine mammals linked to sonar use during the exercise. The observations contained in the report do not identify or estimate the number of endangered or threatened species that might have been exposed to mid-frequency active sonar during the exercise. The Navy did not evaluate the efficacy of the mitigation measures nor did they evaluate the efficacy of the monitoring program associated with the exercises.

Between June and July 2008, the U.S. Navy conducted another set of RIMPAC exercises in the HRC, with the at-sea portions that involved mid-frequency active sonar occurring between July 7 and 31 2008. Based on the U.S. Navy's 30 November 2008 After-Action Report, over the 25 calendar days of the 2008 RIMPAC (U.S. Navy 2008d), mid-frequency active sonars and sonobuoys were employed for a total of 547 hours. Of this total, active sonar was employed between the shoreline and the 200-meter bathymetric contour for about 6 hours.

Participants in the 2008 RIMPAC exercises reported 29 sightings of marine mammal groups totaling about 200 animals; dolphins represented 72 percent of these sightings. Six whale groups were sighted during the exercise, all in waters more than 100 nm west of the Island of Hawaii. An aerial survey over a portion of the area in which the 2008 RIMPAC exercises occurred reported 24 sightings of marine mammal groups involving eight species of small odontocetes, Hawaiian monk seals, or unidentified dolphins or sea turtles. A shipboard survey that also occurred in a portion of the area in which the 2008 RIMPAC exercises occurred reported 9 sightings of marine mammal groups consisting of either bottlenose dolphins, rough-toothed dolphins, or Hawaiian spinner dolphins. None of the observers reported unusual behavior or adverse behavioral responses to active sonar exposures or vessel traffic associated with the exercises.

The U.S. Navy has also conducted Undersea Warfare Exercises in the HRC for several years, but the components of these exercises can vary widely. For example, an Undersea Warfare Exercise conducted in the HRC from 13 to 15 November 2007, involved two ships equipped and entailed a total of 77 hours of mid-frequency active sonar from all sources (U.S. Navy 2008d). An Undersea Warfare Exercise conducted in the HRC from 25 to 27 March 2008, involved a total of 169 hours of mid-frequency active sonar from all sources (U.S. Navy 2008c). An Undersea Warfare Exercise conducted in the HRC from 27 to 31 May 2008, involved four ships, and

entailed a total of 204 hours of mid-frequency active sonar from all sources (hull-mounted sonars, dipping sonars, and sonobuoys; U.S. (U.S. Navy 2008b).

Monitoring surveys associated with the November 2007 Undersea Warfare Exercises reported 26 sightings of five species during exercise, including green sea turtles and Hawaiian monk seals. None of the marine animals observed from survey vessels or aircraft were reported to have exhibited unusual behavior or changes in behavior during the surveys. Monitoring surveys associated. Monitoring surveys associated with the March 2008 Undersea Warfare Exercises reported 47 sightings of five species during exercise, including humpback whales (40 sightings of 68 individuals) and an unidentified sea turtle. None of the marine animals observed from survey vessels or aircraft were reported to have exhibited unusual behavior or changes in behavior during the surveys.

H. Pollutants

The accumulation of stable pollutants is a possible human-induced source of mortality in long-lived high trophic level animals (Waring *et al.* 2004), and some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Contaminants may be introduced by rivers, coastal runoff, wind, ocean dumping, dumping of raw sewage by boats and various industrial activities, including offshore oil and gas or mineral exploitation. Due to their large amount of blubber and fat, marine mammals readily accumulate lipid-soluble contaminants – for example, polychlorinated biphenyls (PCBs) (O'Hara and Rice 1996).

Cetaceans
Concentrations of organochlorides have been documented in humpback, fin, blue, and sei whales (Gauthier *et al.* 1997b; Hobbs *et al.* 2001; Metcalfe *et al.* 2004). We therefore assume that exposure to such contaminants may be affecting all listed whales in the action area. However, organochlorines bioaccumulate at higher trophic levels, and contaminant levels in planktivorous mysticetes are reported to be one to two orders of magnitude lower compared to piscivorous odontocetes (Borrell 1993; O'Shea and Brownell Jr. 1994; O'Hara and Rice 1996; O'Hara *et al.* 1999).

Chronic exposure to the neurotoxins associated with paralytic shellfish poisoning (PSP) via zooplankton prey has also been shown to have detrimental effects on marine mammals. Estimated ingestion rates are sufficiently high to suggest that the PSP toxins may be affecting marine mammals, possibly resulting in lower respiratory function, changes in feeding behavior, and diminished reproduction (Durbin *et al.* 2002).

The organochlorines dichloro-diphenyl-trichloroethane (DDT), dichloro-diphenyl-dichloroethylene (DDE), and PCBs have been identified from fin whale blubber, but levels are lower than in toothed whales due to the lower level in the food chain than fin whales feed (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.* 1997a; Gauthier *et al.* 1997b). 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).

Sei whales are known to accumulate DDT, DDE, and PCBs (Borrell 1993; Borrell and Aguilar 1987; Henry and Best 1983). As in fin whales, males carry larger burdens than females, as gestation and lactation transfer these toxins from mother to offspring. The sei whale's strong preference for copepods and euphausiids (i.e., low trophic level organisms), at least in the North Atlantic, may make it less susceptible to the bioaccumulation of organochlorine and metal contaminants than, for example, fin, humpback, and minke whales, all of which seem to feed more regularly on fish and euphausiids (O'Shea and Brownell 1994). Since sei whales off California often feed on pelagic fish as well as invertebrates (Rice 1977), they might accumulate contaminants to a greater degree than sei whales in the North Atlantic. There is no evidence that levels of organochlorines, organotins, or heavy metals in baleen whales generally (including fin and sei whales) are high enough to cause toxic or other damaging effects (O'Shea and Brownell 1994). It should be emphasized, however, that very little is known about the possible long-term and trans-generational effects of exposure to pollutants.

Contaminants have been identified in sperm whales, but vary widely in concentration based upon life history and geographic location, with northern hemisphere sperm whale individuals generally carrying higher burdens (Evans *et al.* 2004). Common sperm whale ontaminants include dieldrin, chlordane, DDT, DDE, PCBs, HCB and HCHs 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, female sperm whales 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 sperm whale individuals did not appear to accumulate chromium at higher levels.

There is a paucity of contaminant data regarding blue whales. Available information indicates that organochlorines, including DDT, PCB, benzene hexachloride (HCH), hexachlorobenzene (HCB), chlordane, dieldrin, methoxychlor, and mirex have been isolated from blue whale blubber and liver samples (Gauthier *et al*. 1997b; Metcalfe *et al*. 2004). As with other baleen whales, contaminants transfer between mother and calf meaning that young often start life with concentrations of contaminants equal to their mothers, before accumulating additional contaminant loads during life and passing higher loads to the next generation (Gauthier *et al.* 1997a; Metcalfe *et al.* 2004).

The overall impact of pollution on habitats used by humpback whales is not known. Concentrations of organochlorine pesticides, heavy metals, and PCB's have been reported in humpback whale tissues from Canadian, United States, and Caribbean waters (Gauthier *et al*. 1997a; Taruski *et al*. 1975). As with the other 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 that of other whales such as blue whales.

Contaminant data on right whales are restricted to data from biopsy-derived samples. These data appear to be relevant to the whole animal given that lipid-normalized contaminant burden is comparable between different blubber depths and locations in large whales (Gauthier *et al.*1997b). Data for right whales are limited to only two studies (Moore *et al*. 1998; Woodley *et al.* 1991). These data show a range of total PCBs of 80 to 1000 ng/g wet weight i.e., in the parts per billion range. No obvious geographic trends were evident in samples from South Africa, South Georgia, Cape Cod Bay USA and Bay of Fundy Canada (Moore *et al*. 1998). In contrast, most odontocete (i.e., toothed whales, porpoises and dolphins) values were in the parts per million range (Aguilar and Borrell 1988). Organic chemical contaminants have been regarded as of less significance for mysticetes than odontocetes and are not considered primary factors in slowing the recovery of any stocks of large whale species (O'Shea and Brownell 1994). This is especially true for planktivorous baleen whales such as right whales, given their lower accumulated contaminant burdens as compared to other marine mammals. However, assessment of contaminant body burden ignores toxic non-halogenated aromatic hydrocarbons (polynuclear aromatic hydrocarbons: PAH) from crude oil and combusted fossil fuels that do not bioaccumulate. Such compounds are metabolized, induce their effects and are mostly excreted. Contaminant impact is therefore insufficiently assayed by blubber burden analysis of parent compounds alone.

The manner in which pollutants negatively impact animals is complex and difficult to study, particularly in taxa (such as large whales) for which many of the key variables and pathways are unknown (O'Shea and Brownell 1994). The transgenerational accumulation of containments is perhaps a more likely source for concern for these whales.

Pinnipeds

Contaminants are a considerable issue for Steller sea lions. Roughly 30 individuals died as a result of the Exxon *Valdez* oil spill and contained particularly high levels of PAH contaminants, presumable as a result of the spill. Blood testing confirmed hydrocarbon exposure. Subsequently, premature birth rates increased and pup survival decreased (Calkins *et al.* 1994; Loughlin *et al.* 1996). Organochlorines, including PCBs and DDT (including its metabolites), have been identified in Steller sea lions in greater concentrations than any other pinniped during the 1980s, although levels appear to be declining (Barron *et al.* 2003; Hoshino *et al.* 2006). The levels of PCBs have been found to have twice the burden in individuals from Russia than from western Alaska (4.3 ng/g wet weight versus 2.1 ng/g wet weight; (Myers *et al.* 2008). Levels of DDT in Russian pups were also on average twice that in western Alaska pups (3.3 ng/g wet weight blood versus 1.6 ng/g wet weight). The source of contamination is likely from pollack, which have been found to contain organochlorines throughout the Gulf of Alaska, but higher in regions occupied by the eastern DPS of Steller sea lions (NMFS 2008c). Heavy metals, including mercury, zinc, copper, metallothionien, and butyltin have been identified in Steller sea lion tissues, but are in concentrations lower than other pinnipeds (Beckmen *et al.* 2002; Castellini 1999; Kim *et al.* 1996; NMFS 2008c; Noda *et al.* 1995). However, contaminants leading to mortality in Steller sea lions have not been identified (NMFS 2008c). Contaminant burdens are lower in females than males, because contaminants are transferred to the fetus *in utero* as well as

through lactation (Lee *et al.* 1996; Myers *et al.* 2008). However, this means that new generations tend to start with higher levels of contaminants than their parents originally had. Concerns over Steller sea lion contaminants are of additional concerns because contaminants in the body tend to be mobilized as fat reserves are used, such as when prey availability is low; a situation that is likely occurring for Steller sea lions today.

As with many other marine mammals, organochlorines have been isolated from Hawaiian monk seals (Willcox 1999; Willcox *et al.* 2004; Ylitalo *et al.* 2008). Chemical species include DDT, DDE, and PCBs, with higher levels in males than in females. This is due to lactation and pregnancy transferring toxins to offspring in sexually mature females (Ylitalo *et al.* 2008). Once menopause is reached, toxins accumulate at equivalent rates in males and females. Toxins have been found in highest concentrations in animals breeding at Midway Atoll, and levels across all atolls are significant enough to potentially affect health (Ylitalo *et al.* 2008). In all contaminant studies of the wild monk seals to date, the OC levels were comparable to or lower than those reported in blubber of various pinnipeds from the Northeastern Pacific (Calambokidis *et al.* 2001; Krahn *et al.* 1997; Lee *et al.* 1996). However, these levels still exceed "safe" levels for marine mammals recommended by (Kannan *et al.* 2000).

I. Climate and Ecosystem Change

There is a close linkage whale foraging and the physical forcing processes that concentrate prey in the oceanic environment (Kenney *et al*. 2001). Interannual, decadal, and longer time-scale variability in climate can alter the distribution and biomass of prey available to marine mammals. For example, decade-scale climatic regime shifts have been related to changes in zooplankton in the North Atlantic (Fromentin & Planque 1996). Decadal trends in the North Atlantic Oscillation (Hurrell 1995) can affect the position of the Gulf Stream (Taylor *et al*. 1998) and other circulation patterns in the North Atlantic that may be important to listed mammals. In the Pacific, 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 listed species' prey abundance (Mantua *et al.*, 1997; Francis *et al.*, 1998; Beamish *et al.*, 1999; Hare *et al.*, 1999; Benson and Trites, 2002). 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). Such shifts in community structure and productivity may alter the distribution and occurrence of foraging in coastal habitats, as well as affecting reproductive potential.

Evidence of climate change in the past few decades, commonly referred to as global warming, has accumulated from a variety of geophysical, biological, oceanographic, and atmospheric sources. The scientific evidence indicates that average air, land, and sea temperatures are increasing at an accelerating rate. Although climate changes have been documented over large areas of the world, the changes are not uniform and affect different areas in different ways and intensities. Arctic regions have experienced some of the largest changes, with major implications for the marine environment as well as for coastal communities.

Climate change is of most concern in this proposed action for the Steller sea lion and whale species that travel into higher latitudes, as these latitudes are currently affected more than any

other region. There is evidence that over the last 10-15 years, there has been a shift in regional weather patterns in the Arctic region (Tynan and DeMaster 1997). Recent assessments of climate change, conducted by international teams of scientists (Gitay *et al*. 2002 for the Intergovernmental Panel on Climate Change (IPCC); Arctic Climate Impact Assessment (ACIA), 2004; IPCC 2007), have reached several conclusions of consequence for these Arctic whales:

• Average arctic temperatures increased at almost twice the global average rate in the past 100 years.
• Satellite data since 1978 show that perennial arctic sea ice extent has shrunk by 2.7% per decade, with larger decreases in sea ice extent in summer of 7.4% per decade.
• Arctic sea ice thickness has declined by about 40% during the late summer and early autumn in the last three decades of the twentieth century.
• The ice pack is retreating from the land sooner in the spring and reforming later in the fall. This affects the timing of phytoplankton blooms and zooplankton concentrations.
• The ice pack is retreating further seaward than in the past, which creates larger areas of open water near coastal areas and leads to larger waves, higher storm surges, and accelerated rates of coastal erosion. This dynamic is exacerbated by rising sea levels due to thermal expansion of seawater and other sources.
• The arctic tundra is warming rapidly, causing permafrost to thaw deeper in the summer and over much larger areas than previously observed, accompanied by substantial changes in vegetation and hydrology.
• The melting ice pack, melting glaciers, and increased precipitation are adding large amounts of freshwater to the sea, causing decreases in salinity that may combine with longer ice-free seasons to affect the timing and intensity of phytoplankton blooms.

Ice-associated animals, such as the Steller sea lion and some whales, may be sensitive to changes in Arctic weather, sea-surface temperatures, or ice extent, and the concomitant effect on prey availability.

J. Offshore Industrial Activities

The major sources of industrial underwater noise appear to be offshore oil, gas or mineral exploration and exploitation. These activities increase vessel traffic, produce loud sounds for seismic profiling, place structures in areas used by whales, and introduce noises from drilling and production into the environment. Malme *et al*. (1985) exposed feeding humpback whales in southeastern Alaska to noise from a single air gun or to playback of recorded sounds of oil drilling, production platforms and aircraft. Whales showed no overall pattern of avoidance during 13 experiments, each of which included between 10 and 40 different animals. Whales died as soon as the airgun was turned on in three experiments. These startle responses, which occurred at received sound levels between 150 to 169 dB (re 1 mPa), were thought to be caused more by the novelty of the air gun sound than by its intensity.

Oil and gas exploration and development are increasingly active in the Chukchi and Beaufort Sea. Additional information is presented on the MMS Alaska OCS Region website: www.mms.gov/alaska. There have been ten federal oil and gas lease sales within the Alaskan

Beaufort Sea beginning with the Joint State of Alaska (State)-Federal Sale held in December 1979. The most recent federal sale was Beaufort Sea Sale 202, held on April 18, 2007. The MMS five-year lease plan for 2007-2012 has additional sales scheduled in 2009 and 2011. Prior to 2000, no permanent facilities, or oil production, existed on the Beaufort Sea OCS outside of state waters. There are presently two offshore production facilities within state waters in the Beaufort Sea: Northstar and Endicott.

The potential effects of those projects and leasing and development of the OCS have been considered in the biological opinions regarding oil and gas leasing and exploration activities and oil production facilities (NMFS, 1999, 2006f). These oil and gas activities introduce noise into the marine environment that may disturb whales. Multiple marine geophysical (seismic) projects are planned for the Beaufort and Chukchi Seas. Additional information on recent and planned oil and gas exploration and development activity near Alaska is found in below.

- NMFS has issued a letter of authorization to BP Exploration, Inc. to take marine mammals incidental to the production of offshore oil and gas at the Northstar development in the Beaufort Sea off Alaska. Authorization is effective from July 7, 2009, through July 6, 2010.

- NMFS has issued an Harassment Authorization (IHA) to take small numbers of marine mammals, by harassment, incidental to conducting a marine geophysical program, including deep seismic surveys, on oil and gas lease blocks located in the Beaufort Sea and in the Northern Chukchi Sea, has been issued to Shell Offshore, Inc. and WesternGeco. Effective from August 19, 2008 through August 18, 2009.

- NMFS has issued an IHA to take marine mammals, by Level B harassment, incidental to conducting open water shallow hazard and site clearance surveys by ConocoPhillips Alaska, Inc. (CPAI) in the Chukchi Sea.

- NMFS has issued an IHA to take marine mammals, by Level-B harassment, incidental to conducting open water shallow hazard and site clearance surveys by ASRC Energy Service in the Chukchi Sea.

- NMFS has issued an IHA to PGS Onshore, Inc. to take, by harassment, small numbers of six species of marine mammals incidental to an exploratory 3D marine seismic survey in the Beaufort Sea, Alaska. Effective July 30, 2008, through July 29, 2009.

K. Hawaiian Monk Seal Malnutrition

In recent years, low juvenile survival (due partly to food limitation) has been evident in all Hawaiian monk seal subpopulations in the NWHI. Recent declines have been associated with poor body condition, particularly amongst juvenile individuals (Parrish *et al.* 2008). Reduced body condition is evident in a time series of axillary girth and standard length measurements taken from juveniles and pups at most sites, where sizes were significantly smaller at FFS (where the subpopulation is in decline) compared to Laysan (Craig and Ragen 1999).

L. Hawaiian Monk Seal Male aggression

The primary cause of adult female mortality affecting recovery potential in the monk seal population during the 1980s and early 1990s was frequent injury and death by multiple male aggression, or "mobbing" attacks (Banish and Gilmartin 1992; Carretta *et al.* 2006). Multiple-male aggression is thought to be related to an imbalance in adult sex ratios, with males outnumbering females. If not killed outright, a wounded female's reproductive success in the year of injury drops.

In response to this threat to recovery, a group of ten adult males that had been observed attacking females, or whose behavior profile was similar to those that attacked females, were captured on Laysan in 1984 and transported to Johnston Atoll. One of the ten died prior to release, and of the remaining nine, most were not seen after a few months. Another group of five problem males was removed from Laysan and placed into permanent captivity in 1987.

To avoid removing individuals from the population, two other remediation methods were attempted in the 1990s. First, suppression of male aggression was attempted by suppressing testosterone initially in captive monk seals and then as a pilot field study (Atkinson and Gilmartin 1992; Atkinson *et al.* 1998). However, severe limitations, including expensive drugs and repeated disturbance through capture and injection led to cessation of this approach. In 1994, 22 problem males were collected at Laysan and relocated to the MHI to balance the Laysan Island adult population sex ratio. One died shortly after capture. However, a significant reduction in deaths due to male aggression followed. In recent years, the sex ratio has become more balanced and was estimated at 1.2 males per female in 2003 (NMFS, unpublished data). Subsequently, problem males have not been identified as a significant, widespread source of injury or mortality for several years.

Males have not only been an important source of injury and mortality for females, but also for pups. At FFS in 1997, at least eight pups died as a result of adult male aggression (Carretta *et al.* 2006). Many more pups were likely killed in the same way, but the cause of their deaths could not be confirmed. Death typically occurred either from immediate drowning when pups are mounted in the water or from infections resulting from bite wounds. In 1991, two adult male seals were identified as being particularly aggressive towards weaned pups, exhibiting unique behaviors such as "lurking" in deep water areas near Trig Island. Upon appearance of a weaned pup, the males would violently and aggressively launch themselves out of the water, landing atop the pup. This was the only time that this behavior has been observed in wild monk seals, and these animals were removed.

M. Scientific Research and Permits

Listed marine mammal species in the action area have also been the subject of scientific research activities, as authorized by NMFS permits. To date, NMFS PR1 has issued dozens of permits for research in the action area covering a variety of activities, including aerial and vessel surveys, photo-identification, remote biopsy sampling, acoustic playbacks, and attachment of scientific instruments.

A total of 35 permits authorize research activities on one or more of the listed target species in the action area (see Table 26). Seven of these permits will be replaced by permits in the

proposed activities. Table 26 illustrates the listed target species and research action areas where each permit is valid.

Table 26. Active Scientific Research Permits and Letters of Confirmation Authorizing Research on Target Species in the Action Area

Permit	Permit Holder	Research Action Area	Species
369-1757-01	Bruce Mate, Oregon State University	Pacific and Atlantic Oceans and high seas	humpback, blue, fin, sperm, gray, killer (not SRKW) whale
1071-1770-02	The Dolphin Institute	HI, CA to AK	humpback, sperm, fin, blue, false killer, melon-headed, pygmy killer, short-finned pilot, killer (not SRKW), pygmy sperm, dwarf sperm, beaked whale; bottlenose, spinner, rough-toothed, striped, pantropical spotted dolphin
782-1719-09*	NMFS, National Marine Mammal Laboratory	Pacific Ocean	humpback, blue, fin, sei, sperm, killer, gray, minke, beaked, short-finned pilot, pygmy sperm, dwarf sperm, beluga, melon-headed whale; bottlenose, common, northern right whale, Pacific white-sided, Risso's, rough-toothed, pantropical spotted, spinner, striped dolphin; Dall's, harbor porpoise
774-1714-10*	NMFS, Southwest Fisheries Science Center	Pacific Ocean	all
473-1700-02*	Jan Straley, University of Alaska Southeast	AK	sperm, humpback, killer (not SRKW), minke, gray, fin
716-1705-02*	Fred Sharpe, Alaska Whale Foundation	AK, WA	humpback, killer (not SRKW)
1049-1718*	Wynne, Universitiy of Alaska Fairbanks	AK	humpback, killer (not SRKW), minke, gray, fin, sperm, sei
1039-1699-01*	Ann Zoidis, Cetos	HI	humpback, short-finned pilot, false killer, pygmy killer, melon-headed whale; spinner, bottlenose dolphin
731-1774-06	Baird, Cascadia Research	HI, CA to AK, high seas	sei, fin, blue, humpback, sperm, gray, minke, bryde's, killer, short-finned pilot, false killer, beaked, dwarf sperm, pygmy sperm, melon-headed, pygmy killer whale; bottlenose, Pacific white-sided, northern right whale, spinner, pantropical spotted, Fraser's, Risso's, rough-toothed, common dolphin; Dall's, harbor porpoise
545-1761	North Gulf Oceanic Society	AK	humpback, killer, minke, gray, beaked whale; Pacific white-sided dolphin; Dall's, harbor porpoise
393-1772-02	Glockner-Ferrari, University of Alaska Southeast	HI	humpback, killer, short-finned pilot, false killer whale; bottlenose, spinner, pantropical spotted dolphin

Permit	Permit Holder	Research Action Area	Species
587-1767-01	Salden, Hawaii Whale Research Foundation	HI, AK	humpback, killer, short-finned pilot, false killer whale; bottlenose, spinner, pantropical spotted dolphin
1000-1617-04	Whit Au, University of Hawaii	HI, CA, high seas	humpback, short-finned pilot, dwarf sperm, pygmy sperm, killer, beaked, false killer, pygmy killer, melon-headed whale; bottlenose, Pacific white-sided, pantropical spotted, Risso's, spinner, striped, rough-toothed, common dolphin
540-1811-03	John Calambokidis, Cascadia Research	North Pacific Ocean, including CA, OR, WA	blue, humpback, fin, sei, sperm, killer, minke, bryde's, gray, pygmy sperm, dwarf sperm, beaked,short-finned pilot, false killer, whale; bottlenose, northern right whale, Pacific white-sided, Risso's, striped, common dolphin; Dall's, harbor porpoise
781-1824-01	NMFS, Northwest Fisheries Science Center	AK to CA	blue, humpback, fin, sperm, killer, minke, gray, pygmy sperm, beaked, short-finned pilot, whale; common, Pacific white-sided, Risso's, striped, northern right whale dolphin; Dall's, harbor porpoise
965-1821-01	Bain, Friday Harbor Laboratories, University of Washington	AK to CA	killer, humpback, fin, minke, gray whale; Pacific white-sided dolphin; Dall's, harbor porpoise
1058-1733-01	Mark Baumgartner, Woods Hole	Pacific and Atlantic Oceans and high seas	North Pacific right, humpback, fin, sei, blue, gray, Antarctic minke whale
1120-1898	Eye of the Whale	AK	humpback
727-1915	Scripps Institute of Oceanography	HI, CA to WA	blue, sei, fin, humpback, sperm, gray, short-finned pilot, beaked, dwarf sperm, pygmy sperm, false killer, pygmy killer, minke, bryde's, melon-headed whale; Pacific white-sided, bottlenose, northern right whale, Fraser's, rough-toothed, striped, spinner, pantropical spotted, Risso's, common dolphin; Dall's porpoise
1127-1921	Hawaii Marine Mammal Consortium	HI	humpback, sperm, blue, sei, fin, beaked, bryde's, dwarf sperm, false killer, pygmy killer, killer, minke, pygmy sperm, short-finned pilot, melon-headed whale; bottlenose, Fraser's, Risso's,rough-toothed, spinner, striped, pantropical spotted dolphin
10018	Rachel Cartwright, Californi State University	HI	humpback, false killer, short-finned pilot whale; bottlenose, spinner, pantropical spotted dolphin
945-1776	Glacier Bay National Park and Preserve	AK	humpback, minke, killer

