NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7
BIOLOGICAL AND CONFERENCE OPINION

Title:	Biological and Conference Opinion on the Issuance of Scientific Research Permit No. 21585 to Oregon State University (Dr. Bruce Mate) for Research on Marine Mammals in the Arctic, Atlantic, Indian, Pacific, and Southern Oceans
Consultation Conducted By:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Action Agency:	Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Publisher:	Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce

Approved:

For Donna S. Wieting
Director, Office of Protected Resources

Date: DEC - 6 2018

Consultation Tracking number: FPR-2018-9277

Digital Object Identifier (DOI): http://doi.org/10.25923/b9bh-4z81

This page left blank intentionally

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat they depend on. Section 7(a)(2) of the ESA requires Federal agencies to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Federal agencies must do so in consultation with National Marine Fisheries Service (NMFS) for threatened or endangered species (ESA-listed), or designated critical habitat that may be affected by the action that are under NMFS jurisdiction (50 C.F.R. §402.14(a)). If a Federal action agency determines that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS concur with that determination for species under NMFS jurisdiction, consultation concludes informally (50 C.F.R. §402.14(b)).

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

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, or conference if combined with a formal consultation, NMFS provides an opinion stating whether the Federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If NMFS determines that the action is likely to jeopardize listed species or destroy or adversely modify critical habitat, NMFS provides reasonable and prudent alternatives that can be taken by the Federal agency or the applicant and allow the action to proceed in compliance with section 7(a)(2) of the ESA. If an incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement that specifies the impact of any incidental taking on the species and includes reasonable and prudent measures NMFS considers necessary or appropriate to minimize such impacts and terms and conditions to implement the reasonable and prudent measures.

The action agency for this consultation is the NMFS, Office of Protected Resources, Permits and Conservation Division (hereafter the Permits and Conservation Division). The Permits and Conservation Division proposes to issue a scientific research permit pursuant to section 10(a)(1)(A) of the ESA and section 104 of the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 U.S.C. §1361 et seq.). Permit No. 21585 will be issued to Bruce Mate, Ph.D., Oregon State University, 2030 Southeast Marine Science Drive, Newport, Oregon 97365. The purpose of the proposed permit is to allow an exception to the moratorium and prohibition on takes established under the ESA and MMPA in order to allow the Oregon State University

(Dr. Bruce Mate) to conduct scientific research on marine mammals in the Arctic, Atlantic, Indian, Pacific, and Southern Oceans (worldwide).

Under the ESA take is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct.” Harm is further defined by regulation (50 C.F.R. §222.102) as “an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering.” While the U.S. Fish and Wildlife Service further defines harass by regulation (50 C.F.R. §17.3), until NMFS promulgates a regulatory definition, we rely on NMFS’ interim guidance, which defines harass as an act that create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering” (NMFSPD 02-110-19).

Under the MMPA take is defined as “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal (16 U.S.C. 1361 et seq.) and further defined by regulation (50 C.F.R. §216.3) as “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;
- The doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal;
- Feeding or attempting to feed a marine mammal in the wild.

For purposes of this action, the two levels of harassment are further defined under the MMPA as any act or pursuit, torment, or annoyance which:

- Has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or,
- Has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment). Under NMFS regulation, Level B harassment does not include an act that has the potential to injure a marine mammal or marine mammal stock in the wild.

NMFS’ interim ESA harass definition does not specifically equate MMPA Level A or Level B harassment, but shares some similarities with both in the use of the terms “injury/injure” and a focus on a disruption of behavior patterns. Since the proposed permits will authorize take under both the ESA and MMPA, our ESA analysis, which relies on NMFS' interim guidance on the ESA term harass, may result in different conclusions than those reached by the Permits and Conservation Division in their MMPA analysis. Given that the MMPA takes a more conservative approach in considering any act that has the potential to disrupt behavioral patterns as harassment, while under the ESA such acts must significantly disrupt normal behavioral patterns, there may be circumstances in which an act is considered harassment, and thus take, under the MMPA but not the ESA.

This consultation, biological and conference opinion, and incidental take statement, were completed in accordance with section 7(a)(2) of the statute (16 U.S.C. 1536 (a)(2)), associated implementing regulations (50 C.F.R. §§401-16), and agency policy and guidance was conducted by NMFS Office of Protected Resources Endangered Species Act Interagency Cooperation Division (hereafter referred to as "we"). This biological and conference opinion (opinion) and incidental take statement were prepared by NMFS Office of Protected Resources Endangered Species Act Interagency Cooperation Division in accordance with section 7(b) of the ESA and implementing regulations at 50 C.F.R. §402.

This document represents NMFS' opinion on the effects of the proposed action under Permit No. 21585 on beluga whales (Cook Inlet distinct population segment [DPS]), blue whales, bowhead whales, Gulf of Mexico Bryde's whales, false killer whales (Main Hawaiian Islands insular DPS), fin whales, gray whales (Western North Pacific population), humpback whales (Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS), killer whales (Southern Resident DPS), North Atlantic right whales, North Pacific right whales, sei whales, southern right whales, sperm whales, bearded seals (Beringia DPS and Okhotsk DPS), Guadalupe fur seals, Hawaiian monk seals, ringed seals (Arctic, Baltic, Ladoga, Okhotsk, and Saimaa subspecies), spotted seals (Southern DPS), Steller sea lions, green turtles (Central North Pacific DPS, Central South Pacific DPS, Central West Pacific DPS, East Pacific DPS, North Atlantic DPS, South Atlantic DPS, East Indian-West Pacific DPS, Mediterranean DPS, North Indian DPS, Southwest Indian DPS, Southwest Pacific DPS), hawksbill turtles, Kemp's ridley turtles, leatherback turtles, loggerhead turtles (North Pacific Ocean DPS, Northwest Atlantic Ocean DPS, Northeast Atlantic Ocean DPS, Mediterranean Sea DPS, North Indian Ocean DPS, South Atlantic Ocean DPS, South Pacific Ocean DPS, Southeast Indo-Pacific Ocean DPS, Southwest Indian Ocean DPS), and olive ridley turtles (Mexico's Pacific Coast Breeding Colonies and All Other Areas) as well as designated critical habitat for beluga whales (Cook Inlet DPS), false killer whales (Main Hawaiian Islands insular DPS), killer whales (Southern Resident DPS), North Atlantic right whales, North Pacific right whales, green turtles (North Atlantic DPS), hawksbill turtles, leatherback turtles, and loggerhead turtles (Northwest Atlantic Ocean DPS). A complete record of this consultation is on file at the NMFS Office of Protected Resources in Silver Spring, Maryland.

1.1 Background

Dr. Bruce Mate, a long term marine mammal researcher at Oregon State University, has held scientific research permits to study cetaceans in similar action areas for more than 40 years (since 1976). We conducted ESA section 7 consultations on research permits for Permit Nos. 0639-1440 and No. 14856. Those consultations determined that the permitted research activities were not likely to jeopardize the continued existence of ESA-listed species and no destruction or adverse modification of designated critical habitat was anticipated. The proposed research activities for Permit No. 21585 are a continuation of those conducted under Permit Nos. 142 (1976 through 1979), 217 (1977 through 1981), 403 (1983 through 1987), 412 (1983 through 1988), 421 (1983 through 1986), 492 (1985 through 1992), 553 (1986 through 1990), 678 (1989 through 1994), 788 (1992 through 1997), 0369-1440 (1998 through 2004), 0369-1757 (2005 through 2013), and 14856 (2013 through 2018).

In this consultation, we build upon our long-term evaluation of the Oregon State University's research activities from these previous consultations, but here consider these previous research permits as part of the *Environmental Baseline* (Section 10) and evaluate the effects of authorizing the Oregon State University to continue to conduct research activities under Permit No. 21585 over the next five years.

1.2 Consultation History

This opinion is based on information provided in the applicant's permit applications, correspondence and discussions with the Permits and Conservation Division and the applicants, previous biological opinions for research permits on which researchers at the Oregon State University were Principal Investigators or Co-Investigators, annual reports from previous research activities on which researchers at the Oregon State University were Primary Investigators or Co-Investigators, other similar research activities for which we have conducted ESA section 7 consultations, and the best scientific and commercial data available from the literature.

On July 27, 2018, we suggested and the Permits and Conservation Division agreed to batch the consultations for Permit Nos. 21585 and 21482 (Dr. Dan Engelhaupt, HDR, Inc.) for streamlining, efficiency, and workload purposes as they have similar research methodologies targeting many of the same ESA-listed species, and have similar due dates. After the Permits and Conservation Division agreed to our suggestion, on August 15, 2018, we sent the Permits and Conservation Division a memorandum informing them that we had initiated consultation on the issuance of Permit Nos. 21585 and 21482 as of June 22, 2018 and June 26, 2018, respectively. Following a change in the target issuance date for Permit No. 21482, the Permits and Conservation Division and the ESA Interagency Cooperation Division mutually agreed to split up the batched consultation on November 5, 2018.

Our communication with the Permits and Conservation Division regarding Permit No. 21585 is summarized as follows:

- On March 5, 2018, the Permits and Conservation Division provided the draft MMPA application, annual reports, environmental assessment, and previous opinion to the ESA Interagency Cooperation Division for and requested technical assistance in the form of comments on the proposed research activities.
- On April 12, 2018, the ESA Interagency Cooperation Division requested maps of the proposed action area from the Permits and Conservation Division.
- On June 1, 2018, the Permits and Conservation Division provided maps of the action area to the ESA Interagency Cooperation Division and requested a species list.
- On June 14, 2018, the ESA Interagency Cooperation Division provided a species and designated critical habitat list to the Permits and Conservation Division.
- On June 22, 2018, the Permits and Conservation Division sent the ESA Interagency Cooperation Division a memorandum and initiation package, including the draft permit, descriptions of active permits for baseline information, and the updated application, requesting formal consultation on the proposed issuance of Permit No. 21585. The memorandum and initiation package was received by the Consulting Biologist on June 22, 2018. The Permits and Conservation Division requested review of the initiation package and requests for additional information be submitted by July 23, 2018. The Permits and Conservation Division requested that formal consultation be concluded and the signed opinion received prior to the proposed target issuance date of December 1, 2018.
- On July 20, 2018, the ESA Interagency Cooperation Division sent the Permits and Conservation Division comments and questions on Permit No. 21585.
- On July 27, 2018, the ESA Interagency Cooperation Division decided to batch the consultations for the issuances of Permit Nos. 21482 and 21585.
- On July 30, 2018, the Permits and Conservation Division addressed comments and questions submitted by the ESA Interagency Cooperation Division on Permit No. 21585.
- On August 15, 2018, the ESA Interagency Cooperation Division determined there is sufficient information to initiate formal consultation. The ESA Interagency Cooperation Division provided the Permits and Conservation Division with an initiation letter on August 15, 2018.
- On November 5, 2018, the ESA Interagency Cooperation Division and the Permits and Conservation Division mutually agreed that the batched consultations (Permit Nos. 21585 and 21482) should be split up as a result of a change in the target issuance date for Permit No. 21482.

2 The Assessment Framework

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

"Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species." 50 C.F.R. §402.02.

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of an ESA-listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 C.F.R. §402.02).

An ESA section 7 assessment involves the following steps:

Description of the Proposed Action (Section 3): We describe the proposed action and those aspects (or stressors) of the proposed action that may have direct or indirect effects on the physical, chemical, and biotic environment.

Interrelated and Interdependent Actions (Section 4): We identify interrelated and interdependent actions. *Interrelated* actions are those that are part of a larger action and depend on that action for their justification. *Interdependent* actions are those that do not have independent use, apart from the action under consideration.

Potential Stressors (Section 5): We identify the stressors that could occur as a result of the proposed action and affect ESA-listed species and designated critical habitat.

Action Area (Section 6): We describe the action area with the spatial extent of those stressors.

Species and Critical Habitat Not Likely to be Adversely Affected (Section 7): We identify the ESA-listed species and designated critical habitat that are likely to either not be affected or are not likely to be adversely affected by the stressors.

Species and Critical Habitat Likely to be Adversely Affected (Section 8): We identify the ESA-listed species and designated critical habitat that are likely to co-occur with those stressors in space and time and evaluate the status of those species and habitat.

Status of Species and Critical Habitat Likely to be Adversely Affected (Section 9): We examine the status of each species that would be adversely affected by the proposed action as well as the condition of designated critical habitat throughout the action area and discuss the condition and current function of designated critical habitat.

Environmental Baseline (Section 10): We describe the environmental baseline in the action area including: past and present impacts of Federal, state, or private actions and other human activities in the action area; anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation, and impacts of state or private actions that are contemporaneous with the consultation in process.

Effects of the Action (Section 11): We identify the number, age (or life stage), and gender of ESA-listed individuals that are likely to be exposed to the stressors and the populations or sub-populations to which those individuals belong. We also consider whether the action “may affect” designated critical habitat. This is our exposure analysis. We evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. We also consider how the action may affect designated critical habitat. This is our response analyses. We assess the consequences of these responses of individuals that are likely to be exposed to the populations those individuals represent, and the species those populations comprise. This is our risk analysis. The adverse modification analysis considers the impacts of the proposed action on the essential habitat features and conservation value of designated critical habitat.

Cumulative Effects (Section 12): Cumulative effects are the effects to ESA-listed species and designated critical habitat of future state or private activities that are reasonably certain to occur within the action area. 50 C.F.R. §402.02. Effects from future Federal actions that are unrelated to the proposed action are not considered because they require separate ESA section 7 compliance.

Integration and Synthesis (Section 13): In this section we integrate the analyses in the opinion to summarize the consequences to ESA-listed species and designated critical habitat under NMFS’ jurisdiction.

Conclusion (Section 14): With full consideration of the status of the species and the designated critical habitat, we consider the effects of the action within the action area on populations or subpopulations and on essential habitat features when added to the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:

- Reduce appreciably the likelihood of survival and recovery of ESA-listed species in the wild by reducing its numbers, reproduction, or distribution, and state our conclusion as to whether the action is likely to jeopardize the continued existence of such species; or
- Appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species, and state our conclusion as to whether the action is likely to destroy or adversely modify designated critical habitat.

If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated critical habitat, then we must identify reasonable and prudent alternative(s) to the action, if any, or indicate that to the best of our knowledge there are no reasonable and prudent alternatives. See 50 C.F.R. §402.14.

In addition, we include an incidental take statement (Section 15) that specifies the impact of the take, reasonable and prudent measures to minimize the impact of the take, and terms and conditions to implement the reasonable and prudent measures. ESA section 7 (b)(4); 50 C.F.R.

§402.14(i). We also provide discretionary conservation recommendations that may be implemented by the action agency (Section 3.8). 50 C.F.R. §402.14(j). Finally, we identify the circumstances in which reinitiation of consultation is required (Section 17) 50 C.F.R. §402.16.

To comply with our obligation to use the best scientific and commercial data available, we collected information identified through searches of Google scholar, and literature cited sections of peer reviewed articles, species listing documentation, and reports published by government and private entities. This opinion is based on our review and analysis of various information sources, including:

- Information submitted by the Permits and Conservation Division and the applicant;
- Government reports (including NMFS biological opinions and stock assessment reports);
- NOAA technical memorandums; and
- Peer-reviewed scientific literature.

These resources were used to identify information relevant to the potential stressors and responses of ESA-listed species and designated critical habitat under NMFS' jurisdiction that may be affected by the proposed action to draw conclusions on risks the action may pose to the continued existence of these species and the value of designated critical habitat for the conservation of ESA-listed species.

3 DESCRIPTION OF THE PROPOSED ACTION

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies. The proposed action for this consultation is the Permits and Conservation Division's issuance of a scientific research permit pursuant to the requirements of section 10 of the ESA and the MMPA to the Oregon State University (Dr. Bruce Mate) (see Section 19).

The Permits and Conservation Division proposes to issue scientific research Permit No. 21585 to the Oregon State University (Dr. Bruce Mate) to study marine mammals in all U.S. and International waters worldwide including the Arctic, Atlantic, Indian, Pacific, and Southern Oceans (worldwide). The ESA-listed cetaceans targeted by the proposed research activities include the blue, fin, Western North Pacific population of gray, Arabian Sea DPS of humpback, Cape Verde Islands/Northwest Africa DPS of humpback, Central America DPS of humpback, Mexico DPS of humpback, Western North Pacific DPS of humpback, North Pacific right, Southern right, and sperm whales. Research methods include manned aerial surveys, vessel surveys, photo-identification, active and passive acoustics, focal follows, photography, behavioral observations, biological sampling (biopsy and sloughed skin), prey sampling, and tagging (partially- and fully-implantable). Biopsy samples will provide information regarding sex, genetics, stock structure, stable isotope ratios, toxicology, lipid composition, and pregnancy confirmation of sampled whales.

The purposes of the research activities are to: characterize the spatial and temporal distribution of whales throughout their range; identify migration routes, home ranges, and core areas of use; characterize foraging behavior; identify important habitat; and characterize ecological relationships to help explain whale movement patterns, and opportunistically study pinnipeds and other cetaceans encountered during whale research. These activities will contribute to NOAA's Recovery Plans for various whale species, including blue, fin, humpback, North Pacific right, and sperm whales. The researchers propose specific hypotheses that will test whether: (1) whale movements and behavioral characteristics are correlated with physical and biological oceanographic conditions, time of day, geographic location, and prey distribution; (2) different age/sex classes within the same species exhibit different movement patterns and behavioral characteristics; (3) migratory routes and destinations are consistent from year to year. Data collected during the proposed research activities will assist the researchers in understanding whales' critical habitat requirements and determining how often whales are exposed to anthropogenic activities. The major components of the research activities are funded by the Cooperative Ecosystem Studies Unit of the U.S. Navy, HDR, Inc., and Oregon State University. The research activities will occur throughout the year (weather permitting), and when logistically feasible for the duration of the five-year permit. The permit expires five years after the date of issuance, but may be extended for up to one year per Federal regulation (50 C.F.R. §216.39). The number of proposed annual takes for ESA-listed species is broken down by species in Table 2.

Table 1. Summary of research methods for Permit No. 21585.

Proposed Research Method	Permit No. 21585
Aerial Surveys – Manned Aerial Surveys	Yes
Aerial Surveys – Unmanned Aircraft Systems	No
Vessel Surveys	Yes
Photo-Identification	Yes
Photogrammetry	No
Underwater Photography and Videography	No
Behavioral Observations	Yes
Focal Follows	Yes
Acoustics – Playbacks	No
Acoustics – Prey Mapping	Yes
Passive Acoustics	Yes
Biopsy Sampling	Yes
Breath Sampling	No
Fecal Sampling	No

Prey Sampling	Yes
Sloughed Skin Sampling	Yes
Partially-Implantable (Dart/Barb)Tagging	Yes
Fully-Implantable Tagging	Yes
Suction-Cup Tagging	No
Export/Import	Yes

Table 2. Proposed permitted annual take for Endangered Species Act-listed species under Permit No. 21585.

Species	Life Stage	Number of Takes*	Takes Per Animal Per Year	Procedures	Details
Bearded seal (Beringia and Okhostsk DPS)	All	20	1	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
Guadalupe fur seal	All	100	1	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
Hawaiian monk seal	All	100	1	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
Ringed seal (Ladoga, Saimaa, Arctic, Baltic, and Okhostsk DPS)	All	20	1	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
Spotted seal (Southern DPS)	All	20	1	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
Steller sea lion	All	40	1	Incidental disturbance; Observation, monitoring; Observations,	

Species	Life Stage	Number of Takes*	Takes Per Animal Per Year	Procedures	Details
				behavioral; Photograph/Video	
Beluga whale (Cook Inlet DPS)	All	400	1	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
Blue whale	Non-neonate	48	4	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year.
Blue whale	All	300	12	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.
Blue whale	Adult	20	1	Collect, sloughed skin; Import/export/receive, parts; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	
Blue whale	Non-neonate	2	4	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument,	Up to 2 individuals may receive 2 tag types per year.

Species	Life Stage	Number of Takes*	Takes Per Animal Per Year	Procedures	Details
				implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	
Bowhead whale	All	50	1	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
False killer whale (Main Hawaiian Islands Insular DPS)	All	300	1	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
Fin whale	Adult/Juvenile	48	4	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year.
Fin whale	Adult	20	1	Collect, sloughed skin; Import/export/receive, parts; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	

Species	Life Stage	Number of Takes*	Takes Per Animal Per Year	Procedures	Details
Fin whale	All	300	12	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.
Fin whale	Adult/Juvenile	2	4	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Up to 2 individuals may receive 2 tag types per year.
Gray whale (Western North Pacific population)	Adult/ Juvenile	6	1	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year. Not to exceed 20 individuals of the life of the permit.
Gray whale (Western North Pacific population)	All	200	12	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.

Species	**Life Stage**	**Number of Takes***	**Takes Per Animal Per Year**	**Procedures**	**Details**
Humpback whale (Range-wide)	Adult/ Juvenile	48	4	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year.
Humpback whale (Range-wide)	Adult	20	1	Collect, sloughed skin; Import/export/receive, parts; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	
Humpback whale (Range-wide)	All	500	12	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.
Humpback whale (Range-wide)	Adult/ Juvenile	2	4	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Up to 2 individuals may receive 2 tag types per year.

Species	Life Stage	Number of Takes*	Takes Per Animal Per Year	Procedures	Details
Killer whale (Southern Resident DPS)	All	50	1	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
North Pacific right whale	Adult/ Juvenile	5	1	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year. Not to exceed 15 individuals of the life of the permit.
North Pacific right whale	All	100	12	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.
Southern right whale	All	300	12	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.
Southern right whale	Adult/ Juvenile	48	4	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag);	Only one tag per individual per year.

Species	Life Stage	Number of Takes*	Takes Per Animal Per Year	Procedures	Details
				Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	
Southern right whale	Adult/ Juvenile	2	4	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Up to 2 individuals may receive 2 tag types per year.
Southern right whale	Adult/ Juvenile	20	4	Collect, sloughed skin; Import/export/receive, parts; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	
Sei whale	All	50	1	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
Sperm whale	Adult/Juvenile	48	4	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id;	Only one tag per individual per year.

Species	Life Stage	Number of Takes*	Takes Per Animal Per Year	Procedures	Details
				Photograph/Video; Sample, skin and blubber biopsy	
Sperm whale	Adult/ Juvenile	20	1	Collect, sloughed skin; Import/export/receive, parts; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	
Sperm whale	All	300	12	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.
Sperm whale	Adult/ Juvenile	2	4	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Up to 2 individuals may receive 2 tag types per year.

*Takes = the maximum number of animals, not necessarily individuals, that may be targeted for research annually for the suite of procedures in each row of the table.

3.1 Proposed Activities

The proposed research activities will occur in all U.S., international, and foreign waters worldwide including the Arctic, Atlantic, Indian, Pacific, and Southern Oceans. These activities include a variety of research methodologies that will take place for the duration of the permit (see Table 1), including manned aerial surveys, vessel surveys, documentation via video and photographic identification, behavioral observations, focal follows, active acoustics (prey mapping), passive acoustics, biological sampling (sloughed skin, prey), biopsy sampling, and tagging (partially- and fully-implantable tags). Due to the nature of field work, multiple objectives can be achieved at the same time using a combination of research methods. These research activities will be directed towards a particular target animal or group of animals and are described in more detail below. In addition, non-target animals in the action areas may be unintentionally disturbed during these research activities. The combination of aerial surveys, vessel surveys, biological sampling (e.g., genetic analysis of tissue samples), and tagging studies (analysis of movement patterns) will add important depth and breadth to the understanding of impacts from anthropogenic activities and other aspects of cetacean life history.

3.2 Aerial Surveys

The proposed research activities will include aerial surveys using manned aircraft under Permit No. 21585. Aerial surveys will take place year-round as needed for all cetacean species, subject to aircraft and funding availability. These surveys will be used to conduct transects and locate marine mammals more efficiently than by boat. Aerial surveys will be conducted from a single or twin engine airplane. Aerial surveys will also be conducted to assist research vessels in locating target individuals. Photographs and behavioral observations will be conducted during aerial surveys. The airplane will target an individual or group of animals and then circle or otherwise maintain visual contact until the research vessel arrives (which may be up to one hour later). The aircraft will fly at an altitude of approximately 150 to 300 meters (492.1 to 984.3 feet). Over the course of the field season, an individual or group of animals may be overflown during aerial surveys multiple times. Aerial surveys will not be flown over pinnipeds hauled out on land.

3.3 Vessel Surveys, Close Approaches, and Documentation

Vessel surveys are the primary means by which cetacean researchers collect data on cetacean species as they provide a platform for researchers to collect a wealth of information on cetacean biology. Here we describe the proposed vessel surveys and associated close approaches more generally and then in each section below, detail the individual research activities that will follow close approaches.

Under Permit No. 21585, the Oregon State University will conduct vessel surveys for photo-identification and behavioral observations as well as biological sampling and tagging of target individuals. The vessel surveys are typically conducted from small rigid-hull inflatable or fiberglass hull research vessels that are less than or equal to approximately 8 meters (26.2 feet) long. Animals would be approached laterally and/or from behind using the minimum speed required to close the distance with the target individual or group.

Photographic-identification, behavioral observations, and focal follows (including post-tag monitoring) will be conducted during vessel surveys at a distance of 5 to 15 meters (16.4 to 49.2 feet).

3.3.1 Documentation (Videography and Photography)

The proposed research activities will include video documentation and photographic identification under Permit No. 21585. These activities will be used to identify individual whales and document tag deployment and attachment. Photographic identification (photo-identification) is a widely used method for identifying individual cetaceans, allowing researchers to track individuals, monitor reproduction and mortality, identify migrations, follow age and sex-dependent behavior and habitat use patterns, and monitor health (Hammond, Mizroch et al. 1990). Photo-identification also allows researchers to determine if anthropogenic risk varies by age and/or reproductive class (Van Der Hoop, Moore et al. 2013), which helps inform protected species management. Still photos will be taken with digital SLR cameras with telephoto lenses (up to 300 millimeters) and digital video cameras with high shutter speeds (>1/1000 of a second) will be used for video documentation. All images will be labeled with the date and location of collection, tag number, species name, age class and sex, and stored on computers as well as back-up external hard drives. Identification photographs will be shared with collaborators maintaining identification catalogues for those species. The optimal approach distance for photographic identification is 10-15 meters. If a whale is suspected to have been previously tagged (by having a scar in a position where we typically attach tags), the animal may be approached to a distance as close as 5 meters to adequately document wound healing. For some species, photographs of both right and left sides would be conducted, entailing at least an approach, a retreat, and a re-approach. Approaches for photo-identification generally last from a few minutes to an hour.

3.3.2 Behavioral Observations

Direct behavioral observations of cetaceans provide a wealth of information on their biology and important information needed by managers to effectively conserve and protect these species (see Mann 1999, Nowacek, Christiansen et al. 2016 for reviews). When combined with tagging data, these observations provide detailed information on both the surface and underwater behavior of cetaceans (Nowacek, Christiansen et al. 2016).

Under Permit No. 21585, behavioral observations will occur concurrently with other research activities including photo identification, focal follows, biopsies, and tagging. Researchers will document whether target or non-target species exhibit behaviors such as quick dives, tail flicks, head lifts, fluke lifts, fluke slaps, rolling, defecation, or combinations of these responses during the proposed research activities.

3.3.3 Focal Follows

Under Permit No. 21585, focal follows before or after tagging attempts may be conducted, largely from a distance that would not disturb individuals (10-200 meters). Total time in association with a target individual or group may be up to several hours. During this time, photographs, video, and behavioral observations may be taken/recorded to document tag locations on individual animals and any reactions exhibited by the animals.

3.4 Acoustics

The proposed research activities will include active prey mapping (echosounders) and passive acoustic monitoring (towed acoustic arrays, directional hydrophones, and acoustic tag dosimeters) under Permit No. 21585.

3.4.1 Active Acoustics – Prey Mapping

Recent advances in cetacean tagging technologies, combined with scientific echosounders used to map prey abundance, have provided unprecedented data on predator-prey relationships among large whale species (e.g., Friedlaender, Hazen et al. 2009, Hazen, Friedlaender et al. 2009).

Under Permit No. 21585, the Oregon State University will conduct prey mapping using echosounders. These echosounders may be single or split-beam, using 38 kiloHertz, 70 kiloHertz, and 120 kiloHertz signals with pulse durations ranging from 0.06 – 4.10 milliseconds. Received levels of sound will be less than 180 decibels re 1 microPascal at 1 meter (root mean square). There is a potential for lower frequency and lower received level components to be audible to marine mammals. The signals used for imaging prey fields will likely be highly directional and the ensonified zone of the water column will be narrow and spatially limited. Also, the total exposure time will be short and is calculated as the product of the pulse duration, pulse rate frequency, and total time that an individual will be exposed in the beam.

3.4.2 Passive Acoustics – Towed Arrays, Hydrophones, Dosimeters

Under Permit No. 21585, the Oregon State University will conduct passive acoustic recordings using towed hydrophone arrays and hand-held directional hydrophones. Passive acoustic monitoring is used to detect, localize, identify, and track animals. The hydrophone arrays will be deployed and towed behind a moving research vessel while hand-held hydrophones would be deployed over the side of the research vessel. The hydrophone array may be up to approximately 400 meters (1,312.3 feet) in length and towed at depths up to approximately 600 meters (1,968.5 feet). Environmental conditions (e.g., wind, tide, currents) as well as the behavior of the animals will dictate how the research vessel is maneuvered in order to position the towed hydrophone array to detect and localize animal vocalizations. Generally, the hydrophone array is towed off to the side or behind the animals. The duration of the encounter with target animals will vary based on behavior, day length, and environmental conditions.