Permit	Permit Holder	Research Action Area	Species
13392	Jefferson, Southwest Fisheries Science Center	CA	bottlenose dolphins
10014	New Jersey Department of Environmental Protection	NJ	humpback, blue, fin, sperm, killer (not SRKW), sei, melon-headed, minke, Northern bottlenose, pilot, Cuvier's beaked, dwarf and pygmy sperm whale; bottlenose, clymene, Risso's, spinner, striped, white-beaked, short-beaked common, Atlantic spotted, Pantropical spotted, Atlantic white-sided dolphin; harbor porpoise
1053-1825	University of South Florida	Atlantic Ocean, including Gulf of Mexico	All stranded cetacean species
1058-1733	Woods Hole Oceanographic Institution	Atlantic Ocean	blue, fin, humpback, sei whale
1095-1837	BIOMIMETICA	Atlantic Ocean	All stranded dolphin, toothed whale, porpoise
1121-1900	NOAA Science and Technology	Atlantic Ocean	Bryde's, humpback, killer, melon-headed, minke, sperm, beaked, false and pygmy killer, dwarf and pygmy sperm whale; bottlenose, Fraser's, Risso's, rough-toothed, spinner, striped, long- and short-beaked common, Atlantic spotted, Pantropical spotted dolphin
1128-1922	SUNY at Buffalo	Atlantic, Caribbean Ocean	Humpback, Cuvier's beaked whale; bottlenose, short-beaked common, unid stenelline dolphin
14241	Woods Hole Oceanographic Institute	Atlantic	Long- and short-finned pilot whale; short-beaked common, Atlantic white-sided dolphin
522-1785	Conservation Biology Department, Chicago Zoological Society	Atlantic, including Gulf of Mexico	Bottlenose dolphin
605-1904	Whale Center of New England	Atlantic	Fin, humpback, sei whale
633-1778	Center for Coastal Studies	Atlantic	Blue, fin, humpback, killer, minke, sei, sperm, long-finned pilot whale; bottlenose, Risso's, Short-beaked common, Atlantic white-sided dolphin; harbor porpoise
775-1875	NMFS, Northeast Fisheries Science Center	Atlantic	Blue, bryde's, fin, humpback, killer, melon-headed, minke, Northern bottlenose, sei, sperm, pilot, Cuvier's beaked, unid beaked, pygmy killer, dwarf and pygmy sperm whale; bottlenose, clymene, Fraser's, Risso's, spinner, striped, white-beaked, short-beaked common, Atlantic spotted, Pantropical spotted, Atlantic white-sided dolphin; harbor porpoise

Permit	Permit Holder	Research Action Area	Species
948-1692	UNC Wilmington	Atlantic	Fin, humpback, killer, minke, sperm, pilot, dwarf and pygmy sperm , unid beaked whale; bottlenose, Risso's, short-beaked common, Atlantic spotted dolphin

* indicates that there is a one-year extension on the permit
Italicized rows indicate permits that would be replaced or amended by permits issued in this action.

No mortalities or serious injuries are currently authorized for any of these species in the action area. It is also important to note that many of the target whales are migratory and may transit in and out of U.S. waters and the high seas. NMFS does not have jurisdiction over the activities of foreign nations conducting field studies in EEZs of other nations or the territorial seas of other nations, and therefore cumulative effects from all scientific research on these species across the proposed action area cannot be fully assessed. However, where possible, NMFS attempts to collaborate with foreign governments to address management and conservation of these transboundary ESA-listed species.

N. Conservation Measures

A number of conservation and management efforts have a positive effect on listed species in the action area. Recovery plans under the ESA help guide the protection and conservation of listed species. NMFS implements conservation and management activities on these species through its Regional offices and Fishery Science Centers in cooperation with states, conservation groups, the public and other federal agencies.

Several efforts aim to reduce the risk of entanglement in fixed fishing gear in the western North Atlantic. The Atlantic Large Whale Take Reduction Team was established to develop a plan to reduce the incidental serious injury and mortality of fin whales, right whales, humpback whales, (and minke whales) in the South Atlantic shark gillnet fishery, the Gulf of Maine and Mid-Atlantic lobster trap/pot fishery, the Mid-Atlantic gillnet fishery, and the Gulf of Maine sink gillnet fishery. This effort included the formation of fishing gear advisory groups, research on fishing gear modifications to reduce entanglement, outreach and education programs for fishermen, expansion of the disentanglement network, as well as a call for continued surveys and other methods of identifying the location of whales and reducing serious injuries (NMFS 2005b). As a result of these efforts, modified gear (sinking ground line between lobster pots, increases in pots per vertical line, and the use of breakaway links) has been employed in areas like Cape Cod Bay to protect endangered whales (Jaquet *et al.* 2005).

In an effort to reduce ship collisions with right whales, the Right Whale Sighting Advisory System (SAS) was developed by NMFS in 1996. SAS provides right whale sighting information to commercial shipping and other marine traffic and receives right whale sighting reports from a variety of sources, including dedicated right whale aerial and shipboard surveys conducted by several organizations. Sightings reported by the general public are verified by staff at the NOAA Northeast Fisheries Science Center (NEFSC) prior to issuing an advisory. Mariners are alerted to areas of right whale activity through Coast Guard and NOAA Weather Radio broadcasts, the Mandatory Ship Reporting System, email, and NOAA websites. Areas of right whale activity

are also bounded by Seasonal Management Areas (SMAs), or when outside of SMAs, Dynamic Management Areas (DMAs). The size and shape of these areas are based on analyses of right whale sighting data by researchers at the NEFSC.

As a result of sightings information, NMFS has issued new regulations to reduce the likelihood of ship collisions with right whales (73 FR 74003; October 10, 2008). The regulations implement speed restrictions of ten knots or less for certain vessels (65 ft or greater) in certain times and areas (e.g., key port entrances) along the U.S. Atlantic coast that correspond to right whale occurrence. Exempted from the rule are State enforcement vessels and U.S. government vessels that will be expected to adhere to guidance provided under ESA Section 7 consultations. The rule also contains a provision exempting vessels from speed restrictions in poor sea and weather conditions, thereby ensuring safe vessel maneuverability under those special conditions. The rule also provides for establishment of temporary, voluntary DMAs in times and/or areas where the seasonal management measures are not in effect, and where whales occur. In these locations, mariners would have the option to cross through the DMA at a speed no greater than ten knots or route around the area. Also, in November 2006, NMFS established a set of recommended vessel routes in four locations to reduce the likelihood of collisions in key right whale habitats.

A recent study of whale watching activities worldwide has found that the business of viewing whales and dolphins in their natural habitat has grown rapidly over the past decade into a billion dollar ($US) industry involving over 80 countries and territories and over nine million participants (Hoyt 2001). In 1988, a workshop sponsored by the Center for Marine Conservation (CMC) and NMFS was held in Monterey, California to review and evaluate whale watching programs and management needs. That workshop produced several recommendations for addressing potential harassment of marine mammals during wildlife viewing activities that include developing regulations to restrict operating thrill craft near cetaceans, swimming and diving with the animals, and feeding cetaceans in the wild.

As a conservation measure NMFS launched an education and outreach campaign to provide commercial operators and the general public with responsible marine mammal viewing guidelines which in part state that viewers should: (1) remain at least 50 yards from dolphins, porpoise, seals, sea lions and sea turtles and 100 yards from large whales; (2) limit observation time to 30 minutes; (3) never encircle, chase or entrap animals with boats; (4) place boat engine in neutral if approached by a wild marine mammal; (5) leave the water if approached while swimming; and (6) never feed wild marine mammals. In January 2002, NMFS also published an official policy on human interactions with wild marine mammals which states that: “NOAA Fisheries cannot support, condone, approve or authorize activities that involve closely approaching, interacting or attempting to interact with whales, dolphins, porpoises, seals or sea lions in the wild. This includes attempting to swim with, pet, touch or elicit a reaction from the animals.”

Conservation actions for blue whales are ongoing, and the most recent efforts by the U.S. include the following. Ongoing monitoring of the status of the California/Oregon/Washington stock of blue whales, via shipboard surveys, is conducted every three years. NMFS is placing observers onboard vessels in the California/Oregon swordfish/thresher shark drift gillnet fishery to monitor the take of protected species, including marine mammals. NMFS has implemented marine

mammal take reduction measures identified in the Pacific Offshore Cetacean Take Reduction Plan (including the use of acoustic pingers) to reduce the bycatch of marine mammals.

As mentioned in the *Status of the Species* section, the IWC called for a ban on subsistence bowhead whaling in 1977, based on increasing concerns about the status of bowhead whale populations and documentation of increases in subsistence whaling in Alaska and loss of struck whales. The United States requested modification of the ban and the IWC responded with a limited quota for subsistence harvest. Currently, subsistence harvest is limited to nine Alaskan villages. Since ending commercial exploitation of bowhead whales, conservation efforts have been focusing on monitoring stocks, determining population structure, identifying calf-rearing habitat, and studying feeding ecology.

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.

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 (SPLASH) 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 (MoNAH) 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.

A variety of methods have been implemented since 1981 to mitigate declining population trends of the Hawaiian monk seal. These have included removal of aggressive males individuals from the population, moving individuals from one location to another (translocation), rehabilitation, and population monitoring. These have met with a variety of success or failure, but have not altered the species' declining population trajectory.

VII. Effects of the Proposed Action

Pursuant to Section 7(a)(2) of the ESA, federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The proposed activities authorized by the 8 proposed permits and one proposed permit amendment would expose listed species to close vessel approaches and associated methods, tagging, biopsy, active and passive acoustics, underwater video/photography, aerial and vessel surveys. In this section, we describe the potential physical, chemical, or biotic stressors associated with the proposed action, the probability of individuals of listed species being exposed to these stressors based on the best scientific and commercial evidence available, and the probable responses of those individuals (given probable exposures) based on the available evidence. As described in the *Approach to the Assessment* section, for any responses that would be expected to reduce an individual's fitness

(i.e., growth, survival, annual reproductive success, and lifetime reproductive success), the assessment would consider the risk posed to the viability of the population(s) those individuals comprise and to the listed species those populations represent. The purpose of this assessment is to determine if it is reasonable to expect the proposed studies to have effects on listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

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 research activities. The ESA does not define harassment nor has NMFS defined the term pursuant to the ESA through regulation. However, the Marine Mammal Protection Act of 1972, as amended, 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 U.S. Fish and Wildlife Service's regulatory definition of "harass"[11] pursuant to the ESA. For this Opinion, we define harassment similarly: an intentional or unintentional human act or omission that creates the probability of injury to an individual animal by disrupting one or more behavioral patterns that are essential to the animal's life history or its contribution to the population the animal represents.

A. Potential Stressors

The assessment for this consultation identified the following possible stressors associated with the proposed permitted activities:

1) vessel transit and tracking during proposed activities;
2) vessel close approaches to listed species in order to conduct various associated methods;
3) aerial surveys for counts;
4) underwater photography/videography with swimmers and associated instruments;
5) passive acoustic recording;
6) suction-cup tagging;
7) invasive tagging (implantable tags, anchor tags, dorsal fin ridge attachments);
8) tag instrument transmissions;
9) biopsy;
10) collection of sloughed skin, feces, and exhaled air;
11) swabbing and blow samples;
12) acoustic playbacks;
13) acoustic side scan sonar for prey mapping;
14) collection and export of dead listed mammal parts; and

[11] An intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3)

15) fishing gear modifications.

Activities are expected to occur in the state and federal waters of the Atlantic, Pacific (including Hawaii, Alaska, Guam and the Mariana Islands), and Gulf of Mexico every year from the date of permit issuance until each permit's expiration - five years from its date of issuance.

Based on a review of available information, we determined the following possible stressors that individual animals would be exposed to would not pose a risk to listed species: vessel transit and tracking; instruments associated with underwater photography/videography; tag instrument transmissions; acoustic side scan sonar for prey mapping; passive acoustic recording; collection of sloughed skin, feces, and exhaled air; swabbing and blow samples; collection and export of dead listed mammal parts; and fishing gear modifications.

Vessel transit associated with the proposed studies is not expected to pose a measurable risk to listed whales given the training and monitoring requirements of the research and fact that vessels will be at sea with the primary purpose of locating each species listed in the proposed activities. We expect that the researcher would be able to locate, identify, and avoid the whales during transit, and we do not expect the risk of vessel strike during the proposed studies to be probable while in transit. We do not expect a ship strike to occur due to the fact that the research vessel will be operating at an extremely reduced speed (3-8 knots) or in neutral when close to a whale. A NMFS rule (73 FR 74003; October 10, 2008) aimed at minimizing ship strikes places speed restrictions of ten knots or less on certain vessels in certain areas along the Atlantic coast. Thus, a reduced speed of 3-8 knots during proposed activities would not likely result in ship strike to these whales.

Instruments associated with underwater swimmers conducting video or photography are not expected to pose a measurable risk to listed animals. Cameras would not emit any sound that is measurable to the species being targeted. Depending on the permit, swimmers could be underwater with scooters to propel themselves through the water more quickly. Scooters emit a sound below 77 dB re uPa 1, which does not pose a risk to targeted animals. In addition, depending on the permit, some swimmers could use photogrammetry devices to measure whale size that emit 200-400 kHz. This sound also would not be detectable by targeted animals.

Passive acoustic recording is not expected to pose a measurable risk to individuals of each listed species. Single hydrophones or hydrophone arrays would be used for passive acoustic recording. The exact methodology of hydrophone use varies among the permits being proposed. None of the hydrophone array components emit any sound into the air or water, and therefore this equipment does not pose a risk of acoustic exposure. However, because use of these hydrophone buoys involves equipment suspended on and into the water column, the possibility for interactions with listed whales was assessed. In all proposed permits, hydrophones are either towed by the vessel as an array, attached to the vessel or underwater video cameras, or deployed as a single hydrophone near the vessel. In essence, the hydrophone or array would be an extension of the vessel itself. In this sense, effects to the target animals would be from the vessel close approach.

Hydrophones are also associated with close approaches and/or tracking. All hydrophone arrays proposed are rigid arrays made of PVC, would be attached to the vessel, and would be more visible to the whales than an array consisting of non-rigid line attachments. Because of this rigid array modification, the fact that hydrophones would be associated with the vessel, and the low number of buoys to be deployed for short lengths of time (for the duration while closely approaching or tracking tagged whales), we were able to conclude these buoys would pose minimal risk for threatened and endangered species during studies under the original permit. Hydrophone arrays have been deployed in the vicinity of whales and literature searches reveal no known entanglements in or interactions with this type of equipment (Hayes *et al*. 2000; Noad *et al*. 2004; Smith *et al*. 2008; Stokes and Deane 2005). In addition, all researchers conducting these proposed activities have used this type of array before and have not reported interactions with this type of array in their permit reports to PR1. Because of the rigid array modification and the fact that hydrophones would be alongside closely approaching vessels, we do not expect the whales to be affected by the hydrophone buoy array or single hydrophones.

During tagging activities, some whales would be exposed to sounds from the VHF and UHF tag attachments and vertical and side scan sonar for estimating prey densities. As described in the *Status of Listed Resources* section, we assume whales hear best at the frequencies at which they vocalize, which based on available information includes sounds in the low frequency (i.e., <1 kHz) range. Ketten (1992) indicates that mysticete whales' hearing is limited primarily to very low frequencies <10 kHz. Baleen whales may hear higher frequency sounds (e.g. Watkins 1986). Some tag configurations might include the use of VHF transmitters to aid researchers in locating tags, but the frequency range for these transmitters would be greater than 148 MHz. This is well above the known hearing range for marine mammals, therefore effects of VHF transmissions are not considered further in this Opinion. Some tag configurations might include the use of UHF transmitters, but the frequency range would consist of a 750 ms phase-modulated transmission at 401.650 MHz which is also out of a marine mammal's hearing range. In conclusion, the high-frequency sounds produced during some of the proposed tagging activities are expected to be outside the functional hearing range of the tagged whales, and are therefore not expected to pose a risk for individuals.

Vertical and side scan sonar would be used to estimate prey biomass and track underwater movement of whales. Since individuals may be pursuing/chasing prey up to the surface, sonar activities would occasionally occur within one body length of a whale. Sonar would be operated at frequencies from 30 to 800 kHz. Again, these frequencies are above the known hearing range for listed mammals in proposed activities.

The collection of sloughed skin and feces would also be authorized under proposed activities. Sloughed skin and feces would be collected from large whales and small cetaceans following certain surface activities (e.g., breaching, tail slapping). Sloughed skin would be collected from the site of the surface activity only after the animals have moved greater than 100 yards from the location. Sloughed skin could also be collected from retrieved suction cups. Since whales will have passed a safe distance of 100 yards by the time the vessel retrieves skin or feces, these actions would result in no effect to these species.

The collection of exhaled air would be authorized under proposed activities. Air is collected on close vessel approach with a sampling device that is held in the air in the path of the whale's exhalation spray and does not touch the whale. Individual whales would be approached to within 10 m from behind and the boat maneuvered so the wind pushes the blow sample towards the sampling device. The collection device would be attached to a 6-10m aluminum pole which would be extended towards the exhaled blow of the whale. The device itself would not pose a measurable risk to the whale, however, the close approach associated with air collection would be considered to pose a measurable risk and is analyzed further in this Opinion.

Skin swabbing would also be authorized. Skin is swabbed for genetic analysis and is conducted in much the same way as the collection of exhaled air samples with a swab attachment to the aluminum pole. Swabbing is similar to exfoliation and would not result in an invasive technique on the target animal. This would not result in a measurable risk to each whale. Again, close approach associated with this technique would be considered to pose the risk and is analyzed further in the Opinion.

The collection of dead listed marine mammal parts would result in no effect to these species since the animals will have been removed from the population by a natural predatory event prior to the take of their parts. These collection would not be for commerce. Salvage is solely for research.

Modifications to normal longline fishing vessel operations would occur under Permit 14122 only. These longliners fish in areas where sperm whales are present. The specific modifications would be:

- Deployment of autonomous passive acoustic recording devices to monitor all subsequent acoustic activity in the area.
- The vessel operator would be requested to activate various systems in sequential fashion before the haul, to isolate the effects of various cues on animals' acoustic behavior. These systems would occur during normal fishing vessel operations with or without research activities.

We expect no measurable effect to sperm whales from these modifications. Passive acoustic recording was already analyzed above and determined to pose no measurable effect on listed species. Modifications to longline systems would only vary the sequence and would not add additional systems to each haul that would not already have existed without research activities.

Accordingly, since none of the activities analyzed above were found to pose a measurable risk to listed species, the effects analysis of this consultation focused on the following potential stressors: 1) vessel close approaches; 2) aerial surveys; 3) suction-cup (non-invasive) tagging; 4) invasive tagging (implantable tags, anchor tags, dorsal fin ridge attachments); 5) biopsy; 6) active acoustic playbacks; and 7) swimmer presence.

B. Exposure Analysis

Exposure analyses identify the co-occurrence of ESA-listed species with the actions' effects in space and time, and identify the nature of that co-occurrence. The Exposure Analysis identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the actions' effects and the population(s) or subpopulation(s) those individuals represent.

Take tables (27-29) exhibited below were meant to exhibit takes from proposed activities by invasiveness and by region. Table 27 identifies the different species of listed marine mammals that are expected to be exposed annually to non-invasive procedures for five years in the Pacific (including Alaska, Hawaii, Guam, and the Mariana Islands) under the proposed permits and permit amendment. Table 28 identifies the different species of listed marine mammals that are expected to be exposed annually to invasive procedures for five years in the Pacific (including Alaska, Hawaii, Guam, and the Mariana Islands). Table 29 identifies non-invasive activities for the Atlantic and Gulf of Mexico; there are no invasive procedures proposed in the Atlantic/Gulf of Mexico.

For non-invasive procedures in the Pacific Ocean, humpback, North Pacific right, fin, sei, sperm, blue, Western North Pacific gray, and unidentified baleen and toothed whales would be exposed. Activities targeting these whales would consist of any combination of close approach, observation, passive recording, active acoustic playbacks, suction-cup tag, photo-i.d., underwater photography and video, and genetic and blow sampling. Based upon time of year and areas targeted, we expect that "unidentified" baleen whales would be some combination of humpback, North Pacific right, fin, sei, blue, Western North Pacific gray, or unlisted whales. We expect that "unidentified" toothed whales would be come combination of sperm and unlisted whales. Predated marine mammal parts would also be collected. Steller sea lions (Eastern and Western) and Hawaiian monk seals would not be targeted, but could be harassed by vessels or playbacks.

For invasive procedures in the Pacific Ocean, humpback, North Pacific right, fin, sei, sperm and blue whales would be exposed. Activities targeting these whales would consist of any combination of the non-invasive procedures listed above (excluding suction-cup tags) with invasive tagging or biopsy methods.

In the Atlantic and Gulf of Mexico, permit 14451 only would conduct non-invasive aerial and vessel surveys, close vessel approach and harassment, observations, photo, photogrammetry, and photograph/video on fin, humpback, sei, sperm, blue, and "unidentified" baleen and toothed whales. Based upon time of year and areas targeted, we expect that "unidentified" baleen whales would be some combination of fin, humpback, sei, blue, North Atlantic right, or unlisted whales. We expect that unidentified toothed whales would be some combination of sperm and unlisted whales.

In our assessment of the potential exposure levels of listed species by the proposed permits and amendment, we considered the available annual reports. Due to new reporting requirements set in place by PR1, takes appearing in annual reports were less than what they would be at present. In the past, permit conditions required annual reports to list the number of animals "harassed", defined as: "to disrupt the normal behavior or prior activity of an animal by any act or omission. This disruption of normal behavior may be

manifested by, among other actions on the part of the animal, interruptions of breeding, nursing, or resting activities, movement away from researchers, including a stampede; or the abandonment of a previously frequented area." Conditions in the proposed permits would indicate that any “approach" of a cetacean constitutes a take by harassment and must be counted and reported; reported takes would no longer be limited to observed behavioral responses. An "approach" is defined as a continuous sequence of maneuvers (episode) [involving a vessel or researcher's body in the water], including drifting, directed toward a cetacean or group of cetaceans closer than 100 yards for large whales, or 50 yards for smaller cetaceans. This clarification would require that listed whales not previously reported as "takes" would be reported in the future. We have assessed the action at the proposed levels for close vessel approaches.

For activities involving invasive or non-invasive tagging and/or biopsy, annual reports tracked vessel approaches with missed attempts and total successful tagging/biopsies annually. Therefore, tagging takes in past reports is still in line with what PR1 requires for reporting under their new requirements. Takes for tagging and biopsy therefore incorporate these proposed numbers based on past research reports. We have assessed the action at the proposed levels for tagging and biopsy takes.

We believe that in any given year, not all proposed takes would occur since researchers ask for takes based on a desired sample size. However, due to changes in annual reporting of takes for the proposed activities being more conservative, we did not further refine the expected level of exposure within the proposed permit limits, and have assessed the action at the proposed levels.

Table 27. Non-invasive procedures - Proposed takes by species and location in the Pacific Ocean. *Takes are configured annually unless otherwise indicated in the table.