In addition, recoverable tags may be equipped with an acoustic dosimeter to passively record marine mammals. These dosimeters will measure received sound levels in five 5-decibel (dB) ranges, each of which can be defined with different frequency bands and duration criteria. The frequency bands and duration criteria will be chosen so as to allow reception of both anthropogenic and whale-generated sounds.

3.5 Biological Sampling

The proposed research activities will include biopsy, prey, and sloughed skin sampling under Permit No. 21585. Biological samples will be archived and analyzed at Dr. Scott Baker's

Cetacean Conservation and Genomics Laboratory (CCGL) at the Oregon State University's Marine Mammal Institute (OSUMMI) in Newport, Oregon.

Skin and blubber samples may be taken as biopsies or sloughed skin from each tagged whale, for sex and reproductive condition determination, genetic analysis, stable isotope analysis, toxicology, and lipid content. Towed nets may be used to assess prey species and abundance.

3.5.1 Biopsy Sampling

Biopsy sampling is a widely used method for obtaining skin and blubber tissue from cetaceans for use in studies on genetics, contaminants, disease, foraging ecology, reproduction, and other physiological and biological processes (reviewed in Noren and Mocklin 2012).

Under Permit No. 21585, biopsy samples will primarily be collected through the deployment of a biopsy dart from a 120 pound recurve crossbow at distances typically no closer than 5 meters (if a biopsy is not obtained during the tagging approach). No more than three attempts to collect a biopsy sample will be conducted per day. Ideally, the biopsy will be obtained during the same surfacing as the tag deployment. If a biopsy sample is not obtained during tag deployment, the tagged whale may be approached again to obtain a biopsy. The biopsy consists of a small plug of tissue (6 mm x 40 mm) from the whale's back using a dart with a sterilized coring tip (Ceta-Dart, Denmark). The coring tips are heat sterilized to remove pathogens and genetic material with a butane or propane torch for 30 seconds before being attached to the dart, and then wrapped in tin foil prior to being placed in the crossbow. Used biopsy tips are cleaned with soap and water and heat sterilized again prior to re-use. Surgical gloves are worn during these procedures. The dart is free-floating and is retrieved immediately after sampling. Samples are preserved in vials containing ethanol and labeled with the date and location of collection, tag number, species name, age class, and sex, if known. At the conclusion of each field season, samples are sent for analysis to laboratories (such as Dr. Scott Baker's CCGL) specializing in genetic techniques appropriate for each species. Samples may be shared with collaborators who have other institutional needs.

Researchers may biopsy sample adults and juvenile animals of both sexes over one year of age, except for blue whales, which may be biopsy sampled at approximately six months of age and longer than 10 meters (32.8 feet) in length. A maximum of 50 biopsy samples will be authorized for most cetacean species per year. Researchers will biopsy sample up to five North Pacific right whales and six Western North Pacific population of gray whales each year. The research vessel will approach target animals within 50 to 100 meters (164 to 328.1 feet) several times; however, the scientific research permit will limit effort to no more than three attempts each to biopsy sample a target animal per day. Researchers may biopsy sample tagged animals two additional times per year (three total biopsy samples per year) to help understand wound healing and tag effects through lipid content analysis.

3.5.2 Prey Sampling

Under Permit No. 21585, the Oregon State University will deploy towed otter trawls or bongo nets (up to 60 centimeters [23.6 inches] in diameter) to sample prey species within 50 to 100 meters (164 to 328.1 feet) of a foraging whale. Visual observations will be conducted from the towing vessel to ensure protected species (including turtles) do not come in contact with the nets. The researchers will use small (up to 60 centimeter diameter) bongo nets or otter trawls that will be easy to recover if protected species are observed near the nets.

3.5.3 Sloughed Skin Sampling

Under Permit No. 21585, the Oregon State University will opportunistically collect sloughed skin samples at the water's surface using dip nets during research activities. Sloughed skin collection may occur after whales have vacated the area or while whales are approached and tagged. Collecting sloughed skin would therefore not necessarily involve close approach. These samples may be used for genetic analyses, which can be used to examine population dynamics, including structure of sub-populations or stocks. However, such samples are often not useful for some species (e.g., sperm whales) as the DNA in sloughed skin has deteriorated.

Genetic variability dispersal patterns, and social structure may indicate if animals, or groups of animals, are more readily exposed to potentially harmful underwater noise, construction activities, or vessel traffic. Other molecular techniques can assess reproductive status, physiological stress, exposure to toxins, prey consumption, or can reveal if animals are more susceptible to, or directly impacted by short- or long-term exposure to human activity (cortisol levels suggestive of a stress response).

3.6 Tagging

Recent advances in tagging technologies have provided unprecedented detail on cetacean biology, allowing researchers to better understand their physiology, foraging, ranging, diving, and sociality, and have improved efforts to protect and conserve these species (Nowacek, Christiansen et al. 2016).

The proposed research activities will include a variety of tags and transmitter attachments under Permit No. 21585, depending on the specific objectives of the study and the development of new and improved tagging technology. Research activities will include instruments such as non-recoverable Argos satellite-monitored long-duration tags (hereafter referred to as fully-implantable tags) and/or recoverable Argos-linked Fastloc GPS/TDR intermediate-duration tags (hereafter referred to as partially-implantable tags). The non-recoverable tag is almost fully implantable, while the recoverable tag is only partially implantable. The latter tags may be equipped with an acoustic dosimeter. Tagging technology and design will improve as research needs evolve as well as to streamline in order to reduce drag as much as possible. Researchers will select the type of tag in consideration of the primary research objective and what will have the least impact on animals.

Data from satellite tags will provide information on finer-scale distribution patterns, migratory behaviors, and “home ranges” of local species. Researchers will gain information on breeding and feeding grounds, migratory routes, dive behavior, and movement related to prey distribution and oceanographic conditions. Monitoring the short-term and long-term movements of animals with tags will address questions related to distribution, habitat use, foraging ecology, and behavioral ecology. Spatial data from tags may inform behavioral response, potential exposure, and management (e.g., monitoring and mitigation) decisions for anthropogenic activities. On occasion researchers may deploy two tags of various types on the same animal in order to maximize data collection. No more than two tags will be deployed on the same individual at a given time. Whales may be tagged with a combination of one partially- and one fully-implantable tag.

Adults and juveniles greater than 10 meters in length, of both sexes will be tagged, including females with calves of any age. Calves will not be tagged with the exception of blue whales. Blue whale calves older than 6 months or longer than 10 meters in length are big enough to accommodate a tag and therefore will be included. The researchers are striving to obtain long-term movement and dive information on mothers with younger calves to determine how mothers and calves use their reproductive areas, as this is important information regarding their exposure to anthropogenic activities in these areas and can identify special areas used by this group. The researchers are also interested in where mother/calf pairs go when they leave these areas and what routes they take. The researchers will attempt to tag equal proportions of adults/juveniles/ and males/females. Multiple candidate whales may be approached before a tag is successfully applied.

Each tagged whale may also be biopsied resulting in potentially three Level A takes per animal, should all three procedures occur on separate days annually. For most species, it may be necessary to maintain close proximity to individual animals for a period up to one hour (longer for sperm whales due to their long dive durations) to assure appropriate positioning before tag application and for identification photographs. Tagged whales will be re-approached for subsequent close-range behavioral observation, tag assessment, and the evaluation of wound healing and tag effects. This post-tagging monitoring may result in tagged whales being approached multiple times annually. Tagged whales may also be biopsy sampled up to two more times per year (but not in the same month) if resighted, to improve our understanding of wound healing and tag effects through lipid content analysis. This may result in an additional two Level A takes for those individuals. No individual animal will experience more than four Level A takes annually. Biopsy sampling of tagged animals will occur at the same time as or immediately after tagging. After an animal is tagged, researchers will conduct focal follows with photography and videography to document tag location, behavioral observations, and monitor for tag detachment (for partially-implantable tags).

Tagging will take place during approaches in small (usually <8 m) boats (either rigid-hulled inflatables or fiberglass hulls). Approaches to whales would be limited to tagging/biopsy darting, photo-identification and photo-documentation of tag attachment, and behavioral observations. Animals may be approached as closely as 1 meter for tagging, with approaches typically no closer than 5 meters for biopsy-darting (if biopsy is not obtained during the tagging approach), photography, and observation. Approaches usually occur from behind and to one side of the whale. Whales would not intentionally be approached head on. During tag deployment, the vessel speed would be slightly greater than the whale's speed in order to catch up to the whale and position the tag. Individual whales would typically be closely approached once to deploy a tag, but in some cases two or three “tagging approaches” may occur for successful tag deployment. All satellite tags would be applied using a modified air-powered line-thrower, similar to the system designed by Heide-Jorgensen et al. (2001). A buoyant deployment shaft fits into the applicator barrel and holds the tag. The shaft separates from the tag after attachment and is usually recovered. Tags will be placed on the dorsal surface of the animals, typically just below or forward of the dorsal fin/ridge/hump or, in the case of adult blue whales, up to approximately 5 meters in front of the dorsal fin.

Both tag types (fully- and partially-implantable) may be used on all species for which authorization is requested, with no more than four partially-implantable tags deployed per species per year. Table 3 provides a comparison of tag types. Future non-recoverable and recoverable tags may vary slightly in terms of materials, but will not exceed the size/weight of current tags.

Two tags may be deployed on the same animal at the same time, or on subsequent surfacings, perhaps even on subsequent days. Deploying two implantable tags on the same whale would offer complementary results and additional data on tag loss/failure in attachment durations. The fully-implantable tags yield long term tracking information, with medium-resolution dive information, whereas the partially-implantable tags yield shorter-term (4-8 weeks) tracking with high-resolution dive information, GPS-quality locations, and future acoustic recordings capabilities. The researchers anticipate double-tagging a maximum of two whales per species per year, although logistical and financial considerations will likely prevent the achievement of this maximum in most years and for most species. Only adult whales will be candidates for double-tagging. Both tags will be deployed on the same surfacing (same tagging approach) in most cases. Rarely a second tagging approach may be necessary to deploy the second tag.

All tags utilize the Argos Data Collection and Location service, whereby the tags' ultra-high frequency (UHF) radio transmissions are received onboard NOAA TIROS-N series weather satellites. When two or more messages are received during a single pass of a satellite, a location is calculated from the Doppler shift of the transmission frequency. This information, along with modest amounts of sensor information (up to 256 bits), is sent with each transmission and is then accessible via computer modem. The quality of Argos locations depends upon the number of messages received during a satellite pass and the time between these transmissions, with the best accuracy being within 150 meters. The recoverable tag also receives data from GPS satellites which are then used to calculate a location. This data is sent to the researchers via the Argos-transmitted message, with location accuracy generally within 60 meters. Transmissions have the best chance of successfully reaching a satellite receiver when a tag is positioned close to the midline of the whale's back, in an area that is above water for the longest period of time. In addition, Norman et al. (2017) showed a reduction in tag wound severity with placement of tags higher on a whale's back. Therefore, tags would be positioned close to one another high on a whale's back for both optimal satellite uplinks and decreased wound response.

Larger vessels (>30 m in length) may be used as support vessels and as a home base when far from shore. The smaller tagging vessel is launched from the larger vessel for day operations, but the two boats may work in tandem to locate whales for tagging or follow-up photographs and observation. The larger vessels will not intentionally approach whales closer than 10 meters.

Table 3. Comparison of the two tag types proposed in the application for Scientific Research Permit No. 21585.

	Non-recoverable Tag	Recoverable Tag
Attachment Method	Implantable ARTS applicator deployment	Partially implantable ARTS applicator deployment
fpSensors	ARGOS-quality locations Percent time at surface Temperature Dive duration Surface duration Dive depth Number of lunges per dive (processed from accelerometer data)	ARGOS-quality and GPS locations Dive depth Dive duration Surface duration Ambient sound Whale vocalizations Swim velocity Swim angle
Data Collection	Satellite download	Satellite download and recovered tag
Total Weight	300 g maximum	620 g
Anchoring system	Four double-edged blades mounted in one endcap, with or without 8 thin, outwardly curved wires (3.5 cm long, 0.9 mm gauge stainless steel) mounted behind the blades, and one or two rows of thin outwardly-curved metal strips (0.6 cm wide, 3.2 cm long) wrapped around the housing at the base of the blades	Four double-edged blades mounted in one endcap, with up to 8 thin, outwardly curved wires (3.5 cm long, 0.9 mm gauge stainless steel) mounted behind the blades, and one or two rows of thin outwardly-curved metal strips (0.6 cm wide, 3.2 cm long) wrapped around the housing at the base of the blades
Maximum Dimensions	2.1 cm diameter x 23.0 cm maximum length cylinder, 6.5 cm bladed endcap, 17.0 cm antenna	Tag - 2.0 cm diameter x 11.5 cm length cylinder with 10.0 cm diameter x 7.0 cm maximum height dome on one end Housing – 2.6 cm diameter x 14.5 cm length cylinder, 5.3 cm bladed endcap, 12.5 cm diameter circular plate

	Non-recoverable Tag	Recoverable Tag
Maximum penetration depth and tissue layer	29.5 cm for the 3-battery version, 20.4 cm for the 1-battery version, implanted into blubber or muscle - Tissue type is dependent on species, time of year, age and size of the animal	20.0 cm, implanted into blubber or muscle - Tissue type is dependent on species, time of year, age and size of the animal
Tag electronics duration/ Battery life	24 months for sperm whales. 18 months for baleen whales	8 weeks all species
Attachment duration	Up to 20 months for sperm whales, less for other species	Same as Tag electronics duration. Has been documented shedding in less than 8 weeks for most tags.

3.6.1 Partially-Implantable Tagging

The partially-implantable tag consists of a certified Argos transmitter and a Wildlife Computers Time-Depth Recorder (SPLASH-MK10), with a three-axis accelerometer and magnetometer, cast in an epoxy tube (2.0 centimeters in diameter and 11.5 centimeters long; Figure 1). A FastLoc® geographic positioning system (GPS) receiver, encased in syntactic foam (10.0-centimeter diameter dome with a maximum height of 4.0 centimeters), is attached to one end of the epoxy tube. Three red light-emitting diode (LED) lights are mounted on top of the syntactic foam to facilitate relocation of the tag (activated upon release of the tag from its housing). The tubular portion of the tag is slid into a cylindrical stainless steel tag housing (2.6 centimeters in diameter and 14.5 centimeters long) for deployment. A circular stainless steel plate, or collar, is welded onto the distal end of the housing to protect the syntactic foam during deployment. A penetrating tip and anchoring system, similar to that of the non-recoverable tags, is mounted onto the cylindrical end of the tag housing. The cylindrical portion of the tag housing is designed for implantation beneath the whale's skin while the plate and syntactic foam GPS receiver sit atop the whale's back. The partially-implanatable tag and housing weigh approximately 570 grams (approximately 340 grams for the tag and approximately 230 grams for the housing). A plastic "D-ring" is mounted on the bottom of the syntactic foam with a corrodible wire. This "D-ring" passes through a slot in the stainless steel plate and is secured on the backside of the plate with a screw. After a pre-determined, programmable time an electrical current is activated within the tag, oxidizing the corrodible wire, whereupon the tag is ejected from the housing and floats to the surface for recovery (Mate et al. 2017). To facilitate successful recovery, these tags are programmed to release from their housings after 3-4 weeks of attachment for long-ranging species like blue whales, despite the fact that the electronic life-span of the tags is approximately 8 weeks. Research cruises would last around one month, so setting release dates for the final week of the cruise would allow the researchers to spend the end of the cruise recovering tags that have not traveled out of the research vessel's range. Tags can be programmed to release after longer periods of attachment for species that have more predictable, short-range distributions within reach of day operations from shore. When a partially-implantable tag releases from its housing, either while still on a whale, or on the seafloor (if the housing comes off a whale prior to the tag's programmed release, both tag and housing will sink), it will float to the surface and begin transmitting every 60 seconds (compared to every 45 seconds prior to release) and the red LEDs will flash every 30 seconds. GPS locations are recovered via Argos to direct the researchers to the vicinity of the tag and a directional antenna would be used to pinpoint the tag's location. With the red LEDs, tags may be recovered more easily at night. The recovery rate was 77 percent for tags deployed on sperm whales in the Gulf of Mexico in 2013, and also 77 percent for tags deployed on blue and fin whales in California in 2014 and 2015. The recoverable tags have the researchers' contact information on them, which has been useful in the past when beachcombers have found tags washed ashore after releasing from their housings too far offshore for recovery.

The recoverable tags are programmed to collect a GPS-quality FastLoc® location every seven minutes or as soon thereafter as a whale surfaces from a dive. Dive depth is recorded every 1 second with 2-meter vertical resolution. Body orientation (from the accelerometer) and magnetic compass heading (from the magnetometer) are also recorded at 1-second intervals. These data are all archived onboard the tag and accessible when the tag is recovered. Qualifying dives (using user-programmable dive depth and duration values) are also summarized for transmission through the Argos system along with GPS locations recorded by the tag. Three dive summary histograms are created for qualifying dives during user-programmable daily summary periods. Histograms summarize percentage of time spent at different depths, maximum dive depths, and maximum dive durations. Separate summary messages (behavior messages) describing individual qualifying dives are also generated by recording dive duration, maximum dive depth, dive shape (U-, V-, or square-shaped- and whether the U- or V-shaped dives were skewed right, left or centered), and the subsequent surfacing duration. Up to four consecutive summarized dives are transmitted in each behavior message. A single message from the tag can send either one GPS location, one histogram summary, or one behavior message (summarizing four dives).

Anticipated life expectancy of the recoverable tag is adjustable depending on the duty cycle, but will not nearly approach the longevity of the non-recoverable tag because of the increased energy demands of GPS acquisition, and increased hydrodynamic drag on the un-implanted portion. With the tag running continuously, the researchers should know the precise location of every surfacing, but they expect the electronic longevity to be approximately 8 weeks. The housing itself will also ultimately be shed from the animal after a shorter period of time than for non-recoverable tags because of the additional drag on the circular plate portion. Shedding of this tag housing has been documented by the researchers for 19 recoverable tags (13 on sperm whales, 4 on fin whales, 2 on blue whales) based on abrupt loss of transmissions before the tag reached the expected end of battery life, which signified the tag and its housing had come off and sunk to the seafloor. This has been confirmed in the depth record retrieved from the tag upon recovery. The attachment duration for these tags ranged from 0.7 to 34.2 days. Shedding of the recoverable tag housing has also been documented for five sperm whales that were resighted during the tagging field effort, from 4 to 59 days after tagging. An additional five sperm whales were resighted during subsequent year(s) field efforts, showing loss of tag housings from 289 to 407 days after tagging. Tag housings were likely shed much earlier than these latter resightings, but this could not be confirmed by the researchers.

Future development of the recoverable tag may include the addition of a thumb-sized acoustic dosimeter which will measure received sound levels in five 5-decibel ranges, each of which can be defined with different frequency bands and duration criteria. The frequency bands and duration criteria would be chosen so as to allow reception of both anthropogenic and whale-generated sounds. Like the TDR data, dosimeter data would not be relayed via Argos, but would be archived for downloading after tag recovery. The addition of a dosimeter would add approximately 2.6 centimeters of height to the syntactic foam dome and approximately 50 grams to the total weight of the GPS tag (for a total tag plus housing weight of 620 grams).

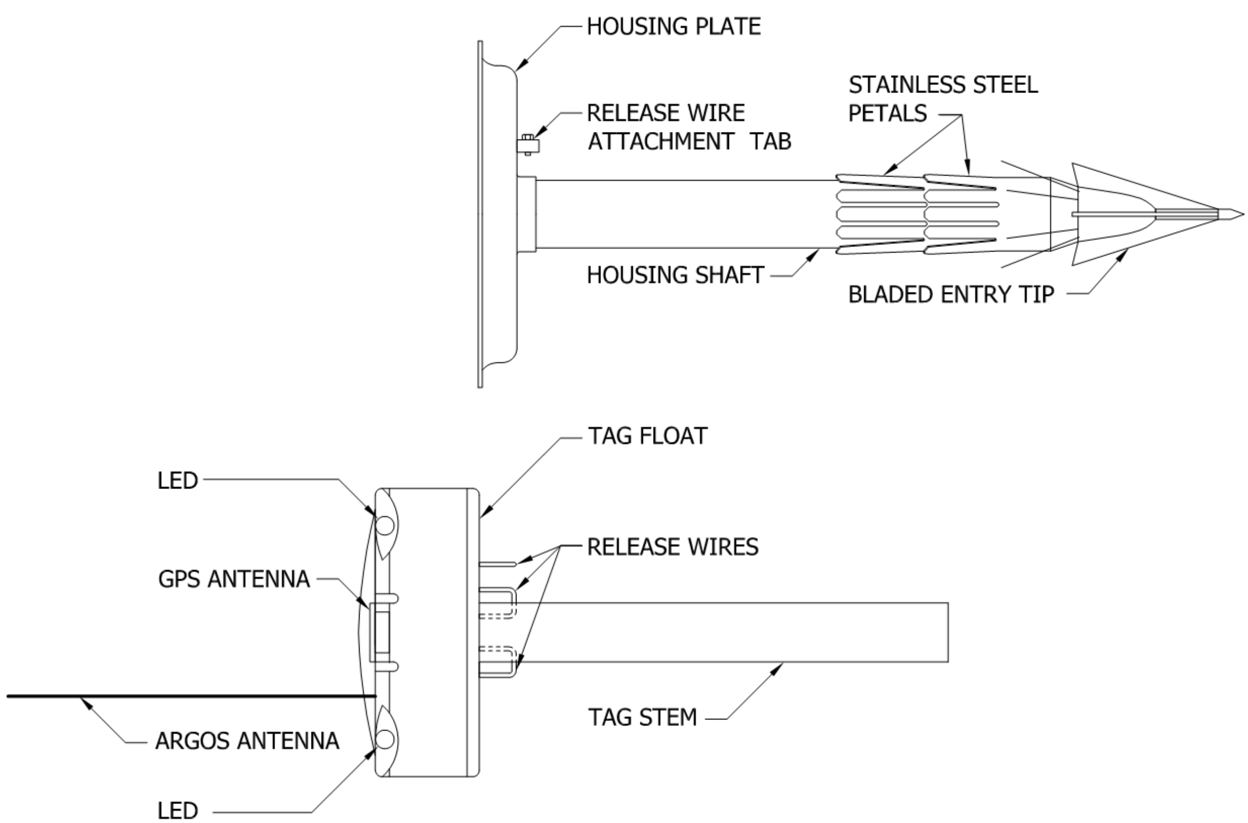

Figure 1. Schematic diagram of the Wildlife Computers partially-implantable (recoverable) tag with the OSUMMI-designed housing. The housing shaft is designed for implantation beneath the animal's skin while the plate and tag float sit atop the animal's back.

3.6.2 Fully-Implantable Tagging

The non-recoverable tags are composed of a main body, a penetrating tip, and an anchoring system (Figure 2 and Figure 3). The main body consists of a certified Argos transmitter (either Wildlife Computers SPOT or Telonics ST-27) housed in a stainless-steel cylinder (2.1 centimeter maximum diameter × 23.0 centimeter maximum length) and deploys to a depth of 29.5 centimeters. A flexible whip antenna and a saltwater conductivity switch are mounted on the distal endcap of this cylinder, while a penetrating tip is screwed onto the other end. The distal endcap has two perpendicular stops (0.83 centimeter maximum thickness) extending approximately 1.5 centimeters laterally to prevent tags from embedding too deeply on deployment or from migrating inward after deployment. In the Wildlife Computers tags, the distal endcap, and stops are made of stainless steel, while the Telonics endcap and stops are made of polycarbonate material. Endcap and stop dimensions are not significantly different between the two manufacturers. The penetrating tip consists of a Delrin® nose cone, into which is pressed a ferrule shaft with four double-edged blades. The ferrule is secured in place with a set screw through the nosecone and ferrule shaft. The anchoring system consists of two or three rows of outwardly curved metal strips mounted on the main body at the nose cone (proximal) end. Maximum tag weight is 300 grams in air. Tag cylinders are partially coated with a broad-spectrum antibiotic (gentamicin sulfate, 2.5 grams per tag) mixed with a long-dispersant methacrylate. This allows for a continual release of antibiotic into the tag site for a period of up to 5 months (Mate et al. 2007). These tags are designed to be almost completely implantable (maximum depth of 29.5 centimeters), except for the perpendicular stops, antenna and saltwater switch, and are ultimately shed from the whale due to hydrodynamic drag and the natural migration of foreign objects out of the tissue (Mate et al. 2007). The researchers wish to deploy tags beyond the blubber/muscle interface for longer duration attachment. Only whales that are in good body condition (no post-cranial depression, no visible scapula, no depression along the dorsal surface of the lateral flanks) will be targeted.

Shorter tags of the same diameter as the current non-recoverable tag have one or two batteries instead of three, with minimum penetration depths of 20.4 centimeters. With fewer batteries, the latter two versions have shorter electronic lifespans than the three-battery tag using the same transmission schedule. However, battery life of the shorter tags can be prolonged by setting daily transmission limits and not transmitting every day. These shorter tags may be used on species with shallower blubber/muscle interface depths. The researchers aim to implant a tag to a depth at which the anchor petals would deploy just below the blubber-muscle interface. When held flush to the tag housing, one row of anchor petals extends to 11.4 centimeters from the tip of the tag's bladed nosecone. Thus the researchers would need to implant a tag at least 11.4 centimeters beyond the blubber-muscle interface to engage the anchors in the desired spot.

In addition to providing transmissions for location calculation, the Wildlife Computers fully-implantable tag reports the percentage of time in user-specified temperature ranges and the percentage of the day the tag is above water. Life expectancy of the electronics of the Wildlife

Computers fully-implantable tag is adjustable depending on the transmission duty cycle. With the typical baleen whale duty cycle, electronic life expectancy is 18 months. Sperm whale tags are programmed to last 24 months. However, tags may be shed sooner, or they may stop functioning due to electronic failure while still attached to a whale. Tracking durations are longest for sperm whales, averaging 165 days with a maximum of 607 days. The maximum tracking duration to date for a blue whale is 513 days, with an average duration of 92.3 days. Attachment durations are shortest for humpback whales, with an average of 34.6 days and a maximum of 220 days.

The Telonics non-recoverable tag generates Argos locations similar to the Wildlife Computers non-recoverable tag and also incorporates a pressure sensor and tri-axial accelerometer, so it is able to record dive depth, duration, body orientation, and motion while attached to a whale. Electronic life expectancy of Telonics non-recoverable tags is less than that of Wildlife Computers non-recoverable tags due to the extra power consumption of the additional sensors and more onboard processing time to organize the more complicated messages. These tags are programmed to last approximately 100 - 150 days, although longer durations can be obtained by having duty cycles that do not report daily.

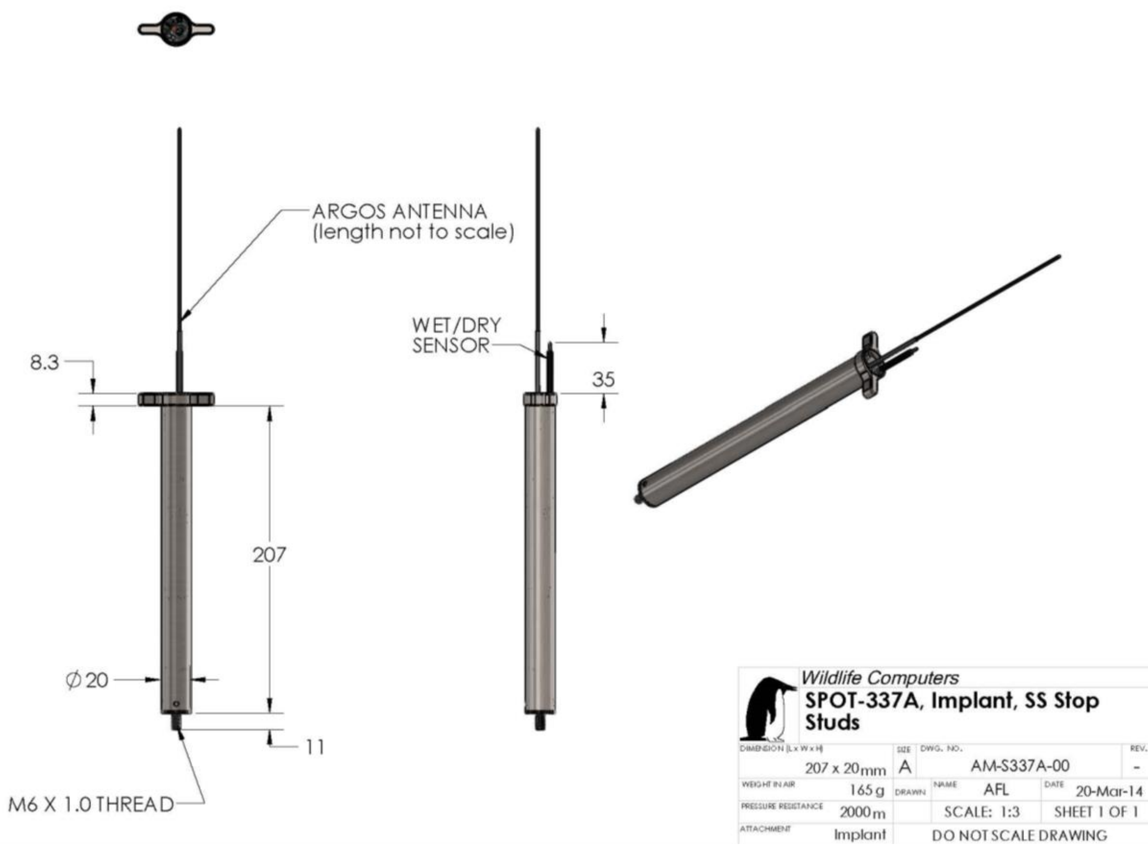

Figure 2. Schematic diagram of the Wildlife Computers fully-implantable (non-recoverable) tag (SPOT transmitter) showing the main body and the distal endcap with the antenna and saltwater conductivity switch.