Humpback Whales - Hawaii			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Acoustic, passive recording; Close vessel approach; Instrument, suction-cup (e.g., VHF, TDR); Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Underwater photo/videography	All male and female	80 over five years (maximum 20 animals tagged annually; calves >1month old)	Au Permit 14682
Survey, vessel; Acoustic, passive recording; Close vessel approach; Observation, monitoring; Observations, behavioral; Photo-id; Photogrammetry; Photograph/Video; Tracking; Underwater photo/videography	All male and female	540 over five years	
Acoustic, passive recording; Aerial/vessel count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video; Underwater photo/videography	All male and female	5335	Mobley Permit 14451
Acoustic, passive recording; harassment; Observations, behavioral; photo-i.d.; underwater photo/videography	All male and female	1110 (3 takes per animal)	Zoidis Permit 14353
Acoustic, passive recording; Instrument, suction-cup (e.g. VHF, TDR); Observations, behavioral; photo-i.d.; underwater photo/videography	Adult; Male and female adult escorts	90 (max. 30 animals tagged per year); 3 takes per animal	
Acoustic, passive recording; Instrument, suction-cup (e.g. VHF, TDR); Observations, behavioral; photo-i.d.; underwater photo/videography	Adult; Female mothers	150 (max. 50 animals tagged per year); 3 takes per animal	
Acoustic, passive recording; Instrument, suction-cup (e.g. VHF, TDR); Observations, behavioral; photo-i.d.; underwater photo/videography	Male and female calves	150 (max 50 animals tagged per year); 3 takes per animal	

Humpback Whales – Hawaii and Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Acoustic, passive recording; Collect, sloughed skin; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Underwater photo/videography	All male and female	4,000	Darling Permit 13846
Survey, aerial; Observations, behavioral; Photograph/Video	All male and female	1,000	

Survey, vessel; Observation, monitoring; Photo-id; Photogrammetry; Photograph/Video; Underwater photo/videography	All male and female	300	
Survey, vessel; Acoustic, active playback/broadcast; Acoustic, passive recording; Observation, monitoring; Observations, behavioral; Photo-id; Photogrammetry; Photograph/Video; Underwater photo/videography; harassment	All male and female	300	

Humpback Whales – Guam and Northern Mariana Islands			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video	All male and female	505	Mobley Permit 14451

Humpback Whales – Alaska			
Close approach by vessel for photo-i.d., behavioral observations, and passive acoustics	Juveniles and adults; Male and female	108	Cartwright Permit 10018-01
Close approach by vessel for photo-i.d., behavioral observations, and passive acoustics	Female adults	54	
Close approach by vessel for photo-i.d., behavioral observations, and passive acoustics	Calves; Male and female	54	
Close approach by vessel for photo-i.d., behavioral observations, and passive acoustics	Juveniles; Male and female	54	
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Count/survey; Harassment; Observations, behavioral; Photo-id; Sample, fecal ; Underwater photo/videography; Annual takes combined for independently conducted photo ID, sonar, acoustic recording, pole cam, SCUBA, behavioral observations & fecal collection, and harassment	All, except calves less than 6 months male and female	1580	Sharpe Permit 14599
Survey, vessel; Acoustic, active playback/broadcast; Observations, behavioral; Photo-id; Annual takes for playbacks; playbacks may be conducted concurrent with suction-cup tagging, not to exceed a total of 300 individuals exposed to playbacks	All, except calves less than 6 months male and female	300	
Survey, aerial; Observations, behavioral; Other; Photo-id; Annual takes for helicopter surveys to document feeding behavior	All, except calves less than 6 months male and female	200	

Survey, vessel; Acoustic, active playback/ broadcast; Instrument, suction-cup (e.g., VHF, TDR); Observations, behavioral; Photo-id; Annual takes for Crittercam suction cup attachment	All, except calves less than 6 months male and female	90 total takes; (successful attachment to no more than 30 ind; up to 90 ind may be approached with tagging attempts; no more than 3 attempts per individual per day	
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, exhaled air; Sample, fecal ; Underwater photo/videography	All male and female	1000; 1 take per animal per day	Straley Permit 14122
Survey, vessel; Acoustic, active playback/broadcast; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, exhaled air; Sample, fecal ; Underwater photo/videography	All male and female	200 (2 takes per animal); Includes missed attempts. Total 50 successful tags annually. Only calves 6 mo. or older will be suction cup tagged.	
Harassment by vessel close approach; Instrument, suction-cup (e.g., VHF, TDR); observations; behavioral; photo-i.d.	Adult/juvenile; male and female	60	Witteveen Permit 14296
Acoustic, passive recording; harassment by close vessel approach; observations; behavioral; photo-i.d.	All; male and female	610	
Acoustic, active playback/broadcast; Harassment; Instrument suction-cup (e.g. VHF, TDR); Observations, behavioral; Photo-i.d.	Adult/Juvenile	30	

Humpback Whales – Washington			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id	All male and female	200	Darling Permit 13846

Humpback Whales – Alaska, Oregon, Washington, and Northern California			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video	All male and female	460	Mobley Permit 14451

Humpback Whales – Hawaii, California to Alaska			
Vessel survey; Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id; Sample, fecal; Underwater photo/videography	All male and female	1,880	Pack Permit 14585
Vessel survey; Acoustic, passive recording; Collect, sloughed skin; Observation, monitoring; Photo-id; Sample, fecal; Sample, skin biopsy; Underwater photo/videography	All but neonates male and female	900	

Humpback Whales – Southern California			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video	All male and female	345	Mobley Permit 14451

North Pacific Right Whales – Hawaii			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Harassment During playback trials	All male and female	5	Darling Permit 13846

North Pacific Right Whales - Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes**	**Permit**
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography	All male and female	50 (1 take per animal per day)	Straley Permit 14122
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography	All male and female	20 (2 takes per animal); includes missed attempts; total 5 successful tags annually; only calves 6 mo. or older will be suction cup tagged	
Acoustic, passive recording; harassment by close vessel approach; observations; behavioral; photo-i.d.	All; male and female	40	Witteveen Permit 14296

Fin Whales - Hawaii			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Acoustic, passive recording; Aerial/vessel count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video; Underwater photo/videography	All male and female	50	Mobley Permit 14451
Vessel survey; Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id; Sample, fecal	All male and female	10	Pack Permit 14585

Fin Whales – Guam and Northern Mariana Islands			
Proposed Takes	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video	All male and female	50	Mobley Permit 14451

Fin Whales – Alaska, Oregon, Washington, and Northern California			
Proposed Takes	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video	All male and female	70	Mobley Permit 14451

Fin Whales – Southern California			
Proposed Takes	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video	All male and female	315	Mobley Permit 14451

Fin Whales - Alaska			
Acoustic, passive recording; Acoustic, sonar for prey mapping; collect soughed skin; count/survey; import/export/receive parts; harassment; measure; observation, monitoring; observations, behavioral; photo-i.d.; photograph/video; sample, fecal; underwater photo/video	All male and female	300; 1 take per animal	Straley Permit 14122
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography	All male and female	50 (2 takes per animal)l Includes missed attempts. Total 10 successful tags annually	
Harassment by vessel close approach; Instrument, suction-cup (e.g., VHF, TDR); observations; behavioral; photo-i.d.	Adult/juvenile; male and female	60	Witteveen Permit 14296
Acoustic, passive recording; harassment by close vessel approach; observations; behavioral; photo-i.d.	All; male and female	640	

Sei Whales - Hawaii			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Acoustic, passive recording; Aerial/vessel count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video; Underwater photo/videography	All male and female	50	Mobley Permit 14451
Vessel survey; Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id; Sample, fecal	All male and female	10	Pack Permit 14585

Sei Whales – Guam and Northern Mariana Islands			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video	All male and female	50	Mobley Permit 14451

Sei Whales – Alaska, Oregon, Washington, and Northern California			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video	All male and female	50	Mobley Permit 14451

Sei Whales – Southern California			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video	All male and female	50	Mobley Permit 14451

Sei Whales - Alaska			
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Other; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography	All male and female	300; 1 take per animal per day	Straley Permit 14122
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography	All male and female	50; 2 takes per animal; includes missed attempts; total 10 successful tags annually; only calves 6 mo. or older will be suction cup tagged	
Acoustic, passive recording; harassment by close vessel approach; observations; behavioral; photo-i.d.	All; male and female	40	Witteveen Permit 14296
Harassment by vessel close approach during directed research on target species	All; male and female	20	

Sperm Whales - Hawaii			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Acoustic, passive recording; Aerial/vessel count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video; Underwater photo/videography	All male and female	50	Mobley Permit 14451

Sperm Whales – Hawaii, California to Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Vessel survey; Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id; Sample, fecal	All male and female	25	Pack Permit 14585

Sperm Whales – Guam and Northern Mariana Islands			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video	All male and female	50	Mobley Permit 14451

Sperm Whales – Alaska, Oregon, Washington, and Northern California			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video	All male and female	245	Mobley Permit 14451

Sperm Whales – Southern California			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video	All male and female	70	Mobley Permit 14451

Sperm Whales - Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Acoustic, active playback/broadcast; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Harassment; Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Other; Photo-id; Photograph/Video; Sample, fecal	All male and female	200; 2 takes per animal; includes missed attempts total 50 successful tags annually; only calves 6 mo. or greater will be suction cup tagged	Straley Permit 14122
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Harassment; Measure; Observation, monitoring; Observations, behavioral; Other; Photo-id; Photograph/Video; Sample, fecal	All male and female	500	
Acoustic, passive recording; harassment by close vessel approach; observations; behavioral; photo-i.d.	All; male and female	40	Witteveen Permit 14296
Harassment by vessel close approach during directed research on target species	All; male and female	20	

Blue Whales - Hawaii			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Acoustic, passive recording; Aerial/vessel count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video; Underwater photo/videography	All male and female	50	Mobley Permit 14451
Vessel survey; Acoustic, passive recording; Collect, sloughed skin; Observations, behavioral; Photo-id; Sample, fecal	All male and female	10	Pack Permit 14585

Blue Whales – Guam and Northern Mariana Islands			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video	All male and female	50	Mobley Permit 14451

Blue Whales – Southern California			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video	All male and female	305	Mobley Permit 14451

Blue Whales - Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography	All male and female	300; 1 take per animal per day	Straley Permit 14122
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography	All male and female	50 (2 takes per animal); Includes missed attempts. Total 10 successful tags annually; only calves 6 mo. or older will be suction cup tagged	
Acoustic, passive recording; harassment by close vessel approach; observations; behavioral; photo-i.d.	All; male and female	40	Witteveen Permit 14296

Western North Pacific Gray Whales – Guam and Northern Mariana Islands			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video	All male and female	50	Mobley Permit 14451

Unidentified Whales – Hawaii – where "unidentified" baleen whale is some combination of blue, fin, humpback, sei or unlisted whale and "unidentified" toothed whale is some combination of sperm or unlisted whale			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Acoustic, passive recording; Aerial/vessel count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video; Underwater photo/videography	All male and female	50 baleen; 50 toothed	Mobley Permit 14451

Unidentified Whales – Guam and Northern Mariana Islands – where "unidentified" baleen whale is some combination of blue, fin, humpback, sei, gray, or unlisted whale and "unidentified" toothed whale is some combination of sperm or unlisted whale			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; Harassment; Observations, behavioral; Photo-i.d.; Photogrammertry; Photograph/Video	All male and female	50 baleen; 50 toothed	Mobley Permit 14451

Unidentified Whales – Alaska, Oregon, Washington, and Northern California – where "unidentified" baleen whale is some combination of fin, humpback, sei, blue, or unlisted whale and "unidentified" toothed whale is some combination of sperm or unlisted whale			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video	All male and female	50 baleen; 50 toothed	Mobley Permit 14451

Unidentified Whales – Southern California – where "unidentified" baleen whale is some combination of fin, humpback, sei, blue, or unlisted whale and "unidentified" toothed whale is some combination of sperm or unlisted whale			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Aerial/vessel count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video	All male and female	50 baleen; 50 toothed	Mobley Permit 14451

Unidentified Cetaceans - Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Net Collect 25 samples total of dead pinniped or cetacean will be collected; remains for predation study; Up to 5 cetaceans (humpback, sei, or fin whales) may be harassed during this collection	All male and female	5	Straley Permit 14122
Collection of dead parts following killer whale predation events; collection of sloughed skin following aerial or surface behaviors	All; male and female	50	Witteveen Permit 14296

Sea Lions - Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Harassment by vessel close approach during directed research on target species	Steller sea lion (Western); All; male and female	50	Witteveen Permit 14296
Survey, vessel; Harassment during playback trials	(Eastern) Steller sea lions; All male and female	100	Darling Permit 13846

Unidentified Pinnipeds - Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Net Collect 25 samples total of dead pinniped or cetacean; remains for predation study; Up to 20 unidentified pinnipeds (Which could include Steller sea lions) may be harassed during sampling	All male and female dead	20	Straley Permit 14122
Collection of dead parts following killer whale predation events	All male and female dead	50	Witteveen Permit 14296

Hawaiian Monk Seals - Hawaii			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Harassment during playback trials	All male and female	5	Darling Permit 13846

Table 28. Invasive procedures - Proposed takes by species and area in Pacific Ocean. *Takes are configured annually unless otherwise indicated in the table.

Humpback Whales - Hawaii			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Acoustic, passive recording; Collect, sloughed skin; Import/export/receive, parts; Close vessel approach; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Adults only male and female	150 over five years (maximum 50 animals sampled annually)	Au Permit 14682

Humpback Whales – Hawaii and Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin biopsy; Underwater photo/videography; Tissue samples may be exported to Sweden	Adult/ Juvenile male and female	300	Darling Permit 13846
Survey, vessel; Acoustic, passive recording; Instrument, dart/barb tag (e.g., satellite tag); Observation, monitoring; Observations, behavioral; Photo-id; Photogrammetry; Photograph/Video; Sample, skin biopsy; Underwater photo/videography; Andrews satellite tag; Tissue samples may be exported to Sweden	Adult male and female	30	
Survey, vessel; Acoustic, passive recording; Instrument, suction-cup tag (e.g., VHF, TDR); Observation, monitoring; Observations, behavioral; Photo-id; Photogrammetry; Photograph/Video; Sample, skin biopsy; Underwater photo/videography; Burgess tag, Crittercam, Dtag, or similar	Adult male and female	30	

Humpback Whales - Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Acoustic, active playback/broadcast; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, exhaled air; Sample, fecal ; Underwater photo/videography	Adult/ Juv. Male and Female	100 (2 takes per animal); Includes missed attempts. Total 10 successful tags annually; (each whale will receive one of the 3 listed tag types)	Straley Permit 14122

Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, exhaled air; Sample, fecal ; Sample, skin and blubber biopsy; Sample, skin biopsy; Underwater photo/videography	All male and female	200 (4 takes per animal); Includes missed attempts. Total 200 successful biopsies annually; calves 4 mo. or older may be biopsied	
Harassment by vessel close approach; observations; behavioral; photo-i.d.; sample, skin and blubber biopsy	All; male and female	300	Witteveen Permit 14296

Humpback Whales – Hawaii, California to Alaska			
Proposed Activities	Life Stage and Sex	Takes*	Permit
Vessel survey; Acoustic, passive recording; Instrument, suction-cup tag (e.g., VHF, TDR); Crittercam; Observations, behavioral; Photo-id; Sample, skin biopsy; Underwater photo/videography; Observations, behavioral; Collect, sloughed skin; Sample, fecal	Adult/ Juvenile male and female	150	Pack Permit 14585

North Pacific Right Whales – Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography	Adult/ Juv. Male and Female	10 (2 takes per animal); includes missed attempts. Total 5 successful tags annually.	Straley Permit 14122
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Sample, skin and blubber biopsy; Sample, skin biopsy; Underwater photo/videography	All male and female	20 (1 take per animal) Includes missed attempts. Total 5 successful biopsies annually; calves 4 mos. or older may be biopsied	
Harassment by vessel close approach; observations; behavioral; photo-i.d.; sample, skin and blubber biopsy	Adult/juvenile; male and female	10	Witteveen Permit 14296

Fin Whales – Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Sample, sperm; Underwater photo/videography	Adult/ Juv. Male and Female	50 (2 takes per animal); Includes missed attempts. Total 10 successful tags annually	Straley Permit 14122
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photogrammetry; Photograph/Video; Sample, fecal ; Sample, skin and blubber biopsy; Sample, skin biopsy; Underwater photo/videography	All male and female; calves 4 months or older may be biopsied	100 (4 takes per animal); Includes missed attempts. Total 50 successful biopsies annually	
Harassment by vessel close approach; observations; behavioral; photo-i.d.; sample, skin and blubber biopsy	All; male and female	300	Witteveen Permit 14296

Sei Whales – Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography	Adult/ Juv. Male and Female	50; 2 takes per animal; includes missed attempts; total 10 successful tags annually	
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Sample, skin and blubber biopsy; Sample, skin biopsy; Underwater photo/videography	All male and female	200; 4 takes per animal; includes missed attempts; total 50 successful biopsies annually; calves 4 months or older may be biopsied	Straley Permit 14122
Harassment by vessel close approach; observations; behavioral; photo-i.d.; sample, skin and blubber biopsy	Adult/juvenile; male and female	10	Witteveen Permit 14296

Sperm Whales – Alaska			
Proposed Activities	**Life Stage and Sex**	**Takes***	**Permit**
Survey, vessel; Acoustic, active playback/broadcast; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Measure; Observation, monitoring; Observations, behavioral; Other; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography	Adult/ Juv. Male and female	100; 2 takes per animal; includes missed attempts; total 10 successful tags annually	Straley Permit 14122
Survey, vessel; Acoustic, active playback/broadcast; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Instrument, suction-cup (e.g., VHF, TDR); Measure; Observation, monitoring; Observations, behavioral; Other; Photo-id; Photograph/Video; Sample, fecal ; Sample, skin and blubber biopsy; Sample, skin biopsy; Underwater photo/videography	All male and female	200; 4 takes per animal; includes missed attempts; total 100 successful biopsies annually; only calves 6 months or older will be suction cup tagged (calves will not be satellite tagged); calves 4 months and older may be biopsied	
Harassment by vessel close approach; observations; behavioral; photo-i.d.; sample, skin and blubber biopsy	Adult/juvenile; male and female	10	Witteveen Permit 14296

Blue Whales – Alaska			
Proposed Activity	**Life Stage and Sex**	**Takes***	**Permit**
Harassment by vessel close approach; observations; behavioral; photo-i.d.; sample, skin and blubber biopsy	Adult/Juvenile; male and female	10	Witteveen Permit 14296
Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Instrument, dart/barb tag; Instrument, dorsal fin/ridge attachment; Instrument, implantable (e.g., satellite tag); Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Underwater photo/videography	Adult/ Juv. Male and Female	50 (2 takes per animal); Includes missed attempts. Total 10 successful tags annually	Straley Permit 14122

Survey, vessel; Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Count/survey; Import/export/receive, parts; Harassment; Measure; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Sample, fecal ; Sample, skin and blubber biopsy; Underwater photo/videography	All male and female	100 (4 takes per animal); Includes missed attempts. Total 50 successful biopsies annually; calves 4 months or older may be biopsied	

Table 29. Proposed takes by species in Atlantic Ocean (Mobley Permit 14451 only) using non-invasive procedures.

Species	Life Stage and Sex	Takes	Proposed Activities
Fin whale	All male and female	345	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Humpback whale	All male and female	475	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Sei whale	All male and female	50	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Sperm whale	All male and female	495	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Blue whale	All male and female	65	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video
Unidentified baleen whale (some combination of fin, humpback, sei, sperm, blue, North Atlantic right, or unlisted whale); unidentified toothed whale (some combination of sperm or unlisted whale)	All male and female	50 baleen; 50 toothed	Count/survey; close vessel approach and harassment; observations, behavioral, photo i.d.; photogrammetry; photograph/video

Duration of Exposure. Under the proposed permits 14682, 13846, 14451, 14585, 14599, 14122, 14296, 14353, and permit amendment 10018-01, exposure to proposed activities would occur each year for five years until each permit's expiration date. The duration of each exposure depends on the duration of close approach, methods performed after close approach, or method of tag attachment or acoustics.

Exposure times are separated depending on the methods of exposure (i.e. exposure to the vessel for close approach, or exposure to a tag or acoustic device) or the given permit. Tagging of

target whales could last 5-10 minutes for close approach and 5 seconds or less for tag or biopsy application. Subsequent monitoring after tagging depends on the observations being made, subsequent methods being employed, or tracking time needed until tag falls off. Depending on methods employed after tagging, whales could be monitored anywhere from 15 minutes up to 24 hours until the longest-lasting tags fall off and are retrieved. Vessel mounted cameras would close approach and film for approximately 15 minutes depending on the permit. Underwater swimmers would have an encounter for approximately 20-40 minutes depending on group size and number of divers in the water. Playbacks would last for a few seconds up to 60 minutes depending on the permit or acoustic exposure. Bursts and signals would last on the order of seconds and singing playbacks would last up to 60 minutes. Aerial survey encounters would last for up to 15 minutes. Fishing vessels with modified equipment usually fish for 3-17 hours at a given time.

C. Response Analysis

As discussed in the *Approach to the Assessment* section of this Opinion, 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 species themselves. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals. Ideally, response analyses would consider and weigh evidence of adverse consequences as well as evidence suggesting the absence of such consequences.

We examine responses on a range of increasing severity to the species, which includes behavioral, sub-lethal, and lethal responses. Within the behavioral response range, we examine reactions based on classifications increasing in severity from startle, to alarm, to avoidance, to abandonment, and displacement. Within the sub-lethal response range, we examine reactions such as reduced feeding success, reduced growth rates, delayed sexual maturity, reduced fecundity, and reproductive failure. Within the lethal response range, we examine reactions that would have a certain lethal probability such as 10%, 20%, 40%, 60%, or 80% probability of death.

1. Responses of Cetaceans and Pinnipeds to Close Vessel Approaches

The proposed permits 14682, 14451, 14353, 14585, 13846, 14599, 14122, 14296 and permit amendment 10018-01 would authorize close approaches to a combination of humpback, fin, sei, sperm, Western North Pacific gray, North Pacific and North Atlantic right, and blue whales depending on the permit and action area. In addition, Eastern (permit 13846) and Western (permits 14296 and 14122) Steller sea lions and Hawaiian monk seals (permit 13846) could be harassed by vessel close approach during proposed activities. These activities would take place in the Pacific and Atlantic Oceans and Gulf of Mexico, including state waters depending on the given permit (see Tables 27-29). Close approaches would be necessary to achieve each permit's combination of count surveys, photo-identification, photogrammetry, video, behavioral observation, monitoring, measurement, collection of dead parts, underwater photo and video, tracking, collection of sloughed skin and/or feces and/or exhaled air, blubber and/or skin biopsy, invasive and non-invasive tagging and associated attempts. A close approach is defined as a

continuous sequence of maneuvers, including drifting, directed toward a whale or group of whales that involves one or more instances of coming within 100 yards. Vessels used for close approach would generally be less than 30 m in length; the majority of research would be conducted from vessels less than 20 m in length. For large whales, boat approaches would be within a whale's length from an individual (10-15 m for an adult-sized whale), although a whale might approach the boat closer than this distance. Boat approaches would be within 5 m for tagging, video, swabbing, or air collection. During close vessel approaches for all activities, disturbance to animals would be minimized by:

- Approaching at minimal speeds (slowest speed required in order to keep forward momentum) from behind or beside the group.
- Remaining parallel to the animals.
- Matching speed with the group once approached.
- Minimizing changes in speed.
- Terminating activities if active behavioral avoidance is occurring.

Behavioral Responses. Studies on the effects of close vessel approach focus on behavioral responses and a variety of studies have detected increased swim speeds as a stereotypical response to vessel traffic (Bauer 1986; Corkeron 1995; Au and Green 2000), however, reactions vary by species or individuals within species (Watkins 1986; Gauthier and Sears 1999). Reactions include little to no observable change in behavior to momentary changes in swimming speed, pattern, orientation, diving and time spent submerged, foraging, respiratory patterns, and may include aerial displays like breaching and lobtailing (Watkins *et al.* 1981; Bauer 1986; Brown *et al*. 1991; Clapham and Mattila 1993; Jahoda *et al*. 2003; Best *et al*. 2005). Baker *et al*. (1983) described two responses of whales to vessels, including: (1) "horizontal avoidance" of vessels 2,000 to 4,000 meters away characterized by faster swimming and fewer long dives; and (2) "vertical avoidance" of vessels from 0 to 2,000 meters away during which whales swam more slowly, but spent more time submerged. Pinnipeds hauled out of the water may dive back into the water if disturbed by a vessel and could, if in the water, exhibit a similar range of responses as whales. Observed responses of species examined in this Opinion are outlined below.

Humpback whale reactions to boat approaches are variable, ranging from approach to avoidance (Salden 1993). Overall, humpbacks attempt to avoid vessels with increased frequencies of surfacings without blows and dives initiated without raised flukes (Bauer 1986); additional responses include reduced time at the surface, longer dives, altered directions of travel, and reduced speeds after the boat departs (Green and Green 1990). Hawaii humpbacks attempt to avoid vessels by making longer dives, swimming away from the path of the vessel, and sometimes by demonstrating agonistic behaviors (Bauer 1986; Bauer and Herman 1986). Hawaiian humpback whales even react to the presence of boats with an increase in swim speed by 50% (Scheidat *et al*. 2004; Bauer *et al*. 1986) and even as much as 300% (Au and Green 2000). Sound may be a major factor with vessel approach, as humpbacks react to sound of vessels by swimming at right angles to the direction headed (Hall 1982). A study of the effects of vessel noise on humpback whales summering in Alaska demonstrated a number of significant responses to nearby boats including increased dive durations and orientation away from the path of moving boats, often at ranges up to 3-4 km (Baker and Herman 1989). It is unlikely that the

levels of sounds produced by whale watching vessels would have any grave effects on the auditory system of humpback whales (inflatables with outboard engines and twin outboard diesel engines) (Au and Green 2000), and humpback whale background chorusing was high enough to contaminate the recording of boat sounds on one measurement day of Au and Green's (2000) study. There is evidence that humpbacks can still hear vessels even when their chorusing is high (Au and Green 2000).