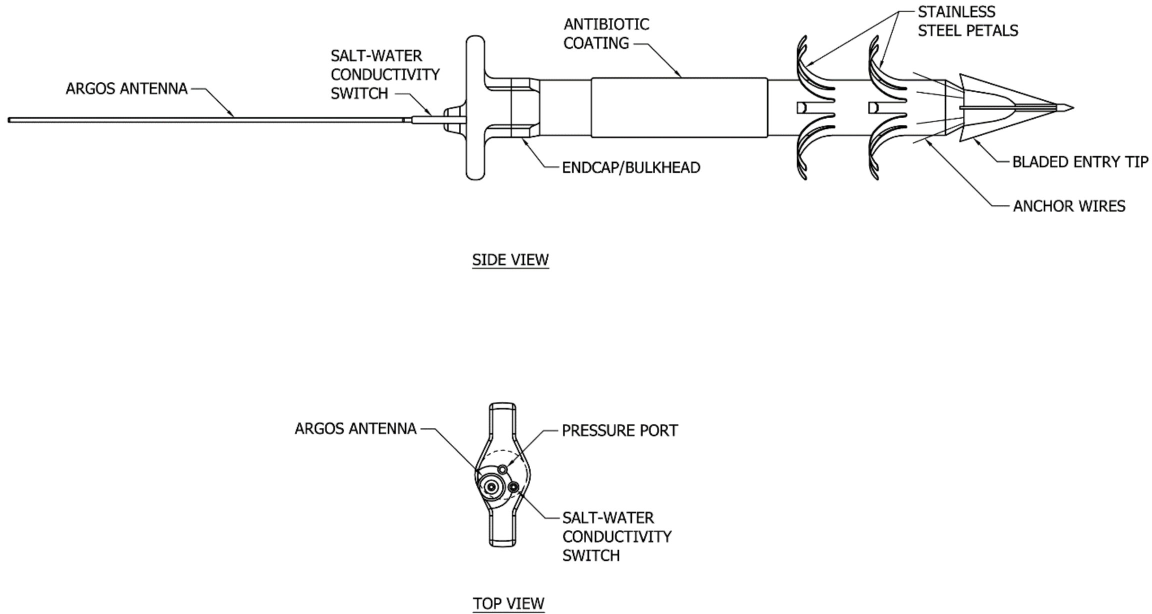

Figure 3. Schematic diagram of the Telonics fully-implantable (non-recoverable) tag (ST-27 transmitter) showing the main body, the distal end with the antenna, and saltwater conductivity switch endcap as well as the penetrating tip and anchoring system.

3.7 Export and Import

Activities requested under Permit No. 21585 include the tagging of whales in international waters. During the 5-year period of this permit, tagging projects may be conducted in foreign countries, under authority of foreign permits. Both situations may result in the need to import cetacean parts, including skin and blubber from biopsies or sloughed skin sampling, into the United States (numbers not to exceed the number of whales tagged in those research projects). In both cases, biopsy samples would be obtained from tagged whales with a remotely-deployed dart in the same manner described above. Samples will be hand-carried into the U.S. by research staff at the conclusion of the field season, or will be mailed into the country. If analytical needs could not be met by a genetics laboratory in the U.S., the researchers would request authorization to export (and re-export samples that have been imported) biopsy samples to appropriate laboratories in foreign countries. CITES import, export, or introduction from the sea permits would be obtained as required.

3.8 Conservation Measures

The Permits and Conservation Division's proposed action requires mitigation measures to minimize potential adverse effects of the proposed research activities. They were considered throughout our *Exposure and Response Analysis* (Section 11.2). Mitigation measures to minimize effects are also included in the Oregon State University's permit applications and are further described below:

-Approaching animals from boats or aircraft with care so as not to unduly stress the animals, and terminating approaches if animals exhibit avoidance behaviors and/or “acute behavioral responses” (i.e., repeated, prolonged, or excessive instances of disturbance or disruption of normal behavior patterns);

-Cautiously approaching mother/calf pairs to prevent separation or stress, not maneuvering between a mother and calf, and terminating efforts if there is any evidence that our activity is interfering with pair-bonding or nursing;

-Conducting visual observations for non-target species including during net tows for prey sampling;

-Conducting prey sampling tows with small, easily retrievable otter trawls or Bongo nets to minimize the possibility of capturing protected species;

-Not tagging cetaceans that appear emaciated;

-Utilizing tags designed to penetrate cetacean tissue at depths recommended by veterinarians;

-Applying tags high on the cetacean’s back and close to the dorsal midline, to minimize impacts on vital organs;

-Sterilizing biopsy darts and tags and coating subdermal portions of tags with a broad-spectrum antibiotic to reduce the risk of infection; and

-Coordinating research activities with other permit holders to minimize repeated harassment of target species.

The draft permit contains updated permit conditions (see Section 19) to minimize the impacts of fully-implantable tags. These include requirements to avoid tagging animals in poor health (e.g., reduction in body mass, excessive skin lesions, behaving abnormally, or known immunocompromised animals). In addition, the permit includes new conditions that require the applicant to conduct post-tag monitoring of any tagged animals re-sighted to monitor for adverse effects of tagging, tag breakage, and changes to tagged animals fecundity or survival.

As detailed above, the Permits and Conservation Division will require that individuals conducting the research activities under both permits possess qualifications commensurate with their roles and responsibilities. In accordance, the only personnel authorized to conduct the research activities will be the Principal Investigators at the Oregon State University as well as Co-Investigators listed in the permit applications, and research assistants. We anticipate that requiring that the research activities be conducted by experienced personnel will further minimize impacts to the ESA-listed cetaceans that may be exposed to stressors, as these individuals should be able to recognize adverse responses and cease or modify their research activities accordingly.

4 INTERRELATED AND INTERDEPENDENT ACTIONS

Interrelated actions are those that are part of a larger action and depend on that action for their justification. *Interdependent* actions are those that do not have independent utility apart from the action under consideration. For this consultation, we consider all vessel transit associated with research activities as interdependent. Thus, we evaluate the effects of vessel transit on ESA-listed species and so include all water traversed during such transits as part of the action area.

5 POTENTIAL STRESSORS

There are several potential stressors that we expect to occur because of the proposed actions resulting from the issuance of Permit No. 21585. The potential stressors include pollution, vessel strike, vessel noise, gear entanglement, aerial surveys, vessel surveys, active acoustics (prey mapping), close approaches, biological sampling, and tagging. These potential stressors are evaluated in detail in Section 11.

6 ACTION AREA

Action area means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 C.F.R. §402.02).

The action area for Permit No. 21585 includes all U.S. and International waters worldwide including the Arctic, Atlantic, Indian, Pacific, and Southern Oceans. Figure 4, Figure 5, and Figure 6 include areas where most, but not necessarily all, research activities will occur. Under Permit No. 21585, research activities within the action area will occur throughout the year, weather permitting and when logistically feasible, for the duration of the permit.

The proposed duration of the scientific research permits is five years. In accordance with Federal regulations (50 C.F.R. §216.39), the duration of a permit may be extended for up to one year via a minor amendment to allow uninterrupted continuation of research if a new five-year permit application has been received and is in-process. In such cases, no additional takes will be authorized during the extension; any takes that were allocated for the fifth year of the permit that were not used may be used during the extension. Thus, the annual takes proposed in the draft permit may be extended for use over a six-year period.

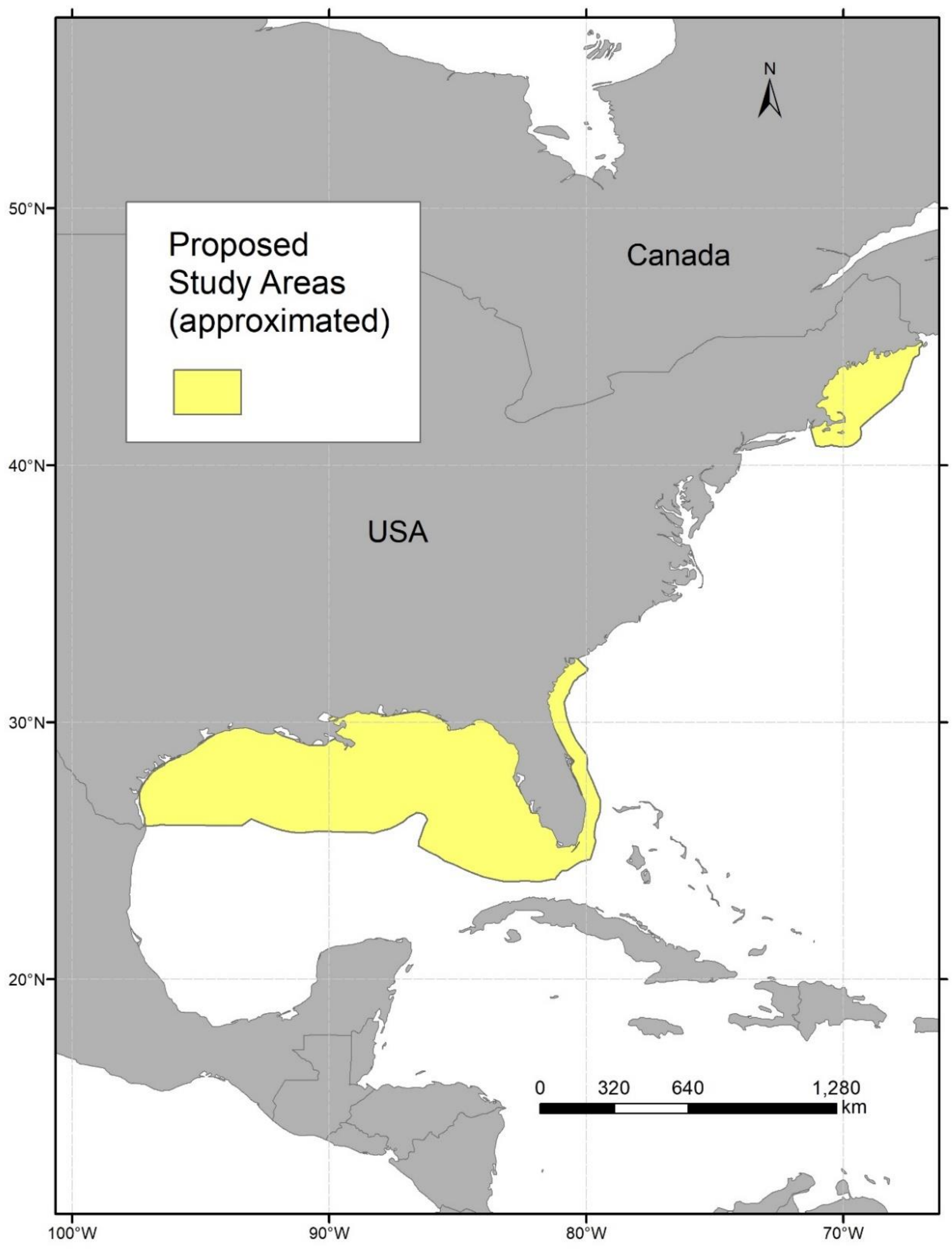

Figure 4. Map of the approximate study areas in United States waters of the Atlantic Ocean and Gulf of Mexico for proposed Permit No. 21585.

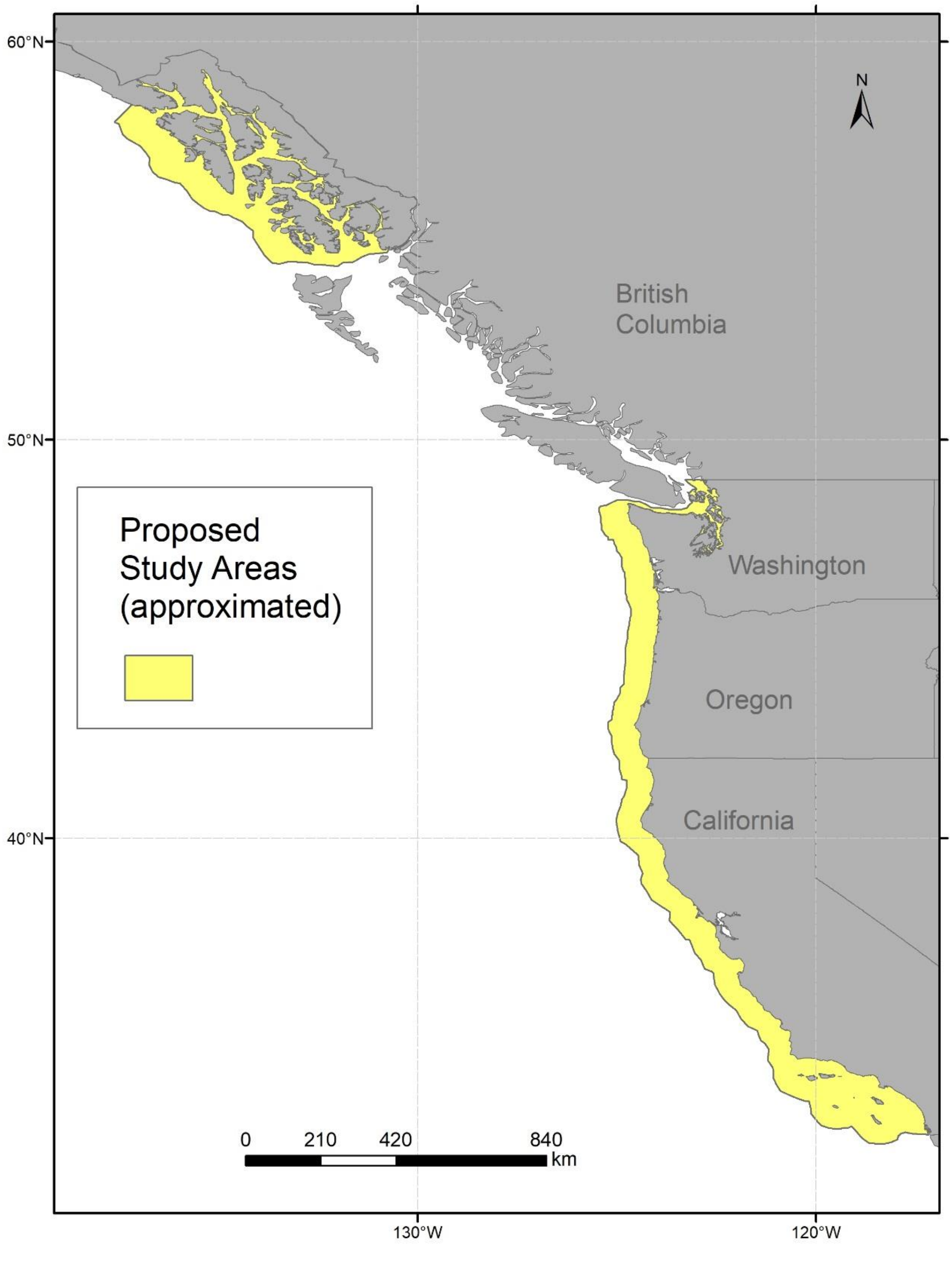

Figure 5. Map of the approximate study areas in United States waters of the Pacific Ocean off the West Coast for proposed Permit No. 21585.

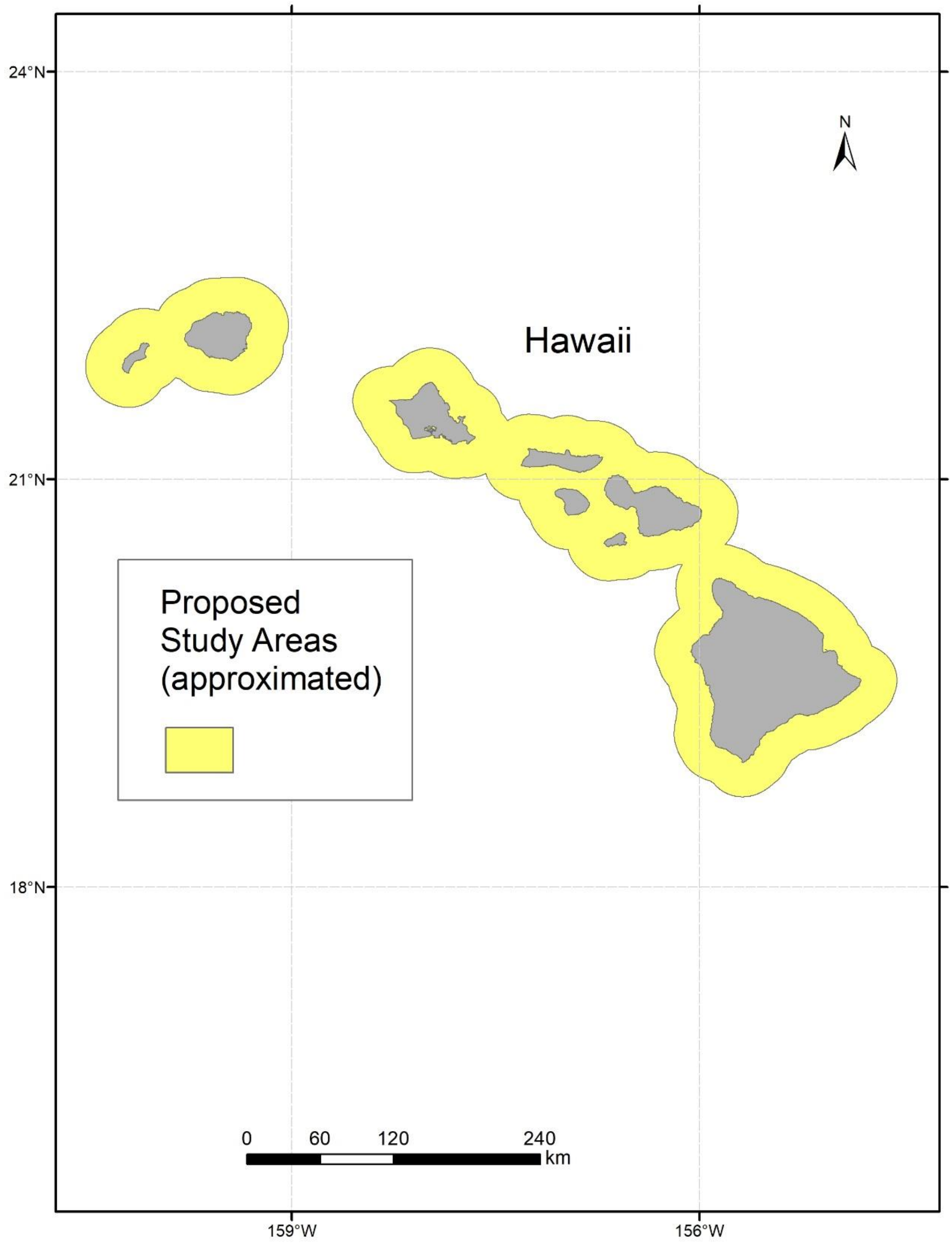

Figure 6. Map of the approximate study areas in United States waters of the Pacific Ocean off the Coast of Hawaii for proposed Permit No. 21585.

7 Species and Critical Habitat Not Likely to be Adversely Affected

This section identifies the ESA-listed species under NMFS jurisdiction that may occur within the action areas (as described in Table 4) that are not likely to be adversely affected by the proposed action. NMFS uses two criteria to identify the ESA-listed or critical habitat that are not likely to be adversely affected by the proposed action, as well as the effects of activities that are interrelated to or interdependent with the Federal agency's proposed action. The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If we conclude that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, we must also conclude that the species or critical habitat is not likely to be adversely affected by those activities.

The second criterion is the probability of a response given exposure. ESA-listed species or designated critical habitat that is exposed to a potential stressor but is likely to be unaffected by the exposure is also not likely to be adversely affected by the proposed action. We applied these criteria to the species ESA-listed in Table 4 and we summarize our results below.

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

Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but will not rise to the level of constituting an adverse effect.

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

In this section, we evaluate effects to several ESA-listed and proposed for ESA-listing species and designated critical habitat that may be affected, but are not likely to be adversely affected, by the proposed action. For the ESA-listed species, we focus specifically on stressors associated with the Permits and Conservation Division's proposed issuance of Permit No. 21585 and their effects on these species. The effects of other stressors associated with the proposed action, which are also not likely to adversely affect ESA-listed species, are evaluated in Section 7. The species potentially occurring within the action areas that may be affected, but are not likely to be adversely affected, are listed in Table 4, along with their regulatory status, designated critical habitat, and recovery plan.

Table 4. Endangered Species Act-listed threatened and endangered species or proposed for Endangered Species Act-listing potentially occurring in the action area for Permit No. 21585 that may be affected, but are not likely to be adversely affected.

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Beluga Whale (*Delphinapterus leucas*) – Cook Inlet DPS	E – 73 FR 62919	76 FR 20179	82 FR 1325
Bowhead Whale (*Balaena mysticetus*)	E – 35 FR 18319	-- --	-- --
Bryde's Whale (*Balaenoptera edeni*) – Gulf of Mexico Subspecies	E – 81 FR 88639 (Proposed)	-- --	-- --
False Killer Whale (*Pseudorca crassidens*) – Main Hawaiian Islands Insular DPS	E – 77 FR 70915	83 FR 35062	-- --
Killer Whale (*Orcinus orca*) – Southern Resident DPS	E – 70 FR 69903	71 FR 69054	73 FR 4176 01/2008
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 FR 12024	81 FR 4837	70 FR 32293 08/2004
Sei Whale (*Balaenoptera borealis*)	E – 35 FR 18319	-- --	12/2011
Marine Mammals – Pinnipeds			
Bearded Seal (*Erignathus barbatus*) – Beringia DPS	T – 77 FR 76739	-- --	-- --
Bearded Seal (*Erignathus barbatus*) – Okhotsk DPS	T – 77 FR 76739	-- --	-- --
Guadalupe fur seal (*Arctocephalus townsendi*)	T – 50 FR 51252	-- --	-- --
Hawaiian Monk Seal (*Neomonachus schauinslandi*)	E – 41 FR 51611	80 FR 50925	72 FR 46966 2007
Ringed Seal (*Phoca hispida*) – Arctic Sub-Species	T – 77 FR 76706 Currently vacated, but listing will be reinstated	79 FR 73010 (Proposed)	-- --
Ringed Seal (*Phoca hispida*) – Baltic Sub-Species	T – 77 FR 76706	-- --	-- --
Ringed Seal (*Phoca hispida*) – Ladoga Sub-Species	E – 77 FR 76706	-- --	-- --

Species	ESA Status	Critical Habitat	Recovery Plan
Ringed Seal (*Phoca hispida*) – Okhotsk Sub-Species	T – 77 FR 76706	-- --	-- --
Ringed Seal (*Phoca hispida*) – Saimaa Sub-Species	E – 58 FR 40538	-- --	-- --
Spotted Seal (*Phoca largha*) – Southern DPS	T – 75 FR 65239	-- --	-- --
Steller Sea Lion (*Eumetopias jubatus*) – Western DPS	E – 55 FR 49204	58 FR 45269	73 FR 11872 2008
Sea Turtles			
Green Turtle (*Chelonia mydas*) – Central North Pacific DPS	T – 81 FR 20057	-- --	63 FR 28359 01/1998
Green Turtle (*Chelonia mydas*) – Central South Pacific DPS	E – 81 FR 20057	-- --	63 FR 28359 01/1998
Green Turtle (*Chelonia mydas*) – Central West Pacific DPS	E – 81 FR 20057	-- --	63 FR 28359 01/1998
Green Turtle (*Chelonia mydas*) – East Pacific DPS	T – 81 FR 20057	-- --	63 FR 28359 01/1998
Green Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 FR 20057	63 FR 46693	FR Not Available 10/1991 – U.S. Atlantic
Green Turtle (*Chelonia mydas*) – South Atlantic DPS	T – 81 FR 20057	-- --	-- --
Green Turtle (*Chelonia mydas*) – East Indian-West Pacific DPS	T – 81 FR 20057	-- --	-- --
Green Turtle (*Chelonia mydas*) – Mediterranean DPS	E – 81 FR 20057	-- --	-- --
Green Turtle (*Chelonia mydas*) – North Indian DPS	T – 81 FR 20057	-- --	-- --
Green Turtle (*Chelonia mydas*) – Southwest Indian DPS	T – 81 FR 20057	-- --	-- --
Green Turtle (*Chelonia mydas*) – Southwest Pacific DPS	T – 81 FR 20057	-- --	-- --

Species	ESA Status	Critical Habitat	Recovery Plan
Hawksbill Turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 46693	57 FR 38818 08/1992 – U.S. Caribbean, Atlantic, and Gulf of Mexico 63 FR 28359 05/1998 – U.S. Pacific
Kemp's Ridley Turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	03/2010 – U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710 and 77 FR 4170	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 63 FR 28359 05/1998 – U.S. Pacific
Loggerhead Turtle (*Caretta caretta*) – North Pacific Ocean DPS	E – 76 FR 58868	-- --	63 FR 28359
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	E – 76 FR 58868	79 FR 39856	74 FR 2995 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 05/1998 – U.S. Pacific 01/2009 – Northwest Atlantic
Loggerhead Turtle (*Caretta caretta*) – Northeast Atlantic Ocean DPS	E – 76 FR 58868	-- --	-- --
Loggerhead Turtle (*Caretta caretta*) – Mediterranean Sea DPS	E – 76 FR 58868	-- --	-- --
Loggerhead Turtle (*Caretta caretta*) – North Indian Ocean DPS	E – 76 FR 58868	-- --	-- --
Loggerhead Turtle (*Caretta caretta*) – South Atlantic Ocean DPS	T – 76 FR 58868	-- --	-- --
Loggerhead Turtle (*Caretta caretta*) – South Pacific Ocean DPS	E – 76 FR 58868	-- --	-- --
Loggerhead Turtle (*Caretta caretta*) – Southeast Indo-Pacific Ocean DPS	T – 76 FR 58868	-- --	-- --

Species	ESA Status	Critical Habitat	Recovery Plan
Loggerhead Turtle (*Caretta caretta*) – Southwest Indian Ocean DPS	T – 76 FR 58868	-- --	-- --
Olive Ridley Turtle (*Lepidochelys olivacea*) – Mexico's Pacific Coast Breeding Colonies	E – 43 FR 32800	-- --	63 FR 28359
Olive Ridley Turtle (*Lepidochelys olivacea*) – All Other Areas/Not Mexico's Pacific Coast Breeding Colonies	T – 43 FR 32800	-- --	-- --

DPS=Distinct Population Segment
E=Endangered
T=Threatened

7.1 Endangered Species Act-Listed Cetaceans

The proposed actions spatially overlap with several ESA-listed cetacean species and/or DPSs including the Cook Inlet DPS of beluga whales, bowhead whales, Gulf of Mexico subspecies of Bryde's whales, Main Hawaiian Islands Insular DPS of false killer whales, Southern Resident DPS of killer whales, North Atlantic right whales (NARWs), and sei whales. Under Permit No. 21585, no takes under the MMPA or ESA will be authorized for the Gulf of Mexico subspecies of Bryde's whales or NARWs. Researchers will not purposefully approach or pursue these species and would stop research activities and move to another area or wait until they have left the area if either species is observed.

Oregon State University researchers would conduct non-invasive research activities that would be considered Level B harassment of the aforementioned ESA-listed cetaceans (with the exception of the Gulf of Mexico subspecies of Bryde's whales and NARWs), including close approaches for photo-identification, passive acoustics, and behavioral observations. Such Level B harassment activities do not constitute harassment under the ESA and we therefore find the effects of disturbance of these activities to the aforementioned ESA-listed cetacean species to be insignificant.

Cetaceans would likely be able to hear all frequency components of the echosounder signal that will be used for prey mapping. However, these pulses would be of extremely short duration (usually less than 1 millisecond), received levels of sound will be less than 180 decibels re 1 microPascal at 1 meter (root mean square), and the animals would have to be located inside the highly directional acoustic beam in order to perceive these sounds. Cetaceans would be expected to exhibit behavioral responses, but based on the criteria needed for cetaceans to hear the echosounder, these responses would likely be rare. Therefore, we find the effects of disturbance to ESA-listed cetaceans from the echosounder to be insignificant.

While ship strikes during research operations are possible, we are aware of only two instances of any research vessel ever striking a whale in thousands of hours at sea (Wiley, Mayo et al. 2016).

Given the rarity of ship strikes of large whale species during all research activities from historical data, the slow speeds at which the Oregon State University would operate, and the extensive experience the researchers have in spotting large whales at sea, we believe the likelihood of a research vessel striking an ESA-listed cetacean is extremely low, and thus discountable.