Fin whales also take evasive tactics when closely pursued by vessel, altering direction underwater occasionally parting company and breathing at irregular intervals (Ray *et al*. 1978). Jahoda *et al*. 2003 found that close disturbance from a speed boat for approximately one hour caused significant change in Mediterranean fin whales' swimming and respiratory patterns as compared to a control period. While a tagging vessel was maneuvering, a group of fin whales stopped feeding and separated temporarily, but remained in the area with the vessel (Watkins *et al*. 1981). While implanting radio tags in fin, humpback, and bryde's whales, Watkins (1981b) observed reaction to the maneuvering of the boat and to sudden underwater sounds with no evidence that the whales recognized the tagging boat.

There are mixed reported responses of sei whales to vessel disturbance. Sei whales are reported to respond to approaching vessel traffic in a similar manner as fin whales (Perry *et al.* 1999). On the other hand, sei whales are also reported to be more difficult to approach than fin whales (Gunther 1949). Sei and blue whales are thought to respond to approaching vessels in a similar manner as other baleen whales, with responses depending on whale behavior and the speed and direction of the approaching vessel (Perry *et al.* 1999).

Gray whales exhibit short-term escape reactions when boats move fast or erratically (Reeves 1977, Swartz and Cummings 1978, Swartz and Jones 1978, 1981). However, they have little response to slow-moving or anchored vessels (Richardson *et al*. 1995). Some gray whales are even attracted to quiet, idling, or slow-moving boats (Swartz and Cummings 1978, Dahlheim *et al.* 1981, 1984).

Sperm whale reactions to vessels are also variable. Startle reactions have been seen during close approaches (Whitehead *et al.* 1990). Course changes and shallow dives are evident with most vessels (Gaskin 1964, Lockyer 1977), although sperm whales may change direction and disperse into smaller subgroups when chased by catcher boats (Gambell 1968, Lockyer 1977). Small motorized vessels or sailing vessels can be used near sperm whales without evident behavioral disturbance (Papastavrou *et al*. 1989).

There is little recent compelling evidence to show that right whales avoid approaching vessels (Vanderlaan and Taggart 2007; Panigada *et al*. 2006). Nowacek *et al*. (2004) conducted a study on North Atlantic right whales, which compared their response to an alert signal sound versus their response to an approaching vessel. Five out of the six whales being studied had a strong response to the alert signal sound, but had no response to the approaching vessel. This indicates right whales may have become habituated to approaching vessels and might not experience behavioral changes and therefore negative energetic and other physiological consequences of close approach. Southern right whales also do not elicit "strong boat-avoidance" behavior (Best *et al*. 2001b). A study from Watkins in 1976 showed right whales to have negative or

uninterested responses to approaching vessels, and this had not changed when he replicated his study ten years later (Watkins 1986). Watkins rated whale responses as either positive (whale permitted close approach or had apparent curiosity), uninterested (whale ignored approach), or negative (whale exhibited sudden changes in activity) in 1976 and again in 1986. Out of the ten right whales approached in 1976, five had uninterested and five had negative responses. Out of the eleven right whales approached in 1986, five had uninterested and six had negative responses. Even though Watkins observed uninterested or negative responses, he did report that the whales appeared to habituate rapidly and only a few encounters were needed to transform a whale's wariness to unapparent concern (1986). A recent rare sighting of North Pacific right whales in the Bering Sea provided an opportunity for satellite-monitored radio tagging of one of the whales, but the authors did not comment on this whale's response to the vessel (Wade *et al.* 2006).

Sea lions hauled out on land are known to be more responsive than sea lions in the water (Peterson and Bartholomew 1967) and rarely react while in water unless a boat approaches within 100-200 meters (Bowles and Stewart 1980). Reactions to nearby boats are most common if motor noise varies in level and visual cues are also involved (Richardson *et al*. 1995). Sea lions in the water are said to tolerate close and frequent approaches by vessels and are even sometimes seen congregating around fishing vessels (Richardson *et al*. 1995). Disturbance effects to sea lions hauled out may range from no response to initiating the flight response in an aggregation (i.e., a stampede). Studies have shown disturbance from aircraft and vessel traffic has highly variable effects on Steller sea lions that are hauled out (Calkins and Pitcher 1982). Response may range from no reaction at all to the immediate and complete evacuation of haulout (Calkins and Pitcher 1982).

There is little available information on responses of Hawaiian monk seals to research vessels specifically. However, there is a good deal of information on monk seal responses to human approaches in general. In 2.0% percent of Hawaiian monk seal approaches, a focal individual raised its head apparently in response to human presence, and is the most common category of response. This "alerting" was transitory and monk seals normally resumed baseline activity within a few seconds to minutes (Gilmartin 2002). Rarely (0.40% of observer approaches), monk seals would be alerted to human presence and move some distance on the beach less than twice the individual's body length. Again, baseline activity normally resumed after a short period. Focal animals also became disturbed enough to enter the water in 0.4% of observer approaches. Over longer time frames (1997-2007) and over the Hawaiian monk seals' entire range, the overall rate of response to approaches is 2.95%, ranging from 0.52-11.6% by location, with less than 1% entering the water (NMFS 2008d). In addition, monk seals may vocalize in response to disturbance by approach (NMFS-PIFSC 2008).

Expected Behavioral Responses from Close Vessel Approach. We assume that cetaceans and pinnipeds exposed to the proposed activities would have reactions similar to those reviewed in the literature above. We expect they would exhibit anywhere from no response, to avoidance, to even possibly approaching a given research vessel.

Available information also suggests the cumulative effect of activities in the action area would be greater than the effect of each individual activity. For example, Beale and Monaghan (2004)

concluded that the level of disturbance is a function of the distance of humans to the animals, the number of humans making the close approach, and the frequency of the approaches. Weinrich *et al.* (1992) concluded that continuous or repeated exposure to stressors that produce moderate, adverse responses could produce alarm reactions and possible stress responses. Permit conditions address the potential for repeat disturbance of these species. To minimize repeated disturbances to individuals, the proposed permit limits takes by harassment (e.g., due to close approach) at two to three per individual in one day (depending on the permit), and requires coordination of the proposed activities with other permit holders conducting similar activities on the same species in the same locations or times of year.

Our review of the literature revealed that studies of the effects of close vessel approaches are mostly centered around looking for behavioral reactions. For any animals that exhibit subtle or no changes in behavior when a vessel approaches, we cannot be certain they are not somehow disturbed by the activity. For animals that do exhibit disturbance and alter their behaviors, Clapham and Mattila (1993) note that human observation of a whale's behavioral response may not reflect an individual whale's actual experience. Gill *et al.* (2001) also note that changes in animal behavior do not necessarily reflect consequences of disturbance at the population level. Therefore, our use of behavior as an indicator of an animal's response to a close approach may or may not be accurate, and we cannot definitively know whether such behavioral responses have long-term consequences, as such consequences would be primarily sub-lethal for individuals (that is, they would affect their growth, health, or reproductive success), and the associated consequences on populations would be delayed in time and concealed by any imprecision in population estimates. Likewise, the affected animals may not respond behaviorally to close approaches or experience stress responses if they have habituated to an activity – such as being closely approached by researchers or whale watch vessels – suggesting the animals would not perceive these close approaches as potential threats (Fowler 1999; Romero and Wikelski 2001).

Evidence indicates that wild animals respond to human disturbance in the same way they respond to predators (Harrington and Veitch 1992; Lima 1998; Gill *et al.* 2001; Frid and Dill 2002; Frid 2003; Beale and Monaghan 2004; Romero 2004). These responses may manifest themselves as stress responses, interruptions of essential behavioral or physiological events, alteration of an animal's time budget, or some combinations of these responses (Sapolsky *et al.* 2000; Frid and Dill 2002; Romero 2004; Walker *et al.* 2005). For behavioral responses, Weinrich *et al.* (1992) associated "moderate" and "strong" responses with alarm reactions and stress responses, respectively. Moderate responses might also be associated with a stress response, but there is no evidence of the magnitude or duration of possible stress responses that would allow us to make inferences about possible fitness consequences for individual whales.

Based on the evidence available, we must provisionally assume that close vessel approaches conducted under the proposed permit would be stressful for a portion of the animals being approached; however, the significance of this stress response and its consequences, if any, on the fitness of individuals are not known.

Manner of Vessel Approach. Studies show the way in which an animal is approached greatly influences how the vessel affects it. The approach of the vessel contributes to the reaction of the animal during other procedures such as biopsy, tagging, etc. (Weinrich *et al*.

1992; Watkins 1981b). As more studies such as biopsy and tagging are being conducted, it is becoming clear that the various components of the sampling procedure elicit different levels of response. For example, the actual biopsy is less likely to elicit a behavior change than the vessel approach (humpbacks, Clapham and Mattila 1993). Therefore, the manner in which a vessel approaches a group has a major influence on the probability that a negative response will be elicited (Clapham and Mattila 1993). It was clear in Clapham and Mattila's study (1993) that slow, patient approach to whale groups produced less evasion and yielded a higher probability of sampling success for other procedures. Noise levels produced by the deployment vessel should be taken into consideration when conducting studies requiring close approach, because the difference in response rate observed between studies may reflect the type of vessel used for sampling (humpback whales, Brown *et al*. 1994). Watkins (1981) commented that fin, humpback, and bryde's whale reactions to tag implantation were difficult to separate completely from their reaction to the maneuvering of the tagging boat. In addition, responses of large whales tagged sub-dermally with satellite tags were usually identical to those exhibited during close approach by the tagging vessel when tags are not deployed (Mate *et al*. 2007) and humpback whales exhibited no overt reaction to satellite tags applied with crossbows beyond that of the reaction elicited by a close approach of the boat without tagging (Mate *et al.* 1998).

For sea lions, Kucey (2005) observed that the nature of the vessel approach (i.e., speed, noise, fumes, combined with other variables like weather) influenced the magnitude of the response.

Expected Responses Due to Manner of Vessel Approach. Our review of the literature above leads us to assume that the way in which the research vessel approaches an animal or group would influence how the vessel affects the animal. The proposed activities all plan to use a slow, patient approach as Clapham and Mattila (1993) suggest. Whales would be approached laterally from behind, approximately 135 degrees to the direction the whale is swimming, at a speed between 3-8 knots. The permits would also require the researchers to exercise caution when approaching animals and to retreat if behaviors indicate the approach may be interfering with reproduction, feeding, or other vital functions. Additional conditions for permits require researchers to exercise caution while closely approaching females with calves to minimize or avoid any startle response. Researchers must terminate efforts if there is evidence they are interfering with pair-bonding or nursing, and must not position the vessel between the mother and its calf.

Behavioral Activities at Time of Approach. Animals may respond differently depending upon what behavior the animals are engaged in at the time the vessel approaches (Wursig *et al*. 1998; Hooker *et al*. 2001; Jahoda *et al*. 2003) and the degree to which they have become accustomed to vessel traffic (Lusseau 2004, Richter *et al*. 2006). For all cetacean species studied in the Gulf of Mexico by Wursig *et al.* (1998), the behavioral states of "milling" and "resting" appeared to be most sensitive to vessel disturbance. Humpback whales appear less likely to react to vessels when actively feeding as compared to resting or when engaged in other activities (Krieger and Wing 1986). The presence of a survey vessel appeared not to interfere with feeding activity of humpbacks or disturb social behavior such as pairing, as these activities continued regardless of the presence of the vessel (Hall 1982). For fin whales, response to vessel noise also depends on the behavior of the animal at the time of vessel approach, as well as the

speed and direction of the vessel (Perry *et al.* 1999) and this is likely the case for other baleen whale species (Richardson *et al*. 1995; Perry *et al.* 1999). While feeding, fin whales react less rapidly and with less obvious avoidance behaviors (Richardson *et al.* 1995). However, feeding Mediterranean fin whales changed their behavior into travelling when approached closely by vessel (Jahoda *et al*. 2003). Sei whales may be less responsive to ships when feeding than at some other times (Lockyer 1981), and blue whales also show quicker and obvious avoidance behavior when not feeding (Sears *et al*. 1983).

Expected Responses Due to Behavioral Activities at Time of Approach. Based on our review of the above literature, we assume the activity whales are engaged in at the time of approach influences how they may respond to the vessel. We would expect possible variable reactions based on whether whales are resting, milling, swimming, feeding, migrating, socializing, breeding, or engaging in any other activities.

As stated previously, the permits would require researchers to exercise caution when approaching animals and to retreat if behaviors indicate the approach may be interfering with reproduction, feeding, or other vital functions. Additional conditions for permits require researchers to exercise caution while closely approaching females with calves to minimize or avoid any startle response. Researchers must terminate efforts if there is evidence they are interfering with pair-bonding or nursing, and must not position the vessel between the mother and its calf.

Group Size. Studies show variations in behavioral response to approaching vessels depending on whether animals are alone, in a group, or paired. Smaller pods of whales and pods with calves seem more responsive to approaches (Bauer 1986; Bauer and Herman 1986). A fin whale tracked in the Irminger Sea was difficult to approach when alone, but approached without difficulty when accompanied by one or more whales (Watkins *et al*. 1984). Reactions of humpbacks to various types of vessels vary among populations, locations, and time of year (Scheidat *et al*. 2004). Bauer (1986) and Bauer and Herman (1986) reported short-term reactions of breeding humpback whales to vessels in Hawaiian waters and results differed among age-sex class, depending on whether the sighting consisted of singers, other lone animals, mothers or calves. Humpback whales in competitive groups were easier to approach for suction-cup tagging than lone whales or whales in groups of 2-3 individuals (Baird *et al*. 2000). Humpback cow/calf pairs tend to be more wary of approaching vessels (Hall 1982), and Bauer *et al*. (1993) also found smaller humpback pods with a calf were more affected by vessel traffic than larger pods.

Expected Responses Due to Group Size. Based on our review of the literature above, we assume that animals could show variations in their response to approaching vessels given the size of their group. We assume that lone animals could show different responses to approach than those that are paired or in a group.

Type of Vessel. The type of vessel used during approach could influence response depending on whether it has a motor, or whether it is fast- or slow-moving. Bowheads are more difficult to approach closely with outboards than with non-motorized boats, exemplifying the influence of vessel noise (Hobbs and Goebel 1982; Goodyear *et al*. 1987). Right whales are

more approachable by slow-moving boats, but move away from vessels that approach rapidly (Watkins 1986; Goodyear 1989; 1993; Brown *et al*. 1991). Goodyear (1993) found that North Atlantic and humpback whales tagged with dermal tags did not respond when tags were fired from kayaks or sailing vessels, but only reacted when tags were fired from diesel-powered vessels. Tagged fin and humpback whales behaved similarly to various types of vessels as observed by Watkins *et al*. (1981).

Expected Responses Due to Type of Vessel. Research activities in the action area will be done from slow-moving, smaller-sized vessels depending on availability and ocean basin. Based upon our review of available literature, we expect the slow-moving motorized vessel used in proposed activities to produce a different response than a fast-moving vessel or a non-motorized vessel. Given that the researchers' motorized vessel will be slow-moving (3-8 knots), we expect that whales would be more approachable than they would with a fast-moving motorized vessel.

Vessel Distance. The distance of the vessel from the animal also influences behavioral reactions. Many reactions to ships or boats are presumably reactions to noise or visual cues (Richardson *et al.* 1995). Researchers tested a fin whale's reaction to their vessel and found no reaction unless the vessel was within 200 m of the whale (Watkins *et al*. 1984). Mate *et al.* (1997) found Northern right whales having stronger reactions to suction-cup tagging attempts by pole than crossbow tag deployment attempts probably due to the closeness of the vessel. Vessels were ignored by fin whales and humpback whales as long as they remained 100 m from the whales (Watkins *et al.* 1981). When boats closed to within 0.8-4 km of bowhead whales summering in the Beaufort Sea, surface/dive cycles became shorter and whales swam rapidly away (Richardson *et al*. 1985). In Alaska, it was found that humpbacks could be followed with a vessel at a distance greater than 100 yards, but any distance closer elicited a reaction to the vessel (Hall 1982). In addition, changes in whale behavior have also been reported to correspond to vessel speed, size, and distance from the whale, as well as the number of vessels operating in the proximity (Baker *et al*. 1988; Koehler 2006). Reactions to vessel noise have been observed when engines are started at distances of 3,000 feet (Malme *et al.* 1983; Richardson *et al.* 1995), suggesting that some level of disturbance may result even at distances maintained for photo-identification activities.

Expected Responses Due to Vessel Distance. The proposed research vessels would approach closest to conduct tagging and other methods within a distance small enough to reach with the 6-10-m tagging or deployment poles. The vessels would not need to approach as closely for air gun tagging, as those particular tags may be fired from greater distances (10-25 m). Similar to Mate *et al*. (1997), we would expect stronger reactions to suction-cup tagging attempts by pole rather than the dermal anchor tag deployment by air guns due to the positioning of the vessel.

For purposes of the proposed permits and amendment, an "approach" is described as a continuous sequence of maneuvers (episode) [involving a vessel, aircraft, or researcher's body in the water], including drifting, directed toward a whale or group of whales for the purpose of conducting authorized research which involves one or more instances of coming closer than 100

yards (large cetaceans) or 50 yards (small cetaceans) to that whale or group of whales. One take would include a series of vessel maneuvers.

Short-Term Effects. Behavioral reactions to approaching vessels appear to be short-term, with little evidence of long-term effects. Many animals apparently return to normal behavior shortly after vessel disturbance, suggesting that behavioral modifications are short-term. Furthermore, many animals show long-term year site fidelity despite the increased presence of vessels which could indicate that they are habituated to vessel presence. Fin whales had returned to normal breathing patterns when observed the day following radio tracking pursuits (Ray *et al*. 1978). The fleeing response of bowheads did not persist for long after a research vessel moved away, but increased spacing and probably social disruption sometimes continued longer (Richardson *et al*. 1985). It is not known exactly how quickly bowhead whales resume activities after disturbance by a boat (Richardson *et al*. 1985). Feeding humpbacks can be displaced temporarily by vessels (Richardson *et al.* 1995).

Expected Short-Term Effects. Based on a review of available information, we would expect whales exposed to close vessel approaches under the proposed permit to exhibit either no visible response or short-term behavioral responses that have no long-term consequences for individual whales. Under proposed permits, animals would be exposed to close approaches in the Atlantic, Pacific, and Gulf of Mexico. These areas contain important foraging grounds for these species, and the proposed close approaches conducted here have the potential to interrupt foraging behaviors. However, many animals show year site fidelity despite the increased presence of vessels in these important areas. Therefore, we expect any behavioral responses to be short-term, and accordingly we do not anticipate that responses to close vessel approaches under this permit would result in reduced foraging opportunities for individuals. Animals could also be exposed to close approaches in important migratory routes and winter foraging areas. With regard to calving activity, the permit would require researchers to exercise caution while closely approaching females with calves to minimize or avoid any startle response. Researchers must terminate efforts if there is evidence they are interfering with pair-bonding or nursing, and must not position the vessel between the mother and its calf. The proposed close approaches conducted here could have the potential to briefly interrupt activities. However, because any behavioral responses are expected to be short-term, and because of included permit precautions regarding calving, we do not anticipate that close vessel approaches under the proposed permit would significantly affect migration or calving or result in reduced foraging opportunities for individuals.

Long-Term Effects. In addition to a return to normal behavior after vessel disturbance, year site fidelity of some animals may allow for repeated disturbance and potentially, habituation (Scheidat *et al*. 2004). Longer-term, humpbacks are seen to remain for extended periods and return annually to areas in the North Atlantic despite exposure to many ships, fishing vessels, and whale watching boats (Beach and Weinrich 1989; Clapham *et al.* 1993). Herman (1979) suggested that humpback whale density may be inversely related to the daily amount of boat traffic and to the local amount of human activity in Hawaii. Later, Mobley *et al*. (1999) found that whale watching is not having an effect on the apparently slow recovery of humpback whales in Hawaii. Although substantial short-term effects were noted for response of humpbacks to vessel traffic, long term negative consequences were not apparent for Bauer *et al*. (1993). After

a close approach, tagged and untagged fin whales generally were evasive for a short period (Watkins *et al*. 1981) but returned to normal behavior. By contrast, killer whales (Trites *et al*. 1995, Williams *et al*. 2002) and bottlenose dolphins (Lusseau 2004) have been seen to avoid areas with increased boat traffic.

Habituation to vessels from close approaches is the only evidential long-term concern for these animals. Tolerance of vessels could subject the animals to potential ship strikes or fishery interactions. However, there is contradictory evidence that animals may either be sensitized by an approach such as evasion of hunting vessels, which increases stress levels. Or, the animals may become habituated to boats or airplanes, possibly eliciting a lesser reaction as a result (Wursig *et al*. 1998; Weinrich *et al*. 1991; Weinrich *et al*. 1992; Clapham and Mattila 1993; Gauthier and Sears 1999; Hooker *et al*. 2001; Jahoda *et al*. 2003; Lusseau 2004; Best *et al*. 2005; Richter *et al*. 2006). Humpback whales appear to habituate to the presence of a vessel given sufficient time, even mothers (Clapham and Mattila 1993). For example, a large oil tanker passed within 800 m of a humpback group while feeding and did not disrupt the group (Watkins *et al*. 1981).

Expected Long-Term Effects. Due to long-term site fidelity where animals return annually to areas that are important to their life history stages, we do not expect long-term effects such as displacement or avoidance. The larger concern could be habituation to vessel traffic, which could expose these whales to increased chance of ship strike or gear interactions.

Summary. Our review of available information indicates individual animals have short-term startle, alarm, and avoidance type responses to approaching vessels and the largest long-term threat is that of habituation to their presence. There are a number of factors influencing whether a reaction occurs or the type of reaction that may ensue. These factors include behavior before approach, the size of the group, and the way in which a vessel approaches. Researchers should consider the type of vessel used when approaching and the distance of the vessel from individuals or groups of individuals. We assume close approaches conducted under the proposed permit might still be stressful for some individuals, and might temporarily interrupt behaviors such as foraging, but evidence from investigators and in the literature suggests that responses would be short-lived. Assuming an animal is no longer disturbed after it returns to pre-approach behavior, we do not expect long-term consequences for the individuals affected. Overall, it has been said that the impact of vessel harassment on these animals is at present probably minor compared to other threats that could come from habituation to those vessels, such as entanglement in fishing gear and ship strikes which may be significant at the population level (Clapham *et al*. 1999).

2. Responses of Cetaceans to Aerial Surveys

Proposed permits 14451, 13846, and 14599 will conduct aerial surveys for humpback whales in the Pacific Ocean. Permit 14451 would also conduct aerial surveys for sperm, fin, blue, sei, Western North Pacific gray, and unidentified toothed and baleen whales in the Pacific. Permit 14451 would be the only permit conducting aerial surveys in the Atlantic and Gulf of Mexico for fin, humpback, sei, sperm, blue, and unidentified toothed and baleen whales.

Aerial surveys would be conducted using fixed-wing or rotary-wing aircraft. Aerial surveys using fixed-wing aircraft would generally be conducted at an altitude of above 750 ft (244m), with descents to a minimum of 500 ft (152m) for species identification and photo-identification. Helicopters would fly at an altitude of 500 feet or above. Individuals could be taken more than once in a day but in a different manner, i.e., an individual may be photographed from both aerial and surface vessel platforms. Up to three close approaches would occur per animal per day over each season. Surveys would not be flown over pinniped haulout sites.

Behavioral Responses. Aircraft overflights often elicit many different behavioral changes in both individual baleen and toothed whales such as sudden dives or turns, swimming away, and occasionally tail or flipper slaps (Richardson *et al.* 1995, Richardson and Wursig 1997). A majority of reacting cetaceans respond to aircraft by diving (Luksenburg and Parsons 2008). About 14 percent of bowhead whales approached during aerial surveys changed their behavior coincident with the approach of the aircraft (Patenaude *et al*. 2002). Reactions of migrating gray whales to a Bell 212 helicopter consisted of abrupt turns, dives, or both (SRA 1988). Beluga and bowhead whale responses to aircraft have been classified as short surfacings, immediate dives or turns, changes in behavioral state, vigorous swimming, and breaching (Patenaude *et al*. 2002). Smultea *et al.* (2008) viewed unique behavioral reactions of a group of sperm whales where the whales ceased their forward movement and positioned themselves closer to each other, first in parallel flank-to-flank formation and later in a semicircle fan formation, which may have represented agitation, distress, or self-defense. This behavior was also seen in another study in the Bahamas when a Cessna 172 passed and circled 6 sperm whales (Luksenburg and Parsons 2008).

The degree to which individuals are disturbed by aerial approach varies and the reactions themselves vary. Responses can range from no apparent reaction to active avoidance. Richter *et al*. (2003, 2006) showed a very high degree of variation in response among gray whale individuals. The sensitivity to disturbance by aircraft may also differ among species. "Cryptic" cetaceans such as beaked whales, pygmy sperm whales, and dwarf sperm whales showed stronger responses to planes than other species observed in the Gulf of Mexico (Wursig *et al.* 1998).

Altitude. Degree of response and reaction could also vary with altitude. A stronger avoidance response has been reported when planes fly at lower altitudes (Walker 1949, Bel'kovich 1960, Kleinenberg *et al.* 1964, Best 1981, Sergeant and Hoek 1988). When survey aircraft fly below certain altitudes (about 500 m), they have caused marine mammals to exhibit behavioral responses that might constitute a significant disruption of their normal behavioral patterns (Perry 1998, Patenaude *et al*. 2002). Bowhead whales have been observed avoiding planes flying at 305 m or lower (Perry 1998). Although some whales show stronger avoidance responses to lower altitude planes, some whales also exhibit no response to low-flying planes. Some humpbacks are disturbed by overflights at 305 m but others show no response to flights at 152 m. Cetaceans sometimes react to an aircraft passing as high as 300 or 400 m, while at other times the same species can show no obvious reaction to the same aircraft at 150 m (Richardson and Wursig 1997). Smultea *et al.* (2008) reported that sperm whales exhibited no reactions to their study's lowest aircraft passes, 103 m and 208 m lateral distance, as compared to the higher passes in their study.

Noise or Visual Cues. The effects of aerial sources of noise have received far less attention than in-water noises, therefore it is unknown exactly whether whales respond to noise or visual cues (or both) from aircraft. Aircraft produce noise at frequencies that are well within the range of cetacean calls and also produce visual signals such as the aircraft itself and its shadow (Richardson *et al.* 1995, Richardson and Wursig 1997). The underwater sound intensity from aircraft is less than that produced by boats; and visually, aircraft are more difficult for whales to locate since they aren't in the water and move rapidly (Richter *et al*. 2006). Migrating gray whales react to underwater helicopter playbacks, which show that the whales were responding to the noise itself, since visual cues were absent (Malme *et al*. 1983, 1984). There is anecdotal evidence indicating that visual cues affect cetacean behavior (Luksenburg and Parsons 2008). Watkins (1981) observed fin whales from an aircraft at 50-300 m and implied that engine noise or the aircraft's shadow caused reactions. Other cetaceans also react if the aircraft shadow passes over them (Watkins 1981b, Mullin *et al.* 1991). Bottlenose dolphins have been observed to react when an aircraft's shadow passed over them (Mullin *et al*. 1991). Some species such as beluga whales and Dall's porpoises have been observed looking up at aircraft (Withrow *et al*. 1985, Richardson *et al.* 1995, Richardson and Wursig 1997). Sperm whales have also been observed looking up at aircraft (Smultea *et al.* 2008).

Vocalization. Aircraft noise could affect cetacean vocalizations. Once study documented a delay in the production of first click after fluke-up dives in sperm whales (Richter *et al.* 2006). Cetaceans may modify their calls in various ways by changing the source level (Holt *et al.* 2009), frequency (Lesage *et al.* 1989), duration (Miller *et al.* 2000), number of frequency modulations (Morisaka *et al.* 2005) and call rate (Van Parijis and Corckeron 2001, Buckstaff 2004). Repeated exposure in areas with nearby airports may affect the vocalizations of resident cetacean populations (Luksenburg and Parsons 2008).

Activity at the Time of Overflight. Responsiveness and behavioral reactions can depend on activity. Whale activity during overflight sometimes seems to influence whether or not behavior is disturbed. Whales engaged in feeding or social behavior can be less sensitive to overflight (Richardson and Wursig 1997). Belugas, right whales, and bowhead whales seem less responsive to passing aircraft when they're actively engaged in feeding, social activities, or mating than when resting (Payne *et al.* 1983, Richardson and Malme 1993). Feeding belugas have been less prone to disturbance, whereas lone animals often dive under ice floes when the aircraft descend (Bel'Kovich 1960, Kleinenberg *et al.* 1964). Wursig *et al*. 1998 conducted a study in the Gulf of Mexico which revealed that when the initial behaviors of cetaceans were milling and resting, the animals were most sensitive to aircraft. Water depth may also play a factor, as belugas in shallow summer areas react to aircraft, often by swimming away or diving (Fraker 1978, Fraker and Fraker 1979, Finley 1982, Finley *et al*. 1982, Gales 1982, Caron and Smith 1990).

Group Influence. Behavioral responses to aircraft can depend on group size, composition of the group, and whether or not the group is transient or resident. Humpbacks in large groups showed little response while smaller all-adult groups exhibited avoidance of aircraft (Herman *et al*. 1980b). Whales confined in waters, especially with calves, seem more sensitive (Richardson and Wursig 1997). Gray whale mother-calf pairs were sensitive to a small

turboprop aircraft at 335+ m altitude (Ljungblad *et al*. 1983, Clarke *et al*. 1989). Gray whale cow-calf pairs were sensitive to planes at 305 m in the Chukchi Sea, with calves reacting by swimming beneath their mothers and mothers swimming over their calves (Moore and Clarke 2002). Richter *et al.* (2003, 2006) studied reactions of male sperm whales in New Zealand and found that transient sperm whales responded more strongly to aircraft than residents, with residents exhibiting longer surface times. This study determined that residents may be habituating to frequent aircraft activity.

Manner of Flying. The way an aircraft flies overhead can elicit different responses. Bowheads are more responsive when an aircraft flies directly overhead than when the aircraft passes to the side or circles (Richardson and Wursig 1997). Bowheads and belugas respond more frequently to helicopters than to fixed-wing planes, possibly because measured underwater sounds were stronger for the helicopter (Patenaude *et al.* 2002).

Short-Term. Reactions seem to be short-term with no compelling evidence of long-term displacement of whales due to overflight disturbance. Single and uncommon overflights would seem to have less of an effect on behavioral disturbance as repeated low-altitude or cumulative flights. It is worth noting, however, that behavioral observations from aircraft disturbance are made from observers on board the plane itself, which limits what can be observed and for how long. Luksenburg and Parsons (2008) identified three problems with behavioral reports from aerial studies: 1) such studies typically do not include a control group; 2) because the observer is moving, the opportunity to observe the behavior before, during, and after disturbance is very limited; and 3) there is an inverse relationship between the distance to the animal and the duration of the observation time, which may lead to underestimation in responses.

Long-Term. There is no indication that single or occasional aircraft overflights cause long-term displacement of whales (Richardson *et al*. 1995). However, there is one report of displacement from an entire area due to cumulative aerial disturbance exemplifying a very strong reaction to aerial influences. Inupiat hunters (Native Americans who occupy Alaska's Northwest Arctic and North Slope boroughs) concluded that low-flying aircraft were preventing belugas from entering a northern Alaskan bay, so the timing of aircraft traffic was adjusted to reduce the suspected interference (Burns and Seaman 1985).

Expected Behavioral Responses to Aerial Surveys. We expect listed species to respond similar to what is reported above. Whales could exhibit anywhere from no reaction to avoidance, with diving, turns, swimming speed changes, and breaching as potential manifestations of behavioral changes. We expect that reactions of individual whales could vary and that reactions of whales could vary depending on species. Mitigative measures in proposed permits conducting aerial surveys could minimize abrupt behavioral changes. These include:

- Research activities would be suspended if there is indication that the same individuals would be disrupted from foraging on a repetitive basis.
- Research activities would not occur if other vessels are in the immediate or auditory vicinity of whales.
- Researchers would consult with other researchers to avoid harassing the same animals or pods.

- Every effort would be made not to separate animal(s) from a group.
- Animals would be monitored at all times and if an animal or animals appear to be in serious distress, the operation would be halted.
- Aerial observations of individual whales would not exceed 15 minutes, and would be suspended if the whale(s) exhibited any adverse reactions such as the onset of surface percussive activity, underwater exhalations, lateral tail movements, premature dives or similar disturbance behaviors.
- No more than 8 helicopter hover episodes would occur per day per individual or group if a helicopter is used.
- Helicopters would include lighter models (such as Eurocopter AS35OBA or MDH 500D) that decrease the amount of noise and rotor wash.
- Prop guards would be used on all close approach vessels.

We expect individual whales to react more strongly to aerial surveys at lower altitudes, although the above information reveals that whales have variable reactions to low-flying aircraft. Since available information seems to vary as to whether whales respond to visual or noise cues, we assume that whales react to both noise and visual cues. We expect that cetacean vocalization could be affected by the proposed aerial surveys. We expect that whales preoccupied with necessary activities such as feeding, socializing, or breeding might not react as strongly to whales that are resting or not preoccupied. We also expect that whales in shallower areas might react more strongly to overflights than those in deeper areas. Due to mitigative measures listed above and shortened exposure times, we do not expect that effects on vocalization would have significant long-term effects.

Behaviors exhibited by individual cetaceans due to aerial influences from plane presence and mid-frequency noise appear to be non-visible or short-term. Gaps in knowledge about how cetaceans respond to aircraft stimuli still exist such as quantification of received sound level, the role of vision, knowledge of baseline behavior, and the effect on vocalizations. However, even with these gaps, we do not expect these types of behavioral modifications to result in the type of long-term changes that would result in reduced fitness for individual whales.

3. Responses of Cetaceans to Tagging and Biopsy

Proposed permits 14682, 14353, 14599, 14122, 14296, 13846, and 14585 would authorize a combination of suction-cup tagging, biopsy, and invasive tagging of humpback, North Pacific right, fin, sei, sperm, and blue whales in the Pacific Ocean. Permits 14682, 14353, 14599, 14122, 14296, 13846, and 14585 would suction-cup tag humpback whales. Permit 14122 would also suction-cup tag North Pacific right, fin, sei, sperm, and blue whales in addition to humpbacks. Permit 14296 would also suction-cup tag fin whales in addition to humpbacks. Permits 13846 and 14122 would invasively tag humpback whales. Permit 14122 would invasively tag fin, sei, sperm, and blue whales in addition to humpbacks. Permits 14682, 13846, 14122, 14296, and 14585 would biopsy humpbacks. Permit 14122 would biopsy blue, sei, fin, sperm, and North Pacific right whales in addition to humpbacks. Permit 14296 would biopsy blue, sei, North Pacific right, fin, and sperm whales in addition to humpbacks. North Atlantic right whales and Western North Pacific gray whales would not be tagged. No tagging would take place in the Atlantic Ocean or Gulf of Mexico. Tagging would usually be conducted from

small boats (less than 25 m in length), and only in relatively calm seas (i.e., Beaufort 0-2). Tagging would not be conducted from the longline vessel being used for other procedures (Permit 14122). Animals would be approached to within 2-15 m using the methods described under *Close vessel approach for photo-identification and behavioral observations*. Tags would be attached using a hand-held or cantilevered pole or deployed with a crossbow or airgun.

Tag Types. Tagging involves physical contact with the animal, and is generally categorized as having the potential to injure. Tags may be attached to the animal via suction, dermal anchoring, or implantation. Therefore, there are multiple tag types. Suction-cup tags are usually placed on the whale with a pole outstretched from a vessel and do not penetrate the skin, therefore they are said to be non-invasive. Although non-invasive, Mate *et al*. (2007) report that using an increased suction pressure with suction-cup tags to increase tag longevity for carrying satellite attachments could result in sub-dermal haematomas. In contrast to suction-cup tags, implantable tags, dermal anchor tags, and biopsy darts penetrate the animal's skin and are thus said to be invasive. Anchor tags (used interchangeably here with dermal or sub-dermal tags or barnacle tags) use needles, pins, or barbs to provide an anchor into the epidermis and blubber, and the actual tag remains surface mounted. Implantable tags are fully or partially implanted into the muscle below the hypodermis, or into the blubber, and are designed for long-term attachment. Biopsy darts also penetrate the animal's skin, rebound outward with the biopsy sample, and are thus said to be invasive but do not remain attached to the animal. Since the use of all of these tag types are requested for the proposed activities, we reviewed available information on all invasive and non-invasive techniques – suction-cup tags, implantable tags, anchor tags, and biopsy darts - in order to anticipate all possible effects from tagging.

Effects of Carrying External Tags. A variety of scientific instruments, such as VHF/TDRs, DTAGs, Bioacoustic probes, Acousonde tags, MANTA tags, and Crittercams (described in the Description of the Proposed Action section) can be attached to marine mammals for collection of a wide range of data including location, dive and movement patterns, and ambient noise levels. The duration of the tag placement can be from a few hours to several days, and ultimately the tag is released from the animal and retrieved by the researcher. Information is then used to infer habitat use, migratory and foraging behavior, and habitat quality, which is in turn used to make management decisions for the conservation and recovery of a species. Tags do not contain any hazardous materials.

Although external transmitting devices have been used by many researchers, few studies examine the possible effects of these devices (White and Garrot 1990; Culik *et al*. 1994; Hawkins 2004; Wilson and McMahon 2006). There are a number of ways that animals can be affected by carrying measurement devices: problems arising from capture and handling, and physiological and psychological stress from carrying a foreign body (Wilson and McMahon 2006). Key welfare concerns have arisen regarding these wild animal studies, namely, that capture and handling may cause distress; the physiological impact of bio logging devices on wild animals; and little potential for monitoring instrumented wild animals after release, or for administering antibiotics if necessary (Hawkins 2004). The hyrdrodynamic shape and mechanical properties of a device will have an effect on the animal, and consideration of these, particularly with reference to the anatomical structure to which they are attached, will be important for each study (Pavlov *et al*. 2007). Where external devices are attached to running,

flying, or diving animals it is essential to minimize drag; streamlining the bio logger's shape and ensuring it is attached in an appropriate location so as to smoothly extend the contours of the animal is prudent (Hawkins 2004). Hydrodynamic drag is exerted on surface mounted tags, which produces vibration and lifting forces which are hard to offset with shallow sub-dermal attachments (Mate *et al.* 2007). Keeping implanted tags stable promotes healing, as new epithelial cells and scar tissue form around the foreign body to wall it off (Mate *et al*. 2007). The physical impact of devices will be minimized if researchers consider mass, shape, and location of the device (Hawkins 2004).

Weimerskirch *et al*. (2002) stated that the presence of an attached device may incur increased energy expenditure for a given activity or may even prevent the activity from being performed. For example, Walker and Boveng (1995) found that average foraging-trip and nursing-visit durations were significantly greater for seals carrying time-depth recorders and radio transmitters than for seals carrying radio transmitters only. Furthermore, modeling studies indicate that antenna carrying birds are only about 1/5 as efficient as those not carrying a device (Wilson and McMahon 2006).

Expected Responses to Carrying External Tags. Although tags have the potential to create hydrodynamic drag, which may have an effect on the tagged animal (Hooker *et al.* 2007), the proportion of the tags to be used under the proposed permits relative to the size and weight of the targeted whales is such that the energetic demand on the animal would likely be insignificant. Suction-cup tags have been reported to migrate along a whale's body during attachment (e.g., Baird 1994), and could potentially affect the eyes or blowhole of a tagged whale. However, tags would be placed posterior to the pectoral fin during the proposed studies, and any tag movement that might occur is therefore not expected to pose such a risk to tagged individuals. No abrasion or intrusion into the skin would be caused by the attachment of the suction-cup, and suction-cup tags are not expected to cause any harm to the whales' skin. We expect that invasive tags would cause a wound site and would be rejected from the whale's blubber over time, due to possible infection, reaction to a foreign body, an irritation from motion due to body flexing, as well as mechanical stress from hydrodynamic drag on the external components of the tag (Watkins *et al*. 1981).

Breadth of Tagging Studies. Tagging has been conducted on a variety of marine mammal species, including pilot whales (Mate 1989), killer whales (Baird 1994), North Atlantic right whales (Goodyear 1993; Mate *et al.* 1997; Slay and Kraus 1998; Nowacek *et al*. 2001), sperm whales (Watkins and Tyack 1991; Madsen *et al*. 2002a), beluga whales (Martin and Smith 1992), northern bottlenose whales (Hooker *et al.* 2001), Hector's dolphins (Stone *et al*. 1994), bottlenose dolphins (Schneider *et al*. 1998), Dall's porpoises (Baird and Hanson 1996), and narwhals (Martin *et al*. 1994). Tagging studies have also been conducted on the species targeted by the proposed action, including blue whales (Lagerquist *et al*. 2000; Calambokidis *et al*. 2001; Calambokidis 2003), fin whales (Watkins 1981a; Watkins *et al*. 1984; Panigada *et al*. 1999), humpback whales (Goodyear 1981; Watkins 1981b; Goodyear 1989; Goodyear 1993; Mate *et al*. 1998), sei whales (MAR-ECO 2005), bowhead whales (Mate *et al.* 2000; Krutzikowsky and Mate 2000; Heide-Jorgensen *et al*. 2006; Laidre *et al*. 2007), North Pacific right whales (Wade *et al*. 2006), and North Atlantic right whales (Goodyear 1993; Mate *et al.* 2007; Baumgartner and Mate 2003; Best and Mate 2007 (southern right)). However, few studies have systematically

investigated or recorded the effects on cetaceans from tagging, and available investigations into instrument effects on marine species are often limited to visual assessments of behavior (Walker and Boveng 1995). In addition, reactions to tagging are difficult to differentiate from reactions to close vessel approaches as mentioned in the *Close Vessel Approach* section above, because it is necessary to closely approach the whale to ensure proper placement.

Range of Responses to Tagging in General. Evidence available on the short-term effects of tagging whales indicates that responses vary from little to no observable change in behavior to momentary changes such as skin twitching, startle reactions or flinching, altered swimming speed and orientation, diving, rolling, head lifts, high back arching, fluking, and tail swishing (Goodyear 1981; Watkins *et al*. 1981; Watkins *et al.* 1984; Goodyear 1989; Goodyear 1993; Baird 1994; Mate *et al*. 1997; Mate *et al*. 1998; Hooker *et al*. 2001). Infrequently, aerial displays like breaching are also noted (Goodyear 1989); and Mate *et al.* (2007) reports other infrequent behavioral responses as including fluke slaps and swishes, head lunges, defecation, decreased surfacing rates, disaffiliation with a group of whales, evasive swimming behavior, or cessation of singing (in the case of humpback whales). Cetaceans frequently react when hit by tags delivered by remote devices such as tagging poles, but are also known to react when tags miss and hit the water. Behavioral responses are noted to be short-term (Mate *et al*. 2007), with the likelihood of a reaction possibly depending on an individual's behavioral state at the time of tagging (Hooker *et al*. 2001). The effects of tagging and biopsy techniques, as determined by various studies on large baleen whales, are described in detail below and are divided into suction-cup tag (non-invasive) and invasive sections.

Misses. Tagging is not always successful and there are many missed tagging or biopsy attempts in the literature, which cause anywhere from a startle reaction to no response. Startle reactions most commonly occur when a monofilament retrieval line is used and the line becomes entangled or touches the whale. Weinrich *et al*. (1991) reported that all "strong reactions" to biopsy sampling (on a scale of none, low, moderate, and strong) were always associated with unusual occurrences such as momentary entanglement of the retrieval line of the flukes of the whale or retention of the biopsy dart in its blubber. A later study by Weinrich *et al.* (1992) again reported that strong reactions of humpbacks were always associated with a snagging of biopsy dart retrieval line on the animals' flukes. While dermal tagging with a crossbow, researchers missed a humpback whale and the monofilament retrieval line dangled at the whale's side after it released and failed, which irritated the whale and increased its travelling speed while the whale appeared to shake the arrow off (Goodyear 1983). Brown *et al*. (1991) observed three North Atlantic right whales respond to a missed shot when biopsy dart attempts were made. One North Atlantic right whale was observed to lobtail for 40 minutes following an unsuccessful darting attempt where an arrow trailed the whale stuck on monofilament line (Brown *et al*. 1991).

While monofilament line is an important startling factor during missed attempts, startle reactions are also a result of the sound of a missed tag or dart hitting the water and whales have even circled and investigated missed darts. Brown *et al*. 1994 reported that 16% of cases Australian humpbacks responded when biopsy darts missed them, suggesting that these animals reacted to the sound of the dart hitting the water. Watkins *et al.* (1987) shot a dermal radio tag which missed and struck the water producing a startle reaction in nearby fin whales. Watkins *et al*. (1984) attempted to shoot another fin whale with a dermal radio tag which missed, struck the

water, and made all fin whales in the vicinity move rapidly away. Fin, humpback, and bryde's whales reacted to misses of implantable radio tags as the splashed and hit the water (Watkins 1981). Although it is unlikely that vision plays an important role, one Australian humpback that responded to a sampling investigated a floating dart by circling it twice (Brown *et al*. 1994).

Even though many whales respond to a miss, there is also good evidence of lack of reaction. Clapham and Mattila (1993) were biopsy sampling humpback whales on their breeding ground and reported that a total of 375 (87.7%) of misses involved no reaction. As expected, significantly stronger reactions were displayed when Weinrich's biopsy darts actually hit humpback whales than when they missed (Weinrich *et al.* 1991).

Expected Responses to Misses. We believe that responses to misses would be less than what is reported in the literature. The proposed activities would not use a retrieval line since their tag floats and is therefore retrievable by other means. Startle reactions most commonly occur when a monofilament retrieval line is used and the line becomes entangled or touches the whale. Even though no retrieval line will be used, we assume that individual whales would either respond to the sound of the dart hitting the water or have no response to a missed attempt.

a. Responses of Whales to (Non-Invasive) Suction-Cup Tagging

Permits 14682, 14353, 14599, 14122, 14296, 13846, and 14585 would suction-cup tag humpback whales in the Pacific Ocean. Permit 14122 would also suction-cup tag North Pacific right, fin, sei, sperm, and blue whales in addition to humpbacks in the Pacific. Permit 14296 would also suction-cup tag fin whales in addition to humpbacks in the Pacific. No whales would be suction-cup tagged in the Atlantic Ocean or Gulf of Mexico. Suction cups would be approximately 8-10 cm in diameter. Only the suction cups would be in prolonged contact with the animal's skin. Tags would release from the animal when the natural suction of the cup diminishes, or when a magnesium cap that corrodes in salt water causes the release of the tag. Tags would be retrieved by researchers upon release. The animal's behavior, including breaching, rolling, or rubbing, may cause the tag to shed prematurely. The amount of time that a tag would remain on an animal varies, but would generally be less than 72 hours. Attachments would likely last closer to six to eight hours (Baird *et al.* 2000, Lerczak *et al.* 2000, Croll *et al.* 2001, Calambokidis 2003, Witteveen *et al.* 2008). Targeted whales would be closely approached for tag attachment, and anticipated effects from close vessel approaches were described in the *Responses of Whales to Close Approach* section.

Behavioral Responses. As with the research examining effects of close vessel approach to whales, research examining whale effects of suction-cup tagging concentrate on individual behavioral reactions. Responses of whales to the use of non-invasive suction-cup tags similar to those authorized by the proposed activities are noted by a few researchers who report that a majority of (>50%) whales exhibit no behavioral reaction. Goodyear (1981) attached a suction-cup tag to one humpback whale and found behaviors of the tagged whale and a closely associated whale did not appear to change due to tagging. More recently, Goodyear (1989) tagged 12 humpback whales with suction-cup tags and found responses to tagging were minimal with no long-term changes in behavior detected. Of the tagged whales, 69 percent showed no immediate reaction to tagging, and 31 percent exhibited a detectable reaction including

quickened dive, high back arch, and tail swish. One breach was seen in over 100 tagging attempts (i.e., <1%). After all tagging attempts the author noted that pre-tagging behavior resumed within a few minutes and that some whales curiously approached the tagging vessel. Goodyear (1989) also reported the suction-cup did not appear to harm whales' skin. Baird *et al*. (2000) also tagged humpback whales using suction-cup tags and reported that reactions to tagging occurred in 5 of 31 tagging attempts (17%). Two of these were low-level behavioral responses, and three were moderate responses (on a scale of no response, low, moderate, and strong). In general, the study revealed that humpback whales involved in competitive groups were far easier to approach than lone whales or whales in small groups (2-3 individuals) (Baird *et al*. 2000). Baird *et al*. (2000) reported that reactions to suction-cup tagging were observed less often than has been documented for biopsy darting and all humpback reactions to suction-cup tagging were short term and all whales resumed their pre-attempt behavior, including one whale who was singing during the attempt. No reactions of non-target humpbacks in the vicinity of target whales were seen (Baird *et al*. 2000).

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, or performing head lunges.

Expected Responses to Suction-Cup Tagging. Based upon our literature review above, we would expect a majority of whales to exhibit no behavioral reaction to suction-cup tagging. We would expect a very low percentage of whales to exhibit an extreme reaction such as breaching. Whales would be expected to return to their normal behavior after tagging, similar to Goodyear (1989). Groups of whales might be easier to approach and tag rather than lone whales.

We do not expect injury or mortality to occur due to suction-cup tagging under the proposed activities. No abrasion or intrusion into the skin would be caused by the attachment of the suction-cup, and suction-cup tags are not expected to cause any harm to the whale's skin. Mate *et al*. (2007) report that using increased suction pressure to increase tag longevity (two days required for satellite tagging/tracking) with suction-cup tags could result in sub-dermal haematomas. The proposed activities do not include the use of increased suction, as they aim for shorter tagging duration.

As described in the *close approach* response section, even though whales exhibit short-term behavioral reactions we cannot be sure they are not physiologically affected by the activity. Clapham and Mattila (1993) note that human observation of a whale's behavioral response may not reflect an individual whale's actual experience. Gill *et al.* (2001) also note that changes in animal behavior do not necessarily reflect consequences of disturbance at the population level. Therefore, our use of behavior as an indicator of a whale's response to a close approach may or may not be accurate, and we cannot definitively know whether such behavioral responses have long-term consequences, as such consequences would be primarily sub-lethal for individual whales (that is, they would affect their growth, health, or reproductive success), and the associated consequences on whale populations would be delayed in time and concealed by any imprecision in population estimates.