Discharge from research vessels in the form of leakages of fuel or oil is possible, though effects of any spills would have minimal, if any, effects on the aforementioned ESA-listed cetaceans. Given the experience of the researchers and boat operators in conducting research activities in the action area, it is unlikely that spills or discharges would occur. Therefore, the likelihood of these effects occurring are discountable.

In summary, we concur with the Permits and Conservation Division that the issuance of Permit No. 21585 may affect but is not likely to adversely affect the beluga whale (Cook Inlet DPS), bowhead whale, Gulf of Mexico subspecies of Bryde’s whale, false killer whale (Main Hawaiian Islands Insular DPS), killer whale (Southern Resident DPS), NARWs, North Pacific right whale, and sei whale because the effects of the proposed action are discountable, and we will not discuss these species further in this opinion.

7.2 Endangered Species Act-Listed Pinnipeds

The proposed actions spatially overlap with several ESA-listed pinniped species and/or DPSs including the Beringia DPS and Okhotsk DPS of bearded seals, Guadalupe fur seals, Hawaiian monk seals, Arctic subspecies, Baltic subspecies, Ladoga subspecies, Okhotsk subspecies, and Saimaa subspecies of ringed seals, Southern DPS of spotted seals, and Western DPS of Steller sea lions.

Oregon State University researchers would conduct non-invasive research activities that would be considered Level B harassment of ESA-listed pinnipeds, including close approaches, photo-identification, and behavioral observation. These activities would be conducted to enhance photo-identification catalogs, collect behavioral and species’ range information, and document suspected anthropogenic impacts, such as injuries from entanglements. Close approaches would usually occur at ranges greater than 10 meters but may occasionally occur at closer ranges to assess entanglements.

Both aerial and vessel surveys could disturb ESA-listed pinnipeds. However, researchers will not be authorized to conduct aerial surveys over ESA-listed pinnipeds on land and will avoid rookeries and haul-out areas during aerial surveys. Nonetheless, we recognize that short-term encounters with ESA-listed pinnipeds may occur if researchers do not spot these animals before vessels or aircraft are relatively close. Under these circumstances, we expect ESA-listed pinnipeds will respond similarly to other non-ESA-listed pinniped species and show no behavioral response or avoidance, which may be associated with a mild stress response (Andersen, Teilmann et al. 2012). Given these responses, and the short-term nature of the possible encounters, we do not anticipate that any disturbance from aerial and vessel surveys will have a measureable impact on ESA-listed pinniped behavior or physiology. As such, we find the effects of disturbance to ESA-listed pinnipeds from aerial and vessel surveys to be insignificant.

The likelihood of ship strikes of ESA-listed pinnipeds is expected to be extremely low given that the researchers will adhere to slow transit speeds designed to avoid ship strikes with cetaceans, many of which have less maneuverability than ESA-listed pinnipeds. In addition, observers will always be on the lookout for cetaceans to help vessels avoid collisions. Finally, we are not aware of any case of a cetacean research vessel striking a pinniped. Therefore, we find that it is extremely unlikely that a research vessel will strike an ESA-listed pinniped, and thus such effects are discountable.

Pinnipeds may be able to hear the lower 38 kiloHertz frequencies of the echosounder signal that will be used for prey mapping. However, as described above for cetaceans, these pulses would be of extremely short duration (usually less than 1 millisecond), received levels of sound will be less than 180 decibels re 1 microPascal at 1 meter (root mean square), and the animals would have to be located inside the highly directional acoustic beam in order to perceive these sounds. Pinnipeds would be expected to exhibit behavioral responses, but based on the criteria needed for pinnipeds to hear the echosounder, these responses would likely be rare. Therefore, we find the effects of disturbance to ESA-listed pinnipeds from the echosounder to be insignificant.

In summary, we concur with the Permits and Conservation Division that the issuance of Permit No. 21585 is not likely to adversely affect the Beringia DPS and Okhotsk DPS of bearded seals, Guadalupe fur seals, Hawaiian monk seals, Arctic subspecies, Baltic subspecies, Ladoga subspecies, Okhotsk subspecies, and Saimaa subspecies of ringed seals, Southern DPS of spotted seals, and Western DPS of Steller sea lions, and we will not discuss these species further.

7.3 Endangered Species Act-Listed Sea Turtles

The proposed actions spatially overlap with several non-target ESA-listed sea turtle species and/or DPSs including the Central North Pacific DPS, Central South Pacific DPS, Central West Pacific DPS, East Pacific DPS, North Atlantic DPS, South Atlantic DPS, East Indian-West Pacific DPS, Mediterranean DPS, North Indian DPS, Southwest Indian DPS, and Southwest Pacific DPS of green turtles, hawksbill turtles, Kemp’s ridley turtles, leatherback turtles, the North Pacific Ocean DPS, Northwest Atlantic Ocean DPS, Northeast Atlantic Ocean DPS, Mediterranean Sea DPS, North Indian Ocean DPS, South Atlantic Ocean DPS, South Pacific Ocean DPS, Southeast Indo-Pacific Ocean DPS, and Southwest Indian Ocean DPS of loggerhead turtles, and Mexico’s Pacific Coast breeding colonies as well as all other areas of olive ridley turtles. These species may occasionally be present with targeted cetaceans, but no take under the ESA has been authorized for these species and they would not be directly approached within 50 meters (164 feet) or pursued during research activities.

Research activities that have the potential to disturb sea turtles include aerial surveys, vessel surveys, biological sampling activities, towing equipment for passive acoustic recording and prey sampling, prey mapping with echosounders, observations, and photography targeting cetaceans. Researchers will not purposely approach sea turtles and thus, disturbance is expected to be minimal. Researchers will constantly be on the lookout for cetaceans and thus be able to spot sea turtles at a distance (approximately 100 to 200 meters, Epperly, Avens et al. 2002), well before they are to be expected to respond to aircraft and research vessels (Hazel, Lawler et al. 2007). Furthermore, if a sea turtle were spotted researchers will stop research activities and move to another area or wait until the sea turtle has left the area. Visual observations will be conducted from the research vessel during net tows for prey sampling to ensure sea turtles do not come into contact with the nets. If a sea turtle is exposed to vessel surveys it will likely be brief and temporary and result in short-term behavioral reactions such as swimming away from the vessel that are not expected to have fitness consequences. Sounds associated with prey mapping activities should not be audible to sea turtles, as the dominant frequencies produced by the echosounders (38 kiloHertz, 70 kiloHertz, and 120 kiloHertz) are higher than the frequencies comprising the hearing range of sea turtles. Based on these factors, we find that disturbance of sea turtles associated with vessel surveys and prey mapping is extremely unlikely to occur, and thus discountable.

The likelihood of ship strikes of sea turtles is also expected to be extremely unlikely given that researchers will adhere to slow vessel transit speeds (usually 18.5 kilometers per hour [10 knots] or less) and the numerous observers on lookout for cetaceans will also be able to spot sea turtles that surface for air. For these reasons, we find it is extremely unlikely that a research vessel will strike a sea turtle, and thus such effects related to the operation of vessels to perform cetacean research are discountable.

In summary, we concur with the Permits and Conservation Division that the issuance of Permit No. 21585 is not likely to adversely affect the Central North Pacific DPS, Central South Pacific DPS, Central West Pacific DPS, East Pacific DPS, North Atlantic DPS, South Atlantic DPS, East Indian-West Pacific DPS, Mediterranean DPS, North Indian DPS, Southwest Indian DPS, and Southwest Pacific DPS of green turtles, hawksbill turtles, Kemp's ridley turtles, leatherback turtles, the North Pacific Ocean DPS, Northwest Atlantic Ocean DPS, Northeast Atlantic Ocean DPS, Mediterranean Sea DPS, North Indian Ocean DPS, South Atlantic Ocean DPS, South Pacific Ocean DPS, Southeast Indo-Pacific Ocean DPS, and Southwest Indian Ocean DPS of loggerhead turtles, and Mexico's Pacific Coast breeding colonies as well as all other areas of olive ridley turtles, and we will not discuss these species further in this opinion.

7.4 Designated Critical Habitat

7.4.1 Beluga Whale – Cook Inlet Distinct Population Segment Critical Habitat

NMFS designated critical habitat for the Cook Inlet DPS of beluga whale on April 11, 2011 (76 FR 20180). Two specific areas were designated comprising 7,809 square kilometers (2,276.7 square nautical miles) of marine habitat. Area 1 encompasses 1,918 square kilometers (559.2 square nautical miles) of Cook Inlet northeast of a line from the mouth of Threemile Creek to Point Possession. This area contains shallow tidal flats, river mouths or estuarine areas and is important as foraging and calving habitats. Area 1 has the highest concentrations of beluga whales in the spring through fall as well as the greatest potential for adverse impact from anthropogenic threats. Area 2 includes near and offshore areas of the mid and upper part of Cook Inlet, and nearshore areas of the lower part of Cook Inlet. Area 2 includes Tuxedni, Chinitna, and Kamishak Bays on the west coast and a portion of Kachemak Bay of the east coast. Dive studies indicate that beluga whales in this area dive to deeper depths and are at the surface less frequently than they are when they inhabit Area 1.

The physical and biological features (formerly called primary constituent elements) essential to the conservation of Cook Inlet DPS of beluga whales found in these areas include: (1) intertidal and subtidal waters of Cook Inlet with depths less than 9.1 meters (30 feet) (mean lower low water) and within 8 kilometers (five miles) of high and medium flow accumulation anadromous fish streams; (2) primary prey species consisting of four species of Pacific salmon (Chinook, coho, sockeye, and chum salmon), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole; (3) the absence of toxins or other agents of a type or amount harmful to beluga whales; (4) unrestricted passage within or between the critical habitat areas; and (5) absence of in-water noise at levels result in the abandonment of habitat by Cook Inlet DPS of beluga whales (76 FR 20180).

7.4.2 **False Killer Whale – Main Hawaiian Island Insular Distinct Population Segment Critical Habitat**

On July 24, 2018 (83 FR 35062), NMFS designated critical habitat for the Main Hawaiian Islands insular DPS of false killer whale, which includes waters from the 45 meter (147.6 feet) to the 3,200 meter (10,498.7 feet) depth contour around the Main Hawaiian Islands from Niihau east to the island of Hawaii. This area designated for critical habitat includes approximately 45,504 square kilometers (13,266.8 square nautical miles) surrounding the Main Hawaiian Islands within the geographical area presently occupied by Main Hawaiian Islands insular DPS of false killer whales. Due to the unique ecology of this island associated population, habitat use is largely driven by depth. Thus, the features essential to the species' conservation are found in those depths that allow the false killer whales to travel throughout a majority of their range seeking food and opportunities to socialize and reproduce. The final rule excludes from the designation particular areas where they overlap with the 45 meter (147.6 feet) to the 3,200 meter (10,498.7 feet) depth contour around the Main Hawaiian Islands from Niihau east to the island of Hawaii which include (1) the Bureau of Ocean Energy Management's Call Area offshore of the Island of Oahu (which includes two sites, one off Kaena point and one off the south shore); (2) the U.S. Navy Pacific Missile Range Facilities Offshore ranges (including the Shallow Water Training Range, the Barking Sands Tactical Underwater Range, and the Barking Sands Underwater Range Extension (west of Kauai); (3) the U.S. Navy Kingfisher Range (northeast of Niihau); (4) Warning Area 188 (west of Kauai); (5) Kaula Island and Warning Area 187 (surrounding Kaula Island); (6) the U.S. Navy Fleet Operational Readiness Accuracy Check Site (west of Oahu); (7) the U.S. Navy Shipboard Electronic Systems Evaluation Facility (west of

Oahu); (8) Warning Areas 196 and 191 (south of Oahu); (9) Warning Areas 193 and 194 (south of Oahu); (10) the Kaulakahi Channel portion of Warning Area 186 (the channel between Niihau and Kauai and extending east); (11) the area north of Molokai; (12) the Alenuihaha Channel; (13) Hawaii Area Tracking System; and (14) the Kahoolawe Training Minefield. In addition, the Ewa Training Minefield and the Naval Defensive Sea Area are precluded from designation under section 4(a)(3) of the ESA because they are managed under the Joint Base Pearl Harbor-Hickam Integrated Natural Resource Management Plan and we find provides a benefit to the Main Hawaiian Islands insular DPS of false killer whale. The physical and biological features essential for the conservation of the Main Hawaiian Islands insular DPS of false killer whales includes island-associated marine habitat for the Main Hawaiian Islands insular DPS of false killer whales. The following characteristics of this habitat support the Main Hawaiian Islands insular DPS of false killer whales ability to travel, forage, communicate, and move freely around and among the water surrounding the Main Hawaiian Islands: (1) adequate space for movement and use within shelf and slope habitat; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; (3) waters free of pollutants of a type and amount harmful of Main Hawaiian Islands insular DPS of false killer whales; and (4) sound levels that will not significantly impair false killer whales' use or occupancy.

7.4.3 **Killer Whale – Southern Resident Distinct Population Segment Critical Habitat**

In 2006, NMFS designated critical habitat for the Southern Resident DPS of killer whales (71 FR 69054). The three specific areas designated in Washington include: (1) Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca, which compromise 6,630 square kilometers (2,560 square miles) of marine habitat. The physical and biological features for the conservation of Southern Resident DPS of killer whales include: (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and (3) inter-area passage conditions to allow for migration, resting, and foraging.

7.4.4 **North Atlantic Right Whale Critical Habitat**

Designated critical habitat for the North Atlantic right whale (NARW) is found in the action area in the southeast United States (calving habitat) and northeast United States (foraging area) (81 FR 4837 and 59 FR 28805). The designated areas include important foraging waters in the Gulf of Maine and Georges Bank Region and calving waters off the coast of North Carolina, South Carolina, Georgia, and Florida. The physical and biological features essential to the conservation of the species found in this area include the physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank region that combine to distribute and aggregate the zooplankton species C. *finmarchicus* for right whale foraging, namely prevailing currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes; low flow velocities in Jordan, Wilkinson, and Georges Basins that allow diapausing C. *finmarchicus* to aggregate passively below the convective layer so that the copepods are retained in the basins; late stage C. *finmarchicus* in dense aggregations in the Gulf of Maine and Georges Bank region; and diapausing C. *finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region.

7.4.5 North Pacific Right Whale Critical Habitat

In 2008, NMFS designated critical habitat for the North Pacific right whale, which includes an area in the Southeast Bering Sea and an area south of Kodiak Island in the Gulf of Alaska. Designated critical habitat for the North Pacific right whale is influenced by large eddies, submarine canyons, or frontal zones which enhance nutrient exchange and act to concentrate prey. North Pacific right whale designated critical habitat is adjacent to major ocean currents and characterized by relatively low circulation and water movement. The designated critical habitat supports feeding by North Pacific right whales because they contain specific physical and biological features that include: nutrients, physical oceanography processes, certain species of zooplankton (copepods), and a long photoperiod due to the high latitude (73 FR 19000).