The consequences of suction-cup tagging calves at six months of age or greater under the proposed permit remains largely unknown. However, available evidence indicates that tagging attempts do not affect the close association between mother and calf, as noted by Mate *et al.* (1997; calves not tagged). Goodyear (1989) also found that tracking of tagged adult females with calves did not lead to disassociation of cow-calf pairs. Results from a limited number of studies indicate the short-term responses of calves are similar to those of many adult whales when exposed to biopsy sampling (Clapham and Mattila 1993; Best *et al.* 2005). Based on this available evidence, we anticipate that calves suction-cup tagged in the proposed studies would exhibit responses similar to those expected for many adult whales. In addition, effects of suction-cup tagging on cow-calf pairs are further minimized by conditions in the proposed activities that require researchers to terminate efforts if there is any evidence that the activity may be interfering with pair-bonding or nursing.

Permit conditions are designed to minimize the effects of tagging address the potential for repeat disturbance of these species. Tag take numbers were calculated based on past tagging attempts where the tag package misses but the animal reacts, where the tag package hits the animal but does not attach, or where the tag package successfully attaches. Therefore, the proposed permits limit takes by harassment at three per individual in one day and requires coordination of the proposed activities with other permit holders conducting similar activities on the same species in the same locations or times of year. The permits would not authorize suction-cup tagging of any calves younger than six months or females associated with such calves, and for tagging calves at least six months of age the permit requires researchers to terminate efforts if there is evidence the activity is interfering with pair-bonding or nursing. The permits also require any attempts to tag a particular individual be terminated if an animal exhibits a strong adverse reaction to tagging activity (e.g., breaching, tail lobbing, underwater exhalation, or disassociation from group).

Summary. Whether any long-term effects result from suction-cup tagging remains largely unknown and available information is limited. No research has been done to assess the long-term impacts of suction-cup tagging; however, Goodyear (1989) noted that individual humpback whales monitored several days after being suction-cup tagged did not appear to exhibit altered behavior. Several studies involving more invasive tags as well as biopsy darts also note that whales return to normal behavior. These studies are discussed further in the following section.

b. Responses of Whales to Invasive Tagging

The proposed permits 13846 and 14122 would invasively tag humpback whales in the Pacific Ocean. Permit 14122 would invasively tag fin, sei, sperm, and blue whales in addition to humpbacks in the Pacific Ocean (for a summary of take numbers by species, invasiveness, and ocean basin, *see* Tables 27-29). Blubber implant attachments, dart/limpet/barnacle tags, and partially implantable tags would be used depending on the permit.

Blubber implants attach satellite-linked transmitters to quantify movement patterns and dive behavior of large whales. Tags would be attached by implanting into blubber to varying degrees, depending on the species to be tagged and the desired duration of attachments. Attachment methods could include:

- Darts with backwards facing barbs (tag electronics external to animal).
- Sub-dermal attachments that spread out under the skin, mimicking barnacle attachment (tag electronics external to animal).
- Implanted or partially-implanted electronics packages.

The dart/limpet type tag is an electronics package attached that is attached to the dorsal fin or the body just below the fin with two barbed darts that implant into the skin and/or blubber (Andrews *et al.* 2005). Barnacle tags would include sub-dermal attachments that spread out under the skin. For all types, the tag would remain external to the animal. These tags would be deployed from a crossbow or an air gun.

The implant tag is an electronics package that implants into the blubber of the dorsal flank, near the dorsal fin, with only the top (~2 cm) of the tag and the antenna remaining outside the whale. The tag would be similar to that used successfully on sperm whales (*Physeter macrocephalus;* Mate *et al.* 2007), but would be smaller, with a reduced level of penetration. A "depth stop" consisting of 2 lateral extensions would limit the penetration depth to no more than 10 cm, to ensure the tag would not penetrate the muscle layer. Implant tags would be deployed with an air-gun. Target whales would be greater than 15 m standard length.

In addition to the mitigation measures described above for close approach, mitigation measures used during tagging include:

- Attempts to tag an individual would be discontinued if that animal demonstrates a strong negative response to tagging.
- During any single encounter, no more than three tag deployment attempts per individual would be made.

For our analysis, we reviewed the available information on all invasive tagging techniques.

Invasive Tags. We reviewed available information for both implantable and dermal anchor tags to see what behavioral effects might ensue from the two invasive tagging techniques. A dermal tag used by Goodyear (1993) was created with a pin or needle to restrict depth of penetration and a corrosible release link for retrieval. Goodyear (1993) used dermal tags with sonic and radio transmitters on North Atlantic right and humpback whales and found no evidence to suggest that their research method had significant short or long-term effects on tagged whales or companion animals. Humpback and North Atlantic right whales responded to dermal tags by turning away from the forward path of the vessel or making shallow dives (Goodyear 1993). Humpbacks responded to dermal tags by increasing forward speed (Goodyear 1993). North Atlantic right whales responded to dermal tags by skin twitches followed by turning or shallow dives (Goodyear 1993). Before the humpback and North Atlantic right whales were tagged, their behavior was observed and they seemed to resume their behavior immediately or within a few minutes after approach or tagging, and some even rested by the vessel unaffected by its presence (Goodyear 1993).

Responses of large whales to implantable satellite tags most often include head lifts, fluke lifts, exaggerated fluke beats on diving, quick dives, or increased swimming speeds; responses less

often include fluke slaps, head lunges, fluke swishes, defecation, decreased surfacing rates, disaffiliation with a group of whales, evasive swimming behavior, or cessation of singing (humpbacks) (Mate *et al*. 2007). In addition, responses to satellite tagging seem to vary by species (Mate *et al*. 2007). In all cases where Mate *et al*. (2007) followed satellite-tagged whales, responses to tagging were short-term. For example, a humpback that stopped singing on tagging resumed singing 13 minutes later and a North Atlantic right whale tagged while sleeping went back to sleep within 5 minutes after tagging. Over 40 of Mate *et al*.'s (2007) satellite tagged whales were resighted at the date of their publication and in no case did the animals appear to be in poor health nor did they behave differently than untagged whales. After their study, Mate *et al.* also hypothesized that lack of response to dermal tagging by many whales is because cetaceans have widely dispersed "pressure" sensors on their skin and a blunt object can stimulate many of these stressors while a sharp object would be akin to getting a shot from an experienced nurse (Bill Medway, veterinarian, in Mate *et al*. 2007). The satellite tag's bladed entry tip provides a clean-cut wound, which usually heals faster than ragged wounds (Mate *et al*. 2007). Satellite tag sites produced swelling (localized and regional) among large whales and divots have been seen on humpbacks and North Atlantic right whales that lost their tags due to rupture of fat cells in the blubber layer where tags enter (Mate *et al*. 2007). Resight analysis of data (North Atlantic right whale consortium catalog) showed that resighting rate of tagged versus untagged whales was identical, thus, there was no discernible difference in mortality rates between tagged and untagged whales (Mate *et al*. 2007).

Watkins *et al.* 1984 observed implanted radio tag sites on fin whales and saw that they appeared unchanged with no sign of tissue swelling at 1100 hours. One fin whale with implanted radio tag returned to feeding within minutes (Watkins *et al.* 1984). Although fin whales reacted to the maneuvering of the tagging vessel, neither the implantation of the tags or their presence appeared to affect the behavior of the tagged whale and its companions (Watkins *et al.* 1984). One fin whale received an implanted tag at an angle, and no behavioral differences were observed between the target whale and companions (Watkins *et al.* 1984). Ray *et al*. (1987) also tagged a fin whale (implanted radio tag) that fled its companions and returned to them the next day.

Whales showed little or no obvious reaction to the dermal tag attachment by Mate *et al*. (1997). Often, whales would swim away from the vessel as did many of the whales they closely approached but did not tag (Mate *et al*. 1997). One whale resumed resting 10 minutes after tagging showing a return to normal behavior (Mate *et al*. 1997). Resightings of whales after tagging demonstrated that there was no apparent effect on the close association between mother and calf (Mate *et al*. 1997). Overall, Mate *et al.* (1997) observed no visible evidence of adverse health effects (heavy external parasite loads, skin sloughing, etc.) from tagging. Later, Mate *et al*. 1998 found Hawaiian humpback whales to exhibit no observable reaction to satellite tagging beyond that elicited by close approach of the boat.

Fin and humpback whales in Alaska appeared to be undisturbed by implanted radio tags and behaved in the same ways as their untagged counterparts (Watkins 1981). Implanted radio tagged fin, humpback, and bryde's whales settled down to normal behavior within a short period of time (Watkins 1981). No consistent differences in reaction of fin, humpback, and bryde's whales to implanted radio tags could be related to species, size, number of companions, tagging distance, water depth, duration of tagging effort, or tag location (Watkins 1981).

Several tagging studies have been conducted on bowhead whales, but do not mention behavior as a result of the tag (Mate *et al*. 2000; Krutzikowsky and Mate 2000; Heide-Jorgensen *et al*. 2006; Laidre *et al*. 2007). The fact that researchers did not record behavior could mean that behavior changes were not significant enough to note, or that they were not aiming to record behavior of the bowheads before and after tagging.

Invasive tagging seems to have no bearing on reproductive output. Best and Mate (2007) satellite tagged southern right whales and found that 6/7, or 85.7%, of the cows tagged with calves gave birth to a subsequent calf within intervals comparable to those prior to tagging, which suggests their procedure had not major impact on reproductive output. To further examine effects on reproductive output we also looked to biopsy darting, where Best *et al*. (2005) did not detect adverse effects of biopsy darting on the proportion of successful southern right whale reproductive cycles, and hence calf survival, although the power of their statistical tests was low.

Implantable tags or dermal tags, which can be fired at long-range from a crossbow or airgun, could be used in studies on more evasive whale species. This would avoid the close approach disturbance necessitated through suction-cup attachment by pole. Heide-Jorgensen *et al*. (2001) satellite tagged blue whales using ARTS and commented that baleen whales can be instrumented from long ranges (up to 50 m), making it possible to tag whales that are not easily approached. Mate *et al.* (1997) tagged whales by pole and by crossbow and noted that tagging by pole elicited stronger reactions than crossbow fires due to the necessity of the boat to more closely approach the whales for application.

Whale deaths have occurred that could be attributed to tagging, although the actual tag has not been the confirmed cause. During a tagging study on eastern gray whales, one whale was found dead on the beach without its tag 18 days post-attachment (Mate and Urbán 2005). A necropsy performed on this whale approximately two weeks post-mortem found no evidence of tag site infection or other signs suggesting that the death was tag-related (WGWAP 2006). However, the pronounced state of decomposition and the fact that the tag was no longer implanted precluded a detailed evaluation of the tag-induced wound, including histological assessment. At a North Atlantic right whale tagging workshop (Kraus *et al.* 2000), David St. Aubin provided information on beluga tagging, in which over 70 animals had been tagged with two tag types, both of which went though the blubber, with a maximum retention time of 126 days. He reported that, in the beluga tagging program, some mortality has occurred, although mostly through handling and capture.

Wounds. Invasive tags such as implantable or dermal tags have been known to produce wound sites and healing responses that manifest as swelling, scars, divots (golf ball sized depressions), and cyamids (parasitic crustaceans that live off skin debris). Swelling has been seen around tag sites (as either localized or regional swelling) in North Atlantic right whales and humpbacks (Mate *et al*. 2007). Mate *et al*. (1997) was able to do some monitoring on North Atlantic right whales tagged with implanted satellite tags and observed localized swelling around the attachments as well as white scars with raised mounds, minimal scarring, and pink cyamids in one case. Southern right whales had a noticeable lack of swelling at all but one of the post-tag

wound sites examined during a study, although divots with and without cyamids were a common feature for resightings after one year or more (Best and Mate 2007). Mate *et al.* 1983 observed swelling near the area of a gray whale's lost implanted radio tag wound site. Veterinarians do not agree whether swelling is caused by infection or foreign body response (Mate *et al*. 2007). Divots have also been seen among North Atlantic right whales and humpbacks that have lost their tags (Mate *et al*. 2007). These divots were not unexpected by veterinarians, who predicted depressions due to rupture of fat cells in the blubber layer where tags enter (Mate *et al*. 2007). The physiological effects of tag wounds are unknown, but a whale's physiological response to tissue damage during gear entanglement includes increased secretion of glucocorticoids, which suppresses lymphocytes and, if sustained due to chronic destruction of tissue by gear, comprises the ability of an animal to fight other infections (Cole *et al*. 2006).

Kraus *et al*. (2000) produced a report from a workshop held at the New England Aquarium on October 23, 1999, to review the effects of invasive satellite and radio tags on right whales in the North Atlantic. The workshop concluded that there should not be a moratorium on tagging, but they suggested that researchers not be complacent about the potential effects to the animals and should monitor their effects accordingly. During the workshop, an assessment of tag related wounds was made for each individual right whale that was either satellite tagged or radio tagged between 1988 and 1997, for which photographic documentation was available. As a result, five different healing responses were labeled: white scar, white scar and divot, a divot and cyamids, localized swelling, and regional swelling. Wound types were not related to any particular invasive tag type, and each type of tag caused any of the five described reactions. Also, some animals showed more than one type of healing response in subsequent years to tagging and 12.5% showed no visible wound. No reviewers at the workshop were concerned with either the divots (with or without cyamids) or the scars. The local and regional swelling was believed to be due either to haematoma, abscess, or an active inflammatory response to a foreign body or agent (such as bacteria), rupture through the subdermal sheath, foreign body granuloma, or benign tumor. The timing and longevity of the regional swelling led reviewers to speculate that most likely causes were prolonged infection leading to permanent scar tissue, and a rupture of soft tissue through the subdermal sheath. Two reviewers expressed concern over the potential for migration of tags into the bodies of whales if stop-collars or other retention devices are not employed. Three reviewers expressed concern over the potential of tags penetrating the blubber/muscle interface to introduce serious infections. One reviewer summed this penetration of the interface as follows:

> penetrating the blubber muscle interface is extremely dangerous for a tag that wants to remain external. The amount of shear (movement between blubber and muscle layers) that the [tag's] antenna would be subject to is on the order of 50 cm. If the wound penetrates the interface and becomes infected, the infection will likely be spread and would be difficult for the whale to deal with (Kraus *et al*. 2000).

Expected Responses to Tag Wounds. After reviewing tag wound information, we expect injury to result from invasive tagging. This wound would have to heal over time. The anchor needle would penetrate the whale's epidermis and blubber, but we do not expect the needle to penetrate the blubber-muscle interface, which is the main area of concern for serious infection in invasive tag studies (Kraus *et al.* 2000). Therefore, we do not expect the injury to be

so significant as to decrease fitness in individual whales. The needle is only expected to penetrate the epidermis and blubber due to the blubber thickness of each individual species being tagged and the size of each tag's penetrative end. Additionally, the needles have a "stop" to limit depth of blubber penetration. Veterinarians and scientists at tagging workshops report that invasive tag healing manifests as localized swelling, divots, cyamids, and scarring. Re-sightings of whales with these types of wound responses show no evident long-term effects from these injuries (Best and Mate 2007; Mate *et al*. 2007). Resight analysis of data (North Atlantic right whale consortium catalog) showed that resighting rate of tagged versus untagged whales was identical, thus, there was no discernible difference in mortality rates between tagged and untagged whales (Mate *et al*. 2007). However, we cannot be certain that whales aren't affected by these wounds due to the paucity of data on re-sightings and precise physiological information.

To help ensure that a serious infection does not ensue, prudent precautions are required in the proposed action to eliminate contaminants from the dermal anchor and to sterilize it prior to implantation. Mitigation measures used during biopsy sampling include:

- Using a new sterile dart tip for each sample collected.
- When possible, individuals would be identified prior to sampling to avoid duplication.

Portions of tags that would be inserted into whales would be thoroughly disinfected before attachment. The parts of the tag that are received into the whale and are in contact with whale tissue would be constructed of medical grade stainless steel, titanium, or other material proven to be biocompatible. Furthermore, to aid the scientific community in discovering the long-term effects of suction-cups and dermal attachments, and to monitor the effects of dermal tags, subsequent tracking of each tagged whale could provide the opportunity for close and continuous monitoring of wound sites.

Rejection and Displacement. Besides swelling, scarring, divots, and cyamids, there is rejection and other movements at tag wound sites. Tags are usually rejected and move outward after a period of time, can become dislodged or hang loose, and can change orientation. Some rejection of an implanted tag by the whales' blubber is anticipated because of possible infection, reaction to a foreign body, an irritation from motion due to body flexing, as well as mechanical stress from hydrodynamic drag on the external components of the tag (Watkins *et al*. 1981). Four implanted tags in humpback and fin whales gradually moved outward during 16 to 18 days of tracking (Watkins *et al*. 1981). Watkins *et al*. (1981) implanted radio tags in humpback and fin whales in Alaska and discovered one of the tagged humpbacks' tags was hanging loosely through partially still embedded in the blubber (17th day after tagging). Watkins *et al*. (1981) observed that orientation of implanted tags in fin whales changed more than in humpbacks possibly because of the fin whale's flexible blubber combined with their higher swimming speed as compared to other whales.

Expected Responses of Rejection and Displacement. We would expect that some invasive tags deployed under the proposed studies could become displaced – become dislodged, hang loose, or change orientation. We would also expect each needle or implant to eventually get rejected by the whale's blubber after a certain period of time and move outward as reported by Watkins *et al*. (1981). Furthermore, we would expect variations between species in the way the tag is rejected or displaced, based on the various blubber consistencies and swim speeds of each species.

Blubber Thickness. Blubber thickness plays an important role in whether an invasive tag penetrates the blubber/muscle interface. Some implantable tags are designed to penetrate this interface, while some dermal anchor tags are intended to remain only in the blubber. Blubber is thicker in posterior than in anterior of the body and thickest in the dorsal and ventral region near the fluke (minke whale study; Konishi 2006). The dorsal integument of (skin and blubber) right whales is between 20 and 35 cm thick (Omura *et al.* 1969). In ultrasonic blubber thickness measurements of North Atlantic right whales, ranges were found to be from 12-23 cm depending on the distance from the blowhole (Moore *et al*. 2001). For humpbacks, Matthews (1937) reported minimum blubber thickness of 9 cm and Scammon (1874) reported a minimum thickness of 12.7 cm. Slijper (1962) indicated the average blubber thickness for humpbacks is 12.7 – 17.8 cm and that it is thickest in the dorsal areas – where tagging occurs. Differences in structure of the blubber and activity of the skin between species is not well documented, but it also may have contributed to the retention of several months of an attachment applied manually to gray whales, which appear to have a firmer blubber structure (Watkins *et al.* 1981). Blubber thickness in blue whales is 8-10 cm (male) and 9-11 cm (female) (Mackintosh and Wheeler 1929). For fin whales, thicknesses range from 7-8 cm (male) and 7-11 cm (female) (Mackintosh and Wheeler 1929). Dermal tags deployed on right and humpback whales (similar to those being considered for this Opinion) did not penetrate close to the blubber/muscle interface of those whales (Goodyear 1983).

Target whales for invasive tags under the proposed activities would be juveniles (> 1 year old) and adult whales. Although neonatal cetaceans have thinner blubber layers than their adult counterparts (Blix and Steen 1979; Dunkin *et al*. 2005; Struntz *et al*. 2004), the thermal demand of a highly conductive ocean, buoyancy requirements, or energy storage demands may cause them to quickly increase blubber thickness from birth to the first year (Noren *et al*. 2009). Bottlenose dolphin yearlings are able to maintain a greater proportion of blubber than older bottlenose dolphins but this depends on the season; the yearlings have significantly greater blubber than 2- to 12- year old animals during summer, but this difference diminishes in winter (2-mm increase of yearlings and 3- to 6- mm increase of adults in winter; Noren *et al*. 2009).

Expected Responses Due to Blubber Thickness. Due to the reported minimum thicknesses of each species' blubber layer, we do not expect the anchor needle attachments to penetrate the blubber-muscle interface. The anchor needle is only expected to penetrate the epidermis and blubber due to the blubber thickness of each individual species being tagged and the size and penetration angle of the needle or implant. Researchers would be sensitive to switching from longer needles to shorter needles depending on the reported blubber thicknesses of each species.

We expect that yearlings might have a thicker or thinner blubber layer than adults, depending on season. We do not expect juveniles to have as thin of a blubber layer as neonates, which will not be tagged. Although yearlings may have thinner blubber than adults during a given season, we do not believe it would be on the order such that the choice of a smaller needle penetration would pierce the muscle.

Expected Responses to Invasive Tags. After reviewing available information on the responses of whales to invasive tagging, we do not expect mortality to occur due to invasive tagging under proposed activities. Reports of beluga deaths from tagging studies have been

attributed largely to capture and handling stress (Kraus *et al*. 2000). The eastern gray whale death following tagging has not been definitively attributed to a tag wound, although the carcass decomposition precluded histological analysis (WGWAP 2006). Though we do not expect mortality, we do expect that invasive tags would produce an injury that would have to heal over time.

Based on the available evidence we would expect most whales exposed under the proposed permits to exhibit either no visible reaction or short-term low-level to moderate behavioral responses, and would expect the prior behavior of the whales to influence their response. Disturbance of a tagged whale may occur during the approach of the researchers and during attachment of the tag. Duration of tag attachment under most permits proposed is expected to be shorter than that of suction-cup tags. Given that Weinrich *et al*. (1991, 1992) reported a strong response in less than 5.6% of North Atlantic right and less than 3.3% of humpback whales from invasive techniques, we assume that strong behavioral responses to tagging would be possible but not frequent. We expect the short-term responses to tagging conducted under each permit to last no more than a few minutes, and we do not anticipate that any behavioral changes would have long-term consequences for individual whales.

Whales would be exposed to tagging in important foraging grounds and migratory routes for these whale species, and the proposed tagging activities have the potential to interrupt those activities. However, we expect any behavioral responses to tagging to be short-term, and accordingly we do not anticipate that responses to tagging conducted under this permit would significantly affect whale migration or result in reduced foraging opportunities for individual whales. In addition, the tagging studies themselves necessitate a tagged animal returning to its normal behavior after being tagged, because the purpose of these studies is to examine whale distribution, movement and habitat use, and behavioral patterns such as diving and foraging.

However, as described above for observations of whale behavior in response to close vessel approaches, our use of behavior as an indicator of a whale's response to tagging may or may not accurately reflect the whale's experience, and we cannot definitively know whether such behavioral responses have long-term consequences. Responses to human disturbances, such as tagging, may manifest as stress responses, interruptions of essential behavioral or physiological events, alteration of an animal's time budget, or some combination of these responses. We assume that tagging conducted under the proposed permits may be stressful for a portion of the whales; however, the significance of this stress response and its consequences, if any, on the fitness of individual whales are not known. Recognizing the conditions of the proposed permit and the evidence indicating that behavioral responses would be short-lived, we provisionally assume that the tagging activities would produce short-term stress responses in some individuals, but would not lead to reduced foraging opportunities or negatively affect an individual's growth, survival, annual reproductive success, or lifetime reproductive success.

Tag take numbers were calculated based on tagging attempts where the tag package misses but the animal reacts, where the tag package hits the animal but does not attach, or where the tag package successfully attaches. All whales targeted for tagging each year may either be suction-cup or dermal anchor tagged depending on several conditions (see *Description of the Action* section for explanation of how particular tags are chosen). Permit conditions to minimize the

effects of tagging address the potential for repeat disturbance of these species. The proposed permits limit takes by harassment at three per individual in one day and requires coordination of the proposed activities with other permit holders conducting similar activities on the same species in the same locations or times of year. The permit would not authorize invasive tagging of any juveniles younger than one year. The permits also require any attempts to tag a particular individual be terminated if an animal exhibits a strong adverse reaction to tagging activity (e.g., breaching, tail lobbing, underwater exhalation, or disassociation from group).

C. Reponses of Whales to Biopsy

Temporal Effects. Many researchers claim that biopsy darts or sampling does not result in significant short-term or long-term behavioral disturbance to baleen whales. In 1991, the IWC working group on the effects of biopsy sampling considered that this technique was not likely to have any long-term, or even short-term, effects on individual whales or whale populations (IWC 1991). Weinrich *et al*. (1991) found no evidence that biopsy procedure caused long-term adverse responses in humpback whales, such as individual or herd displacement from a specific geographic region. Clapham and Mattila (1993) concluded that, if properly applied, biopsy sampling does not result in significant behavioral disturbance to humpbacks. Weinrich *et al.* (1992) stated that behavioral reactions of individual North Atlantic right whales to biopsy procedure are detectable but do not seem to be severe and that biopsy sampling of humpback whales results in momentarily painful or surprising stimulus that typically causes short-term disturbance of the subject's behavior (Weinrich *et al.* 1991). Brown *et al*. (1991) also found that reactions of North Atlantic right whales to biopsy sampling for genetic and pollutant analysis were minimal and short-lived with whales resuming normal behavior after darting was complete.

Reactions to Biopsy. Reactions of whales to biopsy darting vary in their level of intensity, and studies usually observe behavior to be on a no, to low, to moderate, to high response scale. Out of 203 successful biopsy dart shots to humpbacks, 41.4% produced an observable response (Brown *et al*. 1994). In 2006 hits, North Atlantic right whales showed an immediate minor change in behavior attributable to the darting itself in 19.4% of cases (Brown *et al*. 1991). Of 71 total biopsy attempts on North Atlantic right whales for which immediate behavioral reactions were recorded, 7% involved no reaction, 26.8% involved a low level reaction, 60.6% involved a moderate reaction, and 5.6% involved a strong reaction (Weinrich *et al.* 1992). Immediate reactions (hard tail flicks) took place in >50% of North Atlantic right whales exposed to biopsy procedure, which is especially noteworthy given the rarity of this behavior in any other context (Weinrich *et al*. 1992). Of 153 biopsy attempts on humpback whales, 24% elicited no detectable reaction, 26.7% a low level reaction, 46% a moderate reaction, and 3.3% a strong reaction (Weinrich *et al.* 1991). None of the North Atlantic right whales in Brown *et al.*'s (1991) study exhibited the "strong" (on a scale of low, moderate, strong) reaction seen by Weinrich *et al*. (1991, 1992). Clapham and Mattila (1993) conducted over 1000 biopsy samples on humpback whales on their west indies breeding ground and found almost half (44.1%) of the whales to show no immediate reaction to a hit, while a further 22.5% showed only low-level reactions.

Other than intensity, effects of biopsy are evident in different types of behavioral reactions such as increased dive ratios, tail flicks, respiratory variations, swimming away, arching backs,

lobtailing, and there is one reported cetacean death in the literature attributed to a biopsy dart. It has been suggested that reaction to the biopsy tip may be due more to the element of surprise to an unknown sensation, rather than to pain (Gautheir and Sears 1999). North Atlantic right whales reacted to biopsy darts by twitching, swimming away, arching their backs, flicking their tails on the surface, or lobtailing (Brown *et al*. 1991). Significant decrease in the surface interval/dive time ratios during post biopsy samples in North Atlantic right whales was also found (Wienrich *et al*. 1992). The strike of a biopsy dart to humpback whales elicits increased rates of display of agonistic behaviors, decreased surface to dive time ratios, and increased rates of linear displacement (Weinrich *et al*. 1991). Only the duration of the first feeding dives subsequent to biopsy were affected by humpback biopsy sampling (Brown *et al*. 1994). Reactions and changes in respiratory variables appeared to be dependent on prebiopsy behavioral state in humpback whales, as those animals feeding or resting were least likely to alter behavior, whereas travelling whales were more likely to show a detectable response (Weinrich *et al*. 1991). Mediterranean fin whales were found to react in two different but simultaneous ways to biopsy: a horizontal avoidance and a vertical avoidance (Jahoda *et al.* 1993). After biopsy disturbance, Mediterranean fin whale respiratory activity became more similar to pre-disturbance condition, while activity appeared to be suspended (Jahoda *et al*. 1993). Finally, there has been a recorded cetacean death from biopsy sampling - a common dolphin (Bearzi 2000). The dart entered the dolphin's muscle mass, possibly because the dolphin had an unusually thin blubber layer, and it is hypothesized that its death was caused by vertebral trauma leading to subdermal hemorrhage, compression of the spinal cord, and subsequent paralysis of the tail muscles (Bearzi 2000).

Repeated Attempts. Conclusions regarding the effects on repeated biopsy sampling attempts on an individual whale vary. Brown *et al*. (1994) concluded that repeated sampling of an individual humpback whale did not increase response intensity, Gauthier and Sears (1999) concluded that repetitive attempts to biopsy baleen whales resulted in a response of similar or decreased intensity, and Weinrich *et al*.'s (1991) field observations indicated that the response to biopsy stimulus may increase in apparent severity with repeated applications to the individual animal.

Group Size, Age, Time of Year. Researchers have examined factors such as whale group size, age class, and time of year to determine if they influence how whales might behave when biopsied. It appears that reactions of southern right whales to biopsying are determined, at least in part, by group, size, activity, and time of year (Best *et al*. 2005). Reactions of southern right whale single animals (either sex) were greater than large groups (Best *et al*. 2005). There was no significant difference in the intensity of reactions by age class in North Atlantic right whales, however, 3 of the 4 "strong" reactions recorded were from juveniles (Wienrich *et al*. 1992). Age, gender, or group size of humpback whales did not significantly affect their response to sampling (Weinrich *et al*. 1991) and group size, geographical region, and number of biopsies taken per whale were not factors that explained variation in behavioral responses of fin, humpback, blue, and minke whales (Gauthier and Sears 1999).

Mothers. Researchers have also examined whether mothers have stronger reactions to biopsy and reveal mixed results, especially for right whales. Southern right whale cows accompanied by calves had the strongest reactions to biopsy darting (Best *et al.* 2005). By contrast, Clapham and Mattila (1993) report a lower response rate for North Atlantic right whale

mothers to biopsy darting. Humpback mothers on their breeding ground showed significantly fewer reactions to biopsy hits than other whales, but similar frequency and type of behavior changes as compared to other whales, although the mothers tended to be more evasive before a shot was made (Clapham and Mattila 1993). Best *et al*. (2005) did not detect adverse effects of biopsy darting on the proportion of successful southern right whale reproductive cycles, and hence calf survival, although the power of their statistical tests was low.

Activities on Feeding and Breeding Grounds. A few studies have examined biopsy responses of baleen whales while on their feeding and breeding grounds and also during migration to see if these factors influence how whales might react. These studies reveal that whales may be stimulated differently while engaged in these important activities. Studies carried out on the feeding (Weinrich *et al.* 1991) and breeding (Clapham and Mattila 1993) grounds in the North Atlantic show more detectable reactions than the 41.6% revealed in Australian humpback biopsy attempts while not on feeding or breeding grounds (Brown *et al*. 1994). Even though humpbacks responded, behavioral *changes* of humpbacks on their breeding ground were seen in only 5.5% of biopsy hits (Clapham and Mattila 1993). Humpback mothers on the breeding ground showed significantly fewer reactions to biopsy hits than other whales, but similar frequency and type of behavior changes as compared to other whales, although the mothers tended to be more evasive before a shot was made (Clapham and Mattila 1993). Competitive group members also reacted significantly less to being struck than other classes on the breeding grounds (Clapham and Mattila 1993). Only one very strong reaction was recorded by Clapham and Mattila (1991) by a humpback on its breeding ground, and calves on the breeding ground reacted significantly more than all the other classes combined (Clapham and Mattila 1993). There was no difference in the response rate of humpback whales on their northward or southward migration (Brown *et al*. 1994).

Gauthier and Sears (1999) conducted biopsy studies on four baleen whales at their feeding grounds. Frequency, intensity, and category of immediate response to biopsy sampling of minke, fin, blue, and humpback whales were determined according to species, sex, group size, geographical region, number of biopsies taken per whale, and length of biopsy sample. There was no reaction to 45.2% of successful biopsy attempts on baleen whale feeding grounds (Gauthier and Sears 1999). Baleen whales responding to biopsy sampling on their feeding grounds resumed their normal behavior immediately or within a few minutes (Gauthier and Sears 1999). Most humpbacks displayed hard tail flicks and a majority of blue and fin whales submerged following biopsy sampling on their feeding grounds (Gauthier and Sears 1999). Response frequencies were similar between males and females for all baleen species biopsied by Gauthier and Sears (1999), with the exception of fin whales where females had a higher response frequency than males on their feeding grounds.

Gender. Whale gender has been examined as a potential factor influencing how whales may respond to biopsy. The gender of humpback whales did not significantly affect their response to sampling in Weinrich *et al*.'s study (1991). By contrast, Brown *et al*. (1991) suggested that sex may be the most important inherent factor governing an individual's response to biopsy. In Brown *et al*.'s (1994) study, female humpbacks did respond to biopsy sampling at a higher rate than males, however the differences in response rate were not statistically significant. Response frequencies were similar between males and females for all baleen species

biopsied by Gauthier and Sears (1999), with the exception of fin whales where females had a higher response frequency than males on their feeding grounds.

Species. Species type has also been examined as a potential factor influencing how whales may respond to biopsy. Significantly different frequencies and intensities of responses were found within baleen whale species (Gautheir and Sears 1999). Blue whales appeared to Gauthier and Sears (1999) to have a low response frequency compared to other baleen whales and minke and humpback whales were found to be more sensitive to biopsy sampling than fin and blue whales (Gauthier and Sears 1999). Further, it has been hypothesized that the susceptibility of reaction to an unknown stimulus, such as biopsy sampling, may be inversely related to size since smaller minke and humpback whales responded 2 to 3 times more frequently to biopsy sampling than blue whales (Gauthier and Sears 1999). Morphological features such as thickness and innervations of skin and blubber thickness may also play a roll in the differential sensitivity of species or individual baleen whales to biopsy (Gauthier and Sears 1999).

Expected Responses to Biopsy. We expect whales to respond similarly to what is reported above with no serious long-term effects to individual whales. It is evident, based upon our review, that biopsy would not cause long-term displacement. We don't expect any whales to die as a result of biopsy or to exhibit the type of rare trauma the dolphin reported by Bearzi (2000). At most, we expect whale reactions to vary in intensity and manifest as changed dive rations, tail flicks, swimming, arching, or respiratory variation. Reactions could also vary depending on sex, species, group size, activity (feeding, breeding), time of year, or whether females are mothers.

D. Tagging and Biopsy Summary

Available information reveals that wound sites, rejection, and short-term displacement occur from the tagging of individual whales. Suction-cup tags would not produce wound sites. Wound sites from invasive techniques reveal divots, cyamids, swelling, and scarring. Whales respond to tag deployment misses as well as successful tag application hits. Factors influencing how whales may respond to biopsy inform our understanding of other invasive techniques and include: individual, group, age class, time of year, feeding grounds, breeding grounds, migration, gender, species, and mothering. It is not evident that important life history stages such as reproduction and reproductive output as well as feeding are affected. It is evident that invasive tags (due to firing from long-range) could cause less disturbance to individual whales because the vessel does not have to approach within short-range. Finally, there have been a few cetacean deaths associated with tagging, although actual causes of death were inconclusive. These deaths were rare occurrences, and a majority of available information reveals short-term behavioral reactions and invasive tag wound sites.

In conclusion, based on the evidence available and with implementation of the permit conditions, all individual whales that would be tagged or biopsied under these proposed permits would be expected to exhibit either no visible reaction or short-term behavioral responses, including possible short-term stress responses in some individuals. Whales tagged or biopsied with invasive methods would be expected to produce a wound site that would heal without serious and debilitating infection. Short-term interruptions in behaviors such as foraging are possible;

however, we do not expect these responses to lead to reduced foraging opportunities for tagged individuals. Because any responses to tagging are expected to be short-lived, assuming an animal is no longer disturbed after it returns to its pre-tagging behavior, and assuming that invasive tag wound sites heal normally, we do not expect long-term consequences for individual tagged whales.

4. Responses of Cetaceans and Pinnipeds to Acoustic Playbacks

All acoustic playback studies would take place in the Pacific Ocean off of Hawaii and Alaska. No playback studies would take place in the Atlantic Ocean or Gulf of Mexico. Permits 13846, 14599, 14122, and 14296 will conduct playback studies on humpback whales in Alaska, with 13846 also conducting these studies in Hawaii. Permit 13846 studies could also cause harassment to 100 Eastern Steller sea lions in Alaska and 5 Hawaiian monk seals in Hawaii. Therefore, takes for these species due to playbacks are also analyzed. Permit 14122 would also conduct playback studies on sperm whales in Alaska. As stated previously, permit 14682 would be conducting playback studies in Hawaii that would target non-listed marine mammal species, and humpback whales will not be in Hawaii at the time of year those studies will be conducted.

Acoustic playback studies would be conducted to gain insight into the function of humpback whale sounds and to determine whether particular sounds evoke alerting responses. A variety of sound types would be broadcast depending on the permit and behavioral reactions would be assessed. Sound levels received by target species would not exceed 180 dB re: 1µPa. Sounds would include sounds produced by cetaceans, blank tape or silent stimulus control sound, non-impulsive synthetic sounds, and impulse signals between 1 kHz-50 kHz. Descriptions specific to each permit's methodology regarding these playbacks follow.

Permit 13846 (Darling) would broadcast humpback songs and social sounds from a small underwater speaker (Lubell LL-9162 Underwater Acoustic Transducer) upon vessel approach (> 100 feet away) of various humpback whale group types in Hawaii and Alaska. The best estimate of maximum source levels from singers is approximately 187 dB (W. Au pers. comm. To J. Darling, West Coast Whale Research Foundation, 2003). All playbacks would be initiated more than 100 feet away from the target animals. If whales approach the sound source, the maximum received level would be no more than 187 dB. Each session would consist of a maximum of two playbacks and would last no more than 60 minutes, with many complete in 30 minutes. A second vessel (which has no speaker) would closely approach the whale or group and listen to playback via passive hydrophone. All whales would also be observed from a third vessel and hillside observer, or a helicopter at 1000 feet, to determine if other whales are present in a 1 km square around the playback. It is possible that 100 Eastern Steller sea lions and 5 Hawaiian monk seals could be harassed by playbacks.

Permit 14599 (Sharpe) would broadcast Alaskan humpback whale feeding calls, Alaskan humpback whale social sounds, Hawaiian humpback whale winter songs, Hawaiian humpback whale social sounds, synthetic (non-impulsive) sounds, and blank tape or silent stimulus control sound to humpback whales in Alaska. Each playback would last 5 minutes, with 25 minutes pre-test passive observation and 25 minutes post-test monitoring. The playbacks would be broadcast at a depth of 20 m and sound would not exceed 170 dB re: 1µPa. No playbacks would be

broadcast to animals closer than 100 m. Individuals would also be monitored up to 1.5 nautical miles from vessels and up to 3 nautical miles from shore stations.

Permit 14122 (Straley) would play various sound signals (airgun, tonal, logarithmic sweep, sperm whale clicks, white noise bursts, silence, transient killer whale whistles and pulsed calls, and humpback whale feeding calls) for humpback and sperm whales in Alaska as demonstrated in Table 16. Sounds will not exceed 170 dB if whale is closer than 10 m. If whale is greater than 10 m away, sounds will be 160 dB or lower.

Total playbacks would be 48 minutes within a 12 hour period from a hydrophone. Playbacks will be simultaneously recorded. Observers will be present and if they note any signs of major disturbance (i.e. breaching, tail slaps, or underwater bubble cloud releases) a disable signal would be sent to the playback device and halt the trial.

Permit 14296 (Witteveen) would employ acoustic deterrent devices (commercial pingers, bottle rockets, large chains banging on metal skiff, pulling seine nets taut, and changes in outboard motor RPMs) for humpback whales in Alaska. Whales previously tagged would be tracked and monitored for one hour to establish dive patterns and behavior. While the tracking vessel is monitoring behavior, a second vessel will activate acoustic deterrent devices for a period of five seconds at various distances (100, 300 and 500 m) from the whales. Each whale would be exposed to sound from the given deterrent device for a maximum total of 15 seconds during three surface intervals spanning 20-25 minutes. A minimum of three dive cycles would separate testing of different deterrents. Acousonade tags would record the sound of acoustic deterrent devices.

Hearing. We assume whales hear best at ranges that they vocalize, since conspecifics need to be able to detect their sounds. Sperm whales produce mostly click sounds in the frequency range of 0.1-30 kHz with dominant frequencies 2-4 and 10-16 kHz and source level up to 160-180 dB re 1µPa at 1 m (Backus and Schevill 1966, Levenson 1974, Watkins 1980a). Source levels of most baleen whale sounds are 150-190 dB re 1µPa at 1 m (Richardson *et al.* 1995), and they are known to utter mostly low frequency sounds (below 1 kHz with some as low as 20 Hz). Humpback whales, specifically, have been reported to react to sonar signals at 3.1-3.6 kHz, beepers at 3.5 kHz, and clinkers emitting broadband pulses centered at 4 kHz, 135-145 dB re 1µPa (Lien *et al.* 1990, 1992; Maybaum 1993). The hearing thresholds of humpback whales, or any baleen whale, have not been explicitly tested. However, models based on humpback whale sound production, such as songs and feeding calls, and ear anatomy have suggested a potential hearing range of 10 Hz to 300 kHz (Helweg *et al.* 2000, Mercado *et al.* 2008). Indirect evidence suggests that baleen whales are most sensitive to frequencies below 1 kHz, but some can hear sounds up to much higher frequencies. Baleen whales were observed to react to sounds at frequencies up to 28 kHz, but did not respond to pingers and sonar at 36 kHz and above (Richardson *et al*. 1995).

We also assume pinnipeds hear best at ranges they vocalize. Monk seal hearing peak hearing sensitivity is 10-30 kHz with a functional high limit of 60 kHz (Richardson *et al.* 1995, Wartzok and Ketten 1999). Thomas *et al.* (1990) determined that the Hawaiian monk seal's range of best frequencies (12-28 kHz) is narrower than that of *phocinid* seals. A recent audiogram study

involving one male and one female Steller sea lion showed the maximum in water hearing sensitivity at 1-25 kHz (Kastelein *et al.* 2005). Although these results only represent the responses of two captive individuals, other eared seals exhibit similar responses and display maximum sensitivities of between 2-28 kHz (Schusterman *et al.*, 1972; Moore and Schusterman, 1987; Babushina *et al.*, 1991; Kastak and Schusterman, 1995). The high frequency cutoff for these species was observed to be around 40 kHz (Schusterman, 1981).

Effects on marine mammal hearing. In the proposed permits, playbacks would include both natural and synthetic sounds, with the majority consisting of humpback whale sounds played to humpbacks. Target whales would not be exposed to sound levels greater than 180 dB re: 1uPa. The best estimate of maximum source levels from singing humpback whales is between 180 and 190 dB (Au *et al.* 2003). At this source level (e.g., 187 dB), for a conspecific approximately 90 ft (27 meters or approximately two whale lengths) away the received level at the whale would be 158 dB due to attenuation of the sound. Singers are often that distance away from cows with calves, with no apparent behavioral disturbance to non-singers. The proposed playbacks would be initiated at lower source levels than those of singing humpbacks. NMFS would not anticipate that marine mammals would experience physiological effects that might result in sensory impairment as a result of exposure to playbacks of natural sounds within the acoustic range of those produced by cetaceans.

The acoustic deterrent devices proposed for use in permit 14296 (Witteveen) are currently used by commercial fisherman to deter cetaceans from entanglement in fishing gear. Alerting whales to the presence of fishing gear with noisemaking devices has been found to reduce humpback whale bycatch in eastern Canada trap fisheries (Lien *et al.*1990) and harbor porpoise bycatch in Canadian (Kraus *et al.* 1997, Trippel *et al.* 1999) and U.S. gillnet fisheries (Barlow and Cameron 2003).

There is concern that widespread use of acoustic deterrent devices will contribute additional anthropogenic noise to an increasingly noisy marine environment (Richardson *et al.* 1995, Jasny *et al.* 2005, Tyack 2008). Playbacks of acoustic deterrent devices in the proposed study would be temporary in nature, not constant, with an ultimate goal of acoustic deterrents that are triggered only when necessary (i.e. in response to a potential interaction), reducing the potential for “ensonification” of the ocean. This would also reduce the potential for habituation by whales to the deterrents used.

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 (Southall *et al*. 2007). 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 researchers and mitigation procedures in the permit, injuries from the proposed playback experiments are not expected. These risks are discountable.

Social Disruption. Social disruption may occur as a result of acoustic playbacks. Research shows that when sperm whales are exposed to some experimental sounds, they stop producing sound themselves. Sperm whales usually cease emitting pulsed sounds when exposed to a short sequence of noise pulses from acoustic pingers emitting at 6-13 kHz, source levels 110-130 dB re 1µPa at 1 m (Watkins and Schevill 1975). Sperm whales exposed to a low frequency sound experiment (Heard Island ocean acoustics study) ceased calling during transmissions, and resumed calling within 36 hours after transmissions ended (Bowles *et al.* 1994). 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.* 1987).

However, sperm and other whales do not always stop calling in response to noise (Richardson *et al*. 1995). Other studies identify instances in which sperm whales did not appear to respond to anthropogenic sounds (Madsen and Mohl 2000). 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*. 2002b). 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 noises 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. There is evidence that baleen whales will cease or reduce calling upon exposure to sounds (Watkins 1986).

Humpback whales responded to sonar in the 3.1–3.6 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 noises were louder (Fristrup *et al.* 2003).

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

The behavioral responses to anthropogenic noise are variable. Although marine mammals elicit a variety of responses to anthropogenic noises 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 noises will be minor. Any behavioral responses to the proposed activities are not expected to adversely affect the fitness of any individual listed species. These effects are therefore discountable.

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 noise 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 noises reach a threshold level (Foote *et al.* 2004). For baleen whales, the frequencies of the noises from the proposed sonar systems are well above the expected upper limit of hearing of baleen whales (see Southall *et al*. 2007), but these species are subject to masking effects from the lower frequency noises 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 noise (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 listed marine mammals is possible from the proposed activities, the low sound levels and short durations of these noises 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 listed animal. The effects of acoustic masking to listed species from these proposed activities are therefore discountable.

Behavioral Reactions to Playbacks. Previous playbacks of various sources to humpback whales in waters off Hawaii indicate only transient effects to whales ranging from rapid approach to the playback vessel, to slight avoidance, to no reaction (Mobley *et al.* 1988; Frankel *et al.* 1995; Frankel and Clark 1998, 2000, and 2002). The work in Hawaii indicated that some whales (not cows with calves) were attracted to playback of social sounds, but no

whales approached, and the majority of whales moved away from song playbacks (Tyack 1983). Baker and Herman (1984) found that song and synthetic sounds were played to humpbacks with no notable response to either. A 1988 study indicated that whales were attracted to playbacks of feeding sounds from Alaska and, like the Tyack (1983) study, social sounds from competitive groups. In a small percentage of trials (3 of 89), whales approached during a song playback but this was a smaller percentage than responded to synthetic sounds (Mobley *et al.* 1988). In this study, 22% of target animals responded by rapidly approaching the playback vessel (Mobley *et al.* 1988).

In a poster presented at the 17th Biennial Conference on the Biology of Marine Mammals, Darling *et al.* (2007) reported that during humpback playback trials in Hawaii, singing whales: 1) were immediately aware of a new song added to their surroundings; 2) could pinpoint a 25 cm speaker from 800 m; and 3) may respond to similar song by stopping and joining its source, which did not occur with playbacks of a different song. During the 19 trials:

- Nine playbacks of similar songs all resulted in neutral to positive (attraction) responses, with the singer joining the playback speaker in five of these trials.
- Seven playbacks of different songs all led to neutral to negative (repulsion) responses, as did playback of two non-whale sounds.
- One compound trial playback beginning with different song led to the singer moving away while continuing to sing; however when the playback was changed to similar song, the whale stopped singing and joined the playback speaker.
- Singing stopped during 70% of playbacks, ranging from immediately (27 sec) to after a full song (17 min). Stop time in similar song playbacks tended to be shorter (median: 2.5 min) than different song (median: 11.5 min).

Although researchers have documented local movements by whales in response to sounds, humpbacks continue to return to known feeding and calving grounds year after year suggesting that playbacks occurring there have not resulted in a permanent shift in habitat use. NMFS expects that the proposed playback sessions would likewise result in no more than local, temporary reactions (via behavior and movements) by targeted whales. No prolonged or permanent shift in habitat use would be expected.

In addition to the behavioral responses to sounds produced by conspecifics described above, marine mammals have shown reactions to sounds made by predators. Cummings and Thompson (1971) played recordings of killer whales to gray whales, eliciting increased levels of spy hopping and a movement away from the playback source. Harbor seals are able to discriminate between the calls of fish-eating and mammal-eating killer whale populations, showing that they possess the ability to discriminate between threatening and non-threatening sounds (Deeke *et al.* 2002). The ability to discriminate information has implications for other issues, including the issue of habituation to warning signals (such as those played to marine mammals for management purposes).

There is very little information about what noises cause avoidance responses in marine mammals, and responses by cetaceans to anthropogenic noise can be highly variable by species. For example, experiments of playbacks to harbor porpoises elicited avoidance responses

(Olesuik *et al* 2002, Koschinski *et al* 2003), but another to fin and blue whales did not elicit any obvious responses to sound (Croll *et al* 2001). Hatsuonki (i.e., Oikami pipes), hollow steel pipes that have been historically used in Japanese drive fisheries, have been effective in moving killer whales and dolphins. They were recently used in an attempt to herd a humpback cow-calf pair in the Sacramento river delta in California (up to 72 nmi inland) back to sea but the response of the humpbacks was not consistent (Gulland *et al*. 2008).

Summary. Based on the proposed source levels and received levels, source levels of vocalizations produced by live humpback whales, the design of the experiments, reports from Permit Holders, and published literature, NMFS does not expect that whales (individuals, populations or species) would be significantly impacted by the proposed playback sessions. No mortality or serious injury would be expected as a result of playback sessions. Individuals targeted for acoustic playbacks would be expected to display behavioral responses, as the goals of playbacks are to determine the effects of these sounds on behavior. NMFS does not expect that hearing would be harmed or injured. Any behavioral impacts to target or non-target animals would likely be short-term and negligible. Consequently, the proposed research activities are not expected to adversely affect the survival, longevity, or lifetime reproductive success of large whales.

Although the proposed experiments would be targeted specifically to humpbacks and sperm whales, Steller sea lions and Hawaiian monk seals occur in the action area and could be exposed as non-target subjects. While responses to playback experiments would incur a physiological cost by disrupting normal behavior and result in additional energy expenditure, they are expected to be temporary and, because they are at frequencies and levels commonly encountered naturally, would not be expected to directly cause any physical injury or mortality. The proposed playback experiments are therefore not expected to reduce the fitness of any individual Steller sea lion or Hawaiian monk seal.

5. Responses of Cetaceans to Swimmers Performing Underwater Photo/Video

All permits conducting underwater photography/videography in Hawaii will deploy swimmers. These include permits 14682, 14451, 14353, 14585, 13846, and 14599. Swimmers would enter the water to photograph or video whales. Swimmers would be snorkeling or SCUBA diving. Some divers would be equipped with an electric scooter.

In Hawaii only, if the whales or small cetaceans under observation become stationary, mill, or are swimming slowly, a swimmer equipped with mask, snorkel, and fins and a still or video camera in an underwater housing would enter the water within approximately 20-30 meters of the targeted group. The swimmer would approach the animals quietly at the surface until they are a whale's length away (ca. 10-15m for an adult whale). Depending on the animal's behavior, a second swimmer equipped with an underwater camera would be deployed to obtain still photographs of key underwater displays, physical appearance, fluke photographs (if not obtainable from the surface), or affiliations. In some cases, a safety diver would be in the water. No more than two swimmers would be in the water at a time, unless specifically authorized by NMFS. The boat crew would stand by with engine idling to assist the swimmer(s) when video recording is complete.

Some divers would be equipped with SCUBA gear and an electric scooter and some swimmers would use new, light re-breathers for silent (no bubble) observation at depth over long periods. The research vessel would approach foraging whales to within 30 m to deploy two divers, who would then approach by swimming or with the aid of an electric scooter to within one whale body length. Sound pressure levels for these devices are not readily available, although the scooters used are likely to have direct drive propulsion, variable pitch propellers, and brush motors, and are estimated to be below 77 dB re 1 uPa-m. It is estimated that most encounters with whales would be relatively brief, typically less than a minute before whales swim away; encounters could last up to 15 minutes.

The amount of time the swimmer is in the water would depend on the number of animals in a group and that group's behavior. For example, more time is generally spent with large competitive groups than small competitive groups. Also, a group that is stationary may provide more opportunities for obtaining data than a group that is traveling. Usually, a single deployment of a swimmer for in-water data collection lasts about 20 min. However, on occasion, a group that dives for long periods (e.g., 40 min) and that is stationary between dives may provide an opportunity of an hour or longer for obtaining data.

Vessel Complications. It is important to point out the complication of studying swimmer presence effects on cetaceans. Since it is necessary for a vessel to bring swimmers to the cetacean being encountered, it is very hard to separate a cetacean's reaction to swimmers from its reaction to the boat. Therefore, most swimmer studies incorporate vessel reactions as well as reaction to swimmers entering the water.

Exhibited Interactions. Little research has been conducted on the effects of swimmers on larger cetaceans. Most research studying the effects of swimmers on cetacean behavior has been conducted on delphinids, due to the popularity of dolphin swim-with programs. Dolphin encounters with human swimmers have been reported to range from interaction, to change in pod behavior, to avoidance. Dolphins are also reported to be in control of human interactions and can avoid humans at will. Bejder (1997) found that hector's dolphins in Porpoise Bay (New Zealand) remained within 200 m of swimmers entering the water from land for more than 5 minutes on 57.1% of the swim attempts. Frohoff and Packard (1995) conducted a comparative study on human interactions with free-ranging and captive bottlenose dolphins off the Florida Keys and showed that dolphin response to towed swimmers was variable and dolphins were in control of the level of interaction with swimmers. Swimmers caused only weak, non-significant effects to dolphins in Porpose Bay, New Zealand perhaps because dolphins could easily avoid swimmers (Bejder *et al.* 1999). The presence of swimmers also results in the probability of a dolphin group remaining in a tighter pod (Bejder 1997). Bottlenose and common dolphins also have been seen to avoid 22% and 38% of swim attempts for a given study (Constantine and Baker 1996).

Percentage of Group Interaction. Swim encounters will usually involve only a certain percentage of a dolphin group, with only a certain percentage of the engaging dolphins resulting in a "successful," or high interaction. Barr (1997) found that nine out of an average group size of 350 dusky dolphins would interact with swimmers. When swim attempts are successful (high

interaction with dolphins), on average they involve 19% of a group (Constantine 2001). For Hector's dolphins, 57% of in-water encounters were sustained for 5 minutes or more and classified as non-disturbing, whereas 42% were classified as at least potentially disturbing (Bejder and Dawson 1998, Bejder *et al*. 1999). For bottlenose and common dolphins, respectively, 60% and 31% of swim attempts were successful (at least 1 dolphin was within 5 m of a swimmer (Constantine and Baker 1996).

Entry Into the Water. Swimmer entry plays a large role in how cetaceans will respond. The strategy for swimmer entry into the water influences a bottlenose dolphin's response to that swimmer, with the greatest avoidance occurring when the swimmer enters in the path of the dolphin (Weir *et al.* 1996). When swimmers enter "line abreast" of the animal, a lower rate of avoidance will result. Other studies agree that the greatest increase in avoidance occurs when swimmers are placed in the dolphin's path of travel (Constantine 2001).

Habituation. There is a good amount of evidence showing dolphin habituation to human swimmers and human presence, with lone and sociable dolphins exhibiting greater interaction over groups of dolphins. Dolphins that are lone and sociable provide the greatest degree of contact with swimmers because they are well-habituated, so scaring them away is less of a worry than failing to provide the lone dolphin with adequate entertainment (Perrine 1998). Of the 26 lone, sociable dolphins that are well-documented (15 males, 8 females, 3 unknown sex), most are reported to have near-daily interactions with humans and infrequent interactions with other dolphins (Constantine *et al.* 2000). Eleven of these lone, sociable dolphins had periods of misdirected sexual behavior towards humans, buoys, and/or vessels and 15 directed aggressive behavior toward humans (Constantine *et al*. 2000). Occasionally, an apparently solitary dolphin will actively seek out human contact on a regular basis (Constantine 1999). Freddy, a lone dolphin, was observed to interact with swimmers or boats during 34% of his observed daylight hours (Bloom *et al*. 1995).

Dolphin groups also exhibit habituation. In Panama City, Florida, many dolphins that interact with swimmers frequently accept fish handouts (Colburn 1999, Ford 1997, Samuels and Bejder 1998). Dolphins can become habituated to regular in-water encounters with humans. In the Florida Keys, tour operators have targeted specific animals at specific locations to gain their trust for tours (Henning 1993). In Rockingham, Australia, a tour operator spent more than six months to habituate dolphins for swim-with-dolphin tours (Orams 1995, Weir *et al.* 1996). In the Bahamas, dolphins frequented a wreck salvage operation which led to swim-with-dolphin tours years later (St John 1988). Atlantic spotted dolphins off Bimini in the Bahamas are in frequent contact with and are habituated to the presence of boats and human swimmers because they are the primary subjects of commercial swim-with-dolphin programs as well as Dolphin Communication Project-DCP's long-term research studies (Melillo *et al.* 2009). Bottlenose dolphins in the same area appear less tolerant than spotted dolphins of boats or human swimmers within close proximity (Melillo *et al.* 2009).

Unhabituated Cetaceans. Unhabituated cetaceans show mixed reactions to human swimmers. A woman had a near death experience with a pilot whale that was unhabituated to human presence (Shane 1995, Shane *et al.* 1993).

Whale Interactions. Some researchers have reported on dwarf minke and dense beaked whale responses to human swimmers. These behaviors range from curiosity when whales initiate contact, to avoidance when humans try to initiate contact. Dwarf minke whales near the Great Barrier Reef initiate encounters with boats and swimmers and even slow down and maintain position near swimmers and displayed no aggression towards humans during more than 30 monitored encounters but did exhibit disturbance behaviors (veering away, speeding up) when swimmers tried to touch them (Arnold and Birtles 1998, 1999). Dense beaked whales remain distant or are curious and approach swimmers and boats (Ritter Brederlau 1999).

Silent Research. Researchers frequently use swimmers to document behavior, movement, and size of larger cetaceans, except these studies are silent as to the effects of swimmer presence on the whales. For example, Pack *et al*. (2002) used underwater swimmers for video/videogrammetry on humpback whales and didn't report any unusual responses to swimmers. Wahlberg *et al.* (2005) deployed an underwater swimmer for underwater video recordings of a sperm whale and did not comment on the effects of the swimmer on the whale. Nolan and Liddle (2000) used underwater photogrammetry with swimmers to measure size of humpback whales and also did not report on any reactions due to swimmer presence.

Southern Right Whale Interactions. There has been one substantial study on swimming interaction with a larger cetacean. Lundquist (2007) conducted a study on behavior and movement of southern right whales from the effects of boats and swimmers. Whales were observed before, during, and after a series of directed interactions with swimmers. Lundquist found that whale group composition had a significant effect on the response of whales to swimmers. Surprisingly, swimmer activity level did not have a substantial effect on the reaction of whales. Resting and socializing activities significantly decreased and traveling activities significantly increased when boats approached and when swimmers entered the water. Effects were greater for mother/calf pairs than for juveniles, while mixed adult/juvenile groups showed no significant changes in behavior or movement. Finally, the initial reaction of whales to approach of the boat and entry of swimmers into the water was a good predictor of the magnitude of effects on the behavior and movement patterns of the whale.

Summary. We expect the research vessel to influence the way whales would react to swimmer presence for underwater photography/videography. Since most research on swimmer influence has been done on dolphins, we most closely read the Lundquist (2007) study as it relates to the large whales targeted under the proposed permits. We expect that large whales would respond differently based on group composition, whale activity, group composition, or mothering. We also expect that the way the photographers enter the water would have an effect on whale response. Under the proposed activities, swimmers would enter the water within approximately 20-30 meters of the targeted whale group and would not do so in the direct path of the whale. The swimmer would approach the animals quietly at the surface until they are a whale's length away (ca. 10-15m for an adult whale) before they begin video/photo. We do not expect swimmers to cause any long-term effects that would reduce fitness in individual whales.

VIII. Cumulative Effects

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the action area considered by this Opinion. 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.

NMFS expects the natural phenomena in the action area will continue to influence these animals as described in the Environmental Baseline. We also expect anthropogenic effects described in the Environmental Baseline will continue, including vessel interactions, fishery interactions, habitat degradation, noise, pollutants, climate change, offshore industrial activities, scientific and research permits, and conservation measures. However, it is the combination and extent to which these phenomena will affect listed species that remains unknown.

We assume that natural phenomena will continue to occur as it has in the past. Whales may continue to become trapped by winter ice settling around them and face starvation if they cannot escape. The essential factor is that they need holes in the ice in order to surface and breathe as they escape to the floe edge, and it is assumed that entrapment may continue given seasonal ice flow cycles. Killer whale and shark predation could remain a potentially significant threat to the conservation and recovery of whales and pinnipeds, although exact implications are unknown. Given the relatively small population sizes of some of these listed species (right whales, gray whales, Hawaiian monk seals), predation could have a significant effect on abundance in combination with other phenomena. Effects of parasitism and disease will likely continue but repercussions to the populations remain unknown. Information on parasites, disease agents, and pathology are available in the literature, but little information is available about the role these agents may play in decline and long-term viability. Infectious diseases and pathogens have been identified as among the top risks endangering species, possibly resulting in extinction (Scott 1988; Anderson and May 1992; Daszak *et al*. 2000; Deem *et al*. 2001; Harvell *et al*. 2002). While disease may not cause the complete extinction of the species, it can produce enough mortality to threaten the species or trigger the disappearance of local stocks or populations, increasing the risk posed by other mechanisms (de Castro and Bolker 2005). Disease alone may be unlikely to drive a species to extinction, but may be much more likely when combined with other contributing risk factors such as pollution, habitat loss, and human disturbance (Smith *et al.* 2006). Finally, interspecific prey competition could occur into the future.

Vessel interactions by way of ship collisions will most likely continue to remain a major human-induced mortality factor affecting large whales and could be a smaller factor for pinnipeds. Quantification of ship strikes and the effect on large whales in the proposed action area is difficult. Collisions with ships are an increasing threat to many large whale species, particularly as commercial shipping lanes cross important large whale breeding and feeding habitats or migratory routes. Ship strikes are known to affect large whales especially in the western North Atlantic portion of the action area, where several high-use shipping corridors occur and we expect this to occur into the future, although the exact implications remain unknown.

Entrapment and entanglement in fishing gear is a frequently documented source of human-caused mortality in large whale species and Hawaiian monk seals and will likely continue into

the future. Entrapment and entanglement in fishing gear may also make animals more vulnerable to additional dangers (e.g., predation and ship strikes) by restricting agility and swimming speed. Injuries and entanglements that are not initially lethal may result in a gradual weakening of entangled individuals, making them more vulnerable to some other direct cause of mortality (Kenney and Kraus 1993). Entanglement-related stress may decrease an individual's reproductive success or reduce its life span, which may in turn depress population growth. There Numerous fisheries operate within the action area, and entanglement in fishing gear or derelict gear is a concern for animals in these ocean basins. There is concern that many marine mammals that die from entanglement in commercial fishing gear tend to sink or drift out to sea rather than strand ashore, thus making it difficult to accurately determine the frequency and number of whales involved. In addition, it is likely that entanglements and resulting injuries to some members of these populations go undetected and unreported. Since factors such as sinking make it hard to ascertain the threat of future entanglements, future effects of this threat on the species in this Opinion remains unknown.

A number of human activities could continue to directly or indirectly affect these animals by degradation of habitat. Anthropogenic activities such as discharge from wastewater systems, dredging, ocean dumping and disposal, aquaculture and additional impacts from coastal development are known to affect marine mammals and their habitat. Undersea exploitation and development of mineral deposits, as well as dredging of major shipping channels pose a continued threat to coastal habitat. Point-source pollutants from coastal runoff, offshore mineral and gravel mining, at-sea disposal of dredged materials and sewage effluent, oil spills, as well as substantial commercial vessel traffic, and the impact of trawling and other fishing gear on the ocean floor are continued threats to marine mammals in the proposed action area. The effects of these activities are difficult to measure, will likely continue, and remain largely unknown.

The effects of noise pollution will likely continue to be a growing concern. In addition to natural sources of noise (e.g., lightning, rain, sub-sea earthquakes, and animal vocalizations), noise generated by human activity occurs within the action area – this includes noise from vessel traffic, aircraft, sonar, coastal and marine construction, mineral extraction, explosives, and seismic activities. This noise may affect listed species; of particular concern is how it may affect their communication at low frequencies (Carretta *et al.* 2007). Effects of noise influence could include tolerance, habituation, sensitization, masking, behavioral disruption, social disruption, or displacement. Long-term effects of noise influence could include mortality, injury, long-term displacement, energetic consequences, or tolerance and stress for the whales. Animals in the proposed action area are regularly exposed to these types of natural and anthropogenic sounds; however, the extent of any effects from this exposure remains unknown.

The accumulation of stable pollutants is a possible human-induced source of mortality in long-lived high trophic level animals (Waring *et al.* 2004) and could continue into the future. Some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Contaminants may be introduced by rivers, coastal runoff, wind, ocean dumping, dumping of raw sewage by boats and various industrial activities, including offshore oil and gas or mineral exploitation. Due to their large amount of blubber and fat, marine mammals readily accumulate lipid-soluble contaminants – for example, polychlorinated biphenyls (PCBs) (O'Hara and Rice 1996). Concentrations of organochlorides have been documented in listed marine

mammals. We therefore assume that exposure to such contaminants may be affecting listed species in the action area. However, organochlorines bioaccumulate at higher trophic levels, and contaminant levels in planktivorous mysticetes are reported to be one to two orders of magnitude lower compared to piscivorous odontocetes (Borrell 1993; O'Shea and Brownell Jr. 1994; O'Hara and Rice 1996; O'Hara *et al.* 1999). The manner in which pollutants negatively impact animals is complex and difficult to study, particularly in taxa for which many of the key variables and pathways are unknown (O'Shea and Brownell 1994). The transgenerational accumulation of containments is perhaps a more likely source for concern for these animals into the future.

Climate change and ecosystem change is likely to persist into the future. Interannual, decadal, and longer time-scale variability in climate can alter the distribution and biomass of prey available to marine mammals. The effects of climate-induced shifts in productivity, biomass, and species composition of zooplankton on the foraging success of marine mammals has received little attention. Such shifts in community structure and productivity may alter the distribution and occurrence of foraging animals in coastal habitats, as well as affecting their reproductive potential. Ice-associated animals may be sensitive to changes in Arctic weather, sea-surface temperatures, or ice extent, and the concomitant effect on prey availability. Climate variability factors for the other marine mammals such as alteration of the distribution and biomass of prey available for feeding is cause for concern, but effects to these listed species remain unknown.

The major sources of industrial underwater noise appear to be offshore oil, gas or mineral exploration and exploitation and will likely continue. These activities increase vessel traffic, produce loud sounds for seismic profiling, place structures in areas used by whales, and introduce noises from drilling and production into the environment. The potential effects of these projects will be considered in Biological Opinions regarding oil and gas leasing and exploration activities and oil production facilities or other federal permitting processes and therefore is not discussed here.

Future federal actions as well as scientific studies contributing to conservation or recovery of these animals will require consultation under the ESA and such studies are not included in the *Cumulative Effects* section of this Opinion. Sources queried for the information on non-federal activities include the U.S. Census Bureau and Lexis-Nexus news and law online search engine. On Nexis, we reviewed bills passed from 2009-2010 and pending bills under consideration were included as further evidence that actions are reasonably certain to occur. In addition, statutes already in place that continue to provide the authority of state agencies to regulate anthropogenic effects were reviewed. State regulation is critical for future anthropogenic impacts in a region. California, Oregon, Washington, Alaska, Florida, Georgia, Hawaii, North Carolina, South Carolina, Maryland, Virginia, New York, New Jersey, Delaware, Connecticut, New Hampshire, Rhode Island, Maine, and Massachusetts legislation address climate change and sea level rise; oil spill prevention and response; off-shore oil drilling; alternative energy development; water supply concerns; ecosystem, natural resource, and endangered species recovery and protection; and regulation of fisheries and invasive species.

IX. Integration and Synthesis of Effects

As explained in the *Approach to the Assessment* section, risks to listed individuals are measured using changes to an individual's "fitness" – i.e., 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 population(s) those individuals represent or the species those populations comprise (Brandon 1978, Mills and Beatty 1979, Stearns 1992, Anderson 2000). 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.

The narrative that follows integrates and synthesizes the information contained in the *Status of the Species*, the *Environmental Baseline*, and the *Effects of the Action* sections of this Opinion to assess the risk the proposed activities pose to these baleen whales. There are known cumulative effects (i.e., from future state, local, tribal, or private actions) that fold into our risk assessment for this species.

The proposed issuance by PR1 of these 8 scientific research permits and permit amendment would authorize directed take of humpback, sei, fin, sperm, blue, North Pacific and North Atlantic right, Western North Pacific gray whales, Eastern and Western Steller sea lions, and Hawaiian monk seals in the Pacific, Atlantic, and Gulf of Mexico. The proposed activities under this permit include close vessel approaches, aerial surveys, tagging, biopsy, active and passive acoustics, underwater photography/video and various genetic sampling. The *Status of listed resources* section identified commercial whaling as the primary reason for the reduction in population size for the listed whales. Other threats to the survival and recovery of listed species include ship strike, entanglement in fishing gear, noise pollution, climate change, possible prey competition, habitat degradation, and accumulation of pollutants. Reasonably likely future actions described in the *Cumulative effects* section include state legislation to address marine issues; oil spill prevention and response; off-shore oil drilling; alternative energy development; ecosystem, natural resource, and endangered species recovery and protection; and regulation of fisheries and invasive species. It is unknown what, if any, recovery the North Atlantic right, North Pacific right, blue, fin, sei, sperm, and Western North Pacific gray whale populations have achieved in recent decades. More is known about the humpback population, whose numbers appear to be increasing.

All animals to be exposed to proposed activities are outlined in Tables 27-29 by action area and invasiveness of procedure. Target animals include humpback, blue, sperm, sei, fin, North Pacific right, and Western North Atlantic gray whales. Non-target animals include North Atlantic right whales, Eastern and Western Steller sea lions, and Hawaiian monk seals. Dead marine mammal parts would also be collected.

Exposure times are separated depending on the methods of exposure (i.e. exposure to the vessel for close approach, or exposure to a tag or acoustic device) or the given permit. Tagging of target whales could last 5-10 minutes for close approach and 5 seconds or less for tag or biopsy application. Subsequent monitoring after tagging depends on the observations being made, subsequent methods being employed, or tracking time needed until tag falls off. Depending on

methods employed after tagging, whales could be monitored anywhere from 15 minutes up to 24 hours until the longest-lasting tags fall off and are retrieved. Vessel mounted cameras would close approach and film for approximately 15 minutes depending on the permit. Underwater swimmers would have an encounter for approximately 20-40 minutes depending on group size and number of divers in the water. Playbacks would last for a few seconds up to 60 minutes depending on the permit or acoustic exposure. Bursts and signals would last on the order of seconds and singing playbacks would last up to 60 minutes. Aerial survey encounters would last for up to 15 minutes. Fishing vessels with modified equipment usually fish for 3-17 hours at a given time.

We believe short-lived stress responses due to close approach, swimmer influence, playbacks, and tagging are possible in a few individuals as are short-term interruptions in behaviors such as foraging; however, we do not expect these responses to lead to reduced opportunities for foraging or reproduction for tagged individuals. Injury from the invasive tags and biopsy would be small and localized for targeted whales and is expected to heal normally and not result in debilitating infection. Resighting, photo monitoring of tagged whales (including after tag has detached), and possibly histological analysis of wound sites would add to our understanding of the effects of tagging cetaceans.

Overall, no individual animal is expected to experience a fitness reduction. As such, no fitness consequences will be experienced by populations or species.

X. Conclusion

After reviewing the current status of humpback, sei, fin, blue, North Atlantic and North Pacific right, sperm, and Western North Pacific gray whales, Hawaiian monk seals, Eastern and Western Steller sea lions, the environmental baseline for the action area, the anticipated effects of the proposed activities, and the cumulative effects, it is NMFS' biological opinion that the activities authorized by the proposed issuance of eight Permits (14682, 13846, 14451, 14585, 14599, 14122, 14296, 14353) and one Permit Amendment (10018-01) to scientific researchers, for research on multiple large whale species and pinnipeds are not likely to jeopardize the continued existence of humpback, sei, fin, blue, sperm, Western North Pacific gray, North Atlantic and North Pacific right whales, Eastern and Western Steller sea lions, or Hawaiian monk seals. Critical habitat that has been designated within the action area is not affected by the proposed activity.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or benefit listed species or their habitats. In order to avoid or minimize adverse effects to listed species we recommend that:

1. Cumulative Impact Analysis. PR1 should work with the Marine Mammal Commission, International Whaling Commission, and the marine mammal research community to identify a research program with sufficient power to determine cumulative impacts of existing levels of research on whales. This includes the cumulative sub-lethal and behavioral impacts of research permits on listed species.

2. Estimation of Actual Levels of "Take." For future permits authorizing activities similar to those contained in the proposed permits, PR1 should review all annual and final reports submitted by researchers that have conducted whale research as well as any data and results that can be obtained from the permit holders. This should be used to estimate the amount of harassment that occurs given the level of research effort, and how the harassment affects the life history of individual animals. The results of the study should be provided to PR3 for use in the consultations on future research activities.

3. Assessment of Coordination Conditions. PR1 should assess the effectiveness of its permit condition for notification and coordination of research.

4. Coordination Meetings. PR1 should continue to work with NMFS' Regional Offices to conduct meetings among regional species coordinators, permit holders conducting research within a region, and future applicants to ensure that the results of all research programs or other studies on specific threatened or endangered species are coordinated among the different investigators.

5. Data Sharing. PR1 should encourage permit holders planning to be in the same geographic area during the same year to coordinate their efforts by sharing research vessels and the data they collect as a way of reducing duplication of effort and the level of harassment threatened and endangered species experience as a result of field investigations.

6. Long-Term Monitoring of Wound Sites. PR1 should encourage permit holders to communicate with one another to fully monitor and realize long-term effects of invasive tag wound sites.

In order for PR3 to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting, listed species or their habitats, PR1 should notify PR3 of any conservation recommendations they implement in their final action.

REINITIATION NOTICE

This concludes formal consultation on the proposed issuance of eight Permits (14682, 13846, 14451, 14585, 14599, 14122, 14296, 14353) and one Permit Amendment (10018-01) to scientific researchers, for research on multiple large whale species and pinnipeds. As provided in 50 CFR 402.16, 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 incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion (e.g., results of the 5-year study on the effects of biopsy sampling of

right whales reveals effects that were not considered in the Opinion); (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

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