7.4.6 Hawaiian Monk Seal Critical Habitat

Hawaiian monk seal critical habitat was originally designated on April 30, 1986 (51 FR 16047) and was extended on May 26, 1988 (53 FR 18988). It includes all beach areas, sand spits, and islets (including all beach crest vegetation to its deepest extent inland), lagoon waters, inner reef waters, and ocean waters out to a depth of twenty fathoms (thirty-seven meters) around the northwestern Hawaiian Islands breeding atolls and islands. The marine component of this habitat serves as foraging areas, while terrestrial habitat provides resting, pupping, and nursing habitat.

On September 21, 2015, NMFS published a final rule to revise critical habitat for Hawaiian monk seals (80 FR 50925), extending the current designation in the northwestern Hawaiian islands out to the 200 meter depth contour (including Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island). It also designates six new areas in in the main Hawaiian islands (i.e., terrestrial and marine habitat from five meters inland from the shoreline extending seaward to the 200 meter depth contour around Kaula, Niihau, Kauai, Oahu, Maui Nui, and Hawaii).

7.4.7 Ringed Seal – Arctic Distinct Population Segment Critical Habitat

Critical habitat for Arctic ringed seals was proposed for designation in the Bering, Chukchi, and Beaufort seas in Alaska (79 FR 73010). Physical or biological features essential to the conservation of the species included sea ice habitat suitable for the formation of and maintenance of subnivean birth lairs, sea ice habitat suitable as a platform for basking and molting, and primary prey resources to support Arctic ringed seals.

7.4.8 Steller Sea Lion – Western Distinct Population Segment Critical Habitat

In 1997, NMFS designated critical habitat for the Steller sea lion (58 FR 45269), which remains in effect for the Western DPS despite the Eastern DPS being delisted in 2013 (78 FR 66139). The designated critical habitat includes specific rookeries, haul-outs, and associated areas, as well as three marine foraging areas that are considered to be essential for health, continued survival, and recovery of the species. In Alaska, areas include major Steller sea lion rookeries, haul-outs and associated terrestrial, air, and aquatic zones. The aquatic zones extend 0.9 kilometers (0.5 nautical miles) seaward from the major rookeries and haul-outs east of 144° West. In addition, NMFS designated special aquatic foraging areas as critical habitat for the Steller sea lion. These areas include the Shelikoff Strait (in the Gulf of Alaska), Bogoslof Island, and Seaguam Pass (the latter two are in the Aleutian Islands). These sites are located near Steller sea lion abundance centers and include important foraging areas, large concentrations of prey, and host large commercial fisheries that often interact with the species. The physical and biological features identified for the aquatic areas of Steller sea lion designated critical habitat that occur within the action area are those that support foraging, such as adequate prey resources and available foraging habitat (58 FR 45269). While Steller sea lions do rest in aquatic habitat, there was insufficient information available at the time critical habitat was designated to include aquatic resting sites as part of the critical habitat designation (58 FR 45269).

The proposed research activities related to the use of aerial and vessel surveys will not affect any terrestrial areas used by the Western DPS of Steller sea lions that are part of designated critical habitat or areas used for hauling-out, resting, or molting. Aquatic areas surround major rookeries and haul-out sites where the proposed research activities will occur, provide foraging habitats, prey resources, and refuge considered essential to the conservation of the Western DPS of Steller sea lions. Proposed research activities will not affect prey resources or foraging and refuge habitat.

7.4.9 Green Turtle – North Atlantic Distinct Population Segment Critical Habitat

The action area may co-occur with designated critical habitat of green turtles (North Atlantic DPS). On September 2, 1998, NMFS designated critical habitat for green sea turtles (63 FR 46694), which include coastal waters surrounding Culebra Island, Puerto Rico. Seagrass beds surrounding Culebra provide important foraging resources for juvenile, subadult and adult green sea turtles. Additionally, coral reefs surrounding the island provide resting shelter and protection from predators. This area provides important developmental habitat for the species. Due to its location, this critical habitat would be accessible by individuals of the North Atlantic DPS.

7.4.10 Hawksbill Turtle Critical Habitat

The action area may co-occur with designated critical habitat of hawksbill turtles. On September 2, 1998, NMFS established critical habitat for hawksbill sea turtles around Mona and Monito Islands, Puerto Rico (63 FR 46693). Aspects of these areas that are important for hawksbill sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for hawksbill sea turtle prey.

7.4.11 Leatherback Turtle Critical Habitat

The action area may co-occur with designated critical habitat of leatherback turtles. On March 23, 1979, leatherback critical habitat was identified adjacent to Sandy Point, St. Croix, Virgin Islands from the 183 meter isobath to mean high tide level between 17° 42’12” N and 65°50’00” W (44 FR 17710). This habitat is essential for nesting, which has been increasingly threatened since 1979, when tourism increased significantly, bringing nesting habitat and people into close and frequent proximity; however, studies do not support significant critical habitat deterioration.

In 2012, NMFS revised designated critical habitat for the leatherback turtle by designating additional areas within the Pacific Ocean. This designation includes approximately 43,798 square kilometers (16,910 square miles) stretching along the California coast from Point Arena to Point Arguello east of the 3,000 meter (9,842.4 feet) depth contour; and 64,760 square kilometers (25,004 square miles) stretching from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 meter (6,561.7 feet) depth contour. The designated areas comprise approximately 108,558 square kilometers (41,914 square miles) of marine habitat and include waters from the ocean surface down to a maximum depth of 80 meters (262 feet). NMFS has identified one physical and biological feature for the conservation of leatherback turtles in marine waters off the U.S. West Coast that includes the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (e.g., *Chrysaora*, *Aurelia*, *Phacellophora*, and *Cyanea*), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks (77 FR 4170).

7.4.12 Loggerhead Turtle – Northwest Atlantic Ocean Distinct Population Segment Critical Habitat

The action area may co-occur with designated critical habitat of loggerhead turtles (Northwest Atlantic Ocean DPS). NMFS designated critical habitat for this species in 2014 (79 FR 39856). The specific areas identified by NMFS were included because they provide protection to loggerhead sea turtles which include Neritic (nearshore reproductive, foraging, winter, breeding, and migratory) and *Sargassum* habitat. The primary constituent elements of reproductive habitat include: (1) nearshore waters directly off the highest density nesting beaches and their adjacent beaches as identified in 50 CFR 17.95(c) to 1.6 km offshore; (2) waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water; and (3) waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents. The primary constituent elements of breeding habitat include: (1) high densities of reproductive male and female loggerheads; (2) proximity to primary Florida migratory corridor; and (3) proximity to Florida nesting grounds. The primary constituent elements of *Sargassum* habitat include: (1) convergence zones, surface-water downwelling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads; (2) *Sargassum* in concentrations that support adequate prey abundance and cover; (3) available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and animals native to the *Sargassum* community such as hydroids and copepods; and (4) sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads, i.e., greater than 10 m depth. The primary constituent elements of migratory habitat include: (1) constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways and (2) passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas.

7.4.13 Effects to Designated Critical Habitat

Marine areas of the above-described designated critical habitats may occur within the action area and as such, may be affected by the research activities. We assess the probable exposure of these designated critical habitats to the research activities (i.e., aircraft noise, vessel traffic, vessel noise, discharge, pollution, active acoustics, passive acoustic monitoring, biological sampling, tagging) and then evaluate the possible effects the proposed action may have on the physical and biological features of each critical habitat that will be exposed.

The above-described critical habitats contain a variety of physical and biological features deemed essential to the conservation of the ESA-listed species for which they were designated. Broadly speaking, these include waters free from obstruction; particular water properties including specific dissolved oxygen levels and temperatures, and low contaminant levels; specific water depths and sea states; oceanographic features and processes; abundant prey species; habitat free of anthropogenic noise; and available foraging habitat. Possible stressors that may affect these physical and biological features associated with exposure to research activities include pollution, vessel strike, vessel noise, gear entanglement, aerial surveys, vessel surveys and associated close approaches to cetaceans for sampling and tagging, and active acoustics. However, as outlined below, the effects of these stressors on the identified physical and biological features of designated critical habitat in the action area were determined to be insignificant or discountable based on the nature of the feature and stressor.

Vessel traffic, noise, and discharge are expected to have an insignificant effect on designated critical habitat physical and biological features for each designated critical habitat described in Sections 7.4.1 through 7.4.12. Small and occasionally large research vessels are proposed to be used during research activities under Permit No. 21585. Operation of research vessels will result in a temporary increase in vessel traffic within designated critical habitat. This increase in vessel traffic is likely to consist of only one research vessel operating within a particular critical habitat.

The action area often has a lot of commercial and recreational vessel traffic, and the addition of a single research vessel may not even be measurable. The physical transit of research vessels may result in brief obstruction of surface waters due to the presence of a vessel and slight changes in dissolved oxygen levels, water temperature, and currents due the vessels displacement and mixing of water, but is not expected to have any effect on contaminant levels, depth, benthic habitat, and sea state. Vessel presence may also cause a slight change in distribution of prey. These effects will be highly localized, occurring only within close proximity to the transiting research vessel, and temporary, with habitat conditions quickly returning to pre-exposure values once the research vessel leaves the area. Given the localized and short-term nature of vessel operation in critical habitats, it is expected to have an insignificant effect on the physical and biological features of designated critical habitats. As such, we find that vessel traffic may affect, but is not likely to adversely affect designated critical habitats and we will not discuss effects from this stressor on designated critical habitat further.

Discharge and pollution from research vessels may occur. The International Convention for the Prevention of Pollution from Ships (MARPOL73/78) prohibits certain discharges of oil, noxious liquid substances, sewage, garbage, and air pollution from vessels within certain distances of the coastline. Unintentional and intentional discharge of pollutants from vessels may affect certain water quality properties, trigger harmful algal blooms, and temporarily affect distributions and behaviors of ESA-listed species and their prey if they are large in size, the size, duration. The localized extent of any accidental discharges from a few research vessels associated with the proposed action will have be minor effects relative to the size of the action areas. In addition, any pollutant discharge would be mixed rapidly into the water column and is likely to be indistinguishable from discharges associated with vessel traffic that is common in the action area. Therefore, the effects of discharge and pollution from research vessels on designated critical habitats are considered to be insignificant. As such, we find that accidental discharge and pollution from research vessels may affect, but are not likely to adversely affect designated critical habitats and we will not discuss effects from these stressors on designated critical habitats further.

Transiting vessels also produce a variety of sounds characterized as low-frequency, continuous, or tonal, with sound pressure levels at a source varying according to speed, burden, capacity, and length (Richardson, Davis et al. 1995, Kipple and Gabriele 2007, Mckenna, Ross et al. 2012). While such noise would not physically obstruct water passage or affect water properties, depth, sea state, or oceanographic, and benthic and algal features, it may affect prey in designated critical habitats. However, the vast majority of fishes do not show strong responses to low frequency sound. In addition, we do not expect invertebrates that are part of the physical and biological features essential to the conservation of some designated critical habitats in the action area of the proposed permit to respond strongly to vessel sound (Bennet, Falter et al. 1994, Albert 2011). A study on the effects of vessel noise on sea hare (*Stylocheilus striatus*) found that chronic exposure to vessel noise may affect development and lead to increased mortality

(Nedelec, Radford et al. 2014). However, the experimental conditions of this study are drastically different than the brief exposure to vessel noise that will result from research vessel operations in the action area. Another recent study examining the effects of broadband sounds, including recorded continuous vessel noise, on three representative benthic invertebrates (the clam, *Ruditapes philippinarum*; the decapod, *Nephrops norvegicus*; and, the brittlestar, *Amphiura filiformis*) indicated that continued exposure to broadband sounds may affect benthic invertebrate behavior in ways that alter nutrient cycling (Solan, Hauton et al. 2016). However, this study found no significant effects on invertebrate tissue biochemistry, and behavioral responses including avoidance behavior, were mixed (Solan, Hauton et al. 2016). Importantly, this study examined time integrated effects, which differ from those that would result from the brief exposure to noise from a single, transiting vessel. While avoidance behavior in prey may lead to a change in distribution, any such change would be short-lived and likely not last much beyond when the research vessel leaves the area. In addition, while at close ranges both fishes and invertebrates may experience injury from certain sound sources (Popper, Carlson et al. 2014, Sole, Lenoir et al. 2016), the injury or even loss of a few individual prey would not have a measurable impact on the overall prey abundance such that it will diminish the conservation value of designated critical habitats for ESA-listed species within the action area for the proposed permit. Thus, we believe the effects of noise associated with vessel transit on designated critical habitats associated with the proposed research activities are insignificant. As a result, we find that vessel transit noise may affect, but is not likely to adversely affect designated critical habitats and we will not discuss effects from this stressor on designated critical habitats further.

The operation of active acoustics (i.e., prey mapping) involves actively transmitting sounds in the marine environment. Like noise from research vessels, such transmission would not physically obstruct water passage or affect water properties, depth, sea state, or oceanographic, and benthic and algal features, but as further outlined below, it may affect prey in designated critical habitats. However, given the frequency bandwidth and sound source, we expect sounds originating from the active acoustic sources will be out of the audible hearing range and/or reduced to negligible sound levels by the time they reach prey, due to transmission loss.

Studies indicate that exposure to sound has limited potential to affect fishes and invertebrates. As indicated by Popper, Hawkins et al. (2014), the relative risk of a fish exhibiting a behavioral reaction in response to sonar is low, regardless of the distance from the sound source. Though squid and some other invertebrates appear to exhibit alarm responses and avoidance of sound sources, individuals will be expected to resume normal behaviors immediately after initial exposure. We do not expect any such responses to have a measurable impact on the abundance of prey within designated critical habitat. Thus, we find that the effects of operating the active acoustic sound sources on designated critical habitats within the action area are insignificant. We find that this stressor may affect, but is not likely to adversely affect designated critical habitats and we will not discuss effects from this stressor on designated critical habitats further.

The research activities involve passive acoustic monitoring. Given that the operation of passive acoustic monitoring only involves the deployment of passive acoustic equipment (e.g., towed hydrophone arrays, free-floating autonomous recording devices [with a buoy system for recovery], and dipping hydrophones from a research vessel), we do not expect effects to critical habitats beyond that which has already been described above for transit of the research vessel. Free-floating autonomous recording devices will be launched from research vessels, but they will float freely at the top of the water column and therefore not expected to have any effects on the essential features of designated critical habitats in the action area. Dipping hydrophones will be temporarily deployed and retrieved from the research vessel and not affect the habitats. Thus, we find that the effects of conducting the proposed passive acoustic monitoring on designated critical habitats in the action area are insignificant. As such, we find that this stressor may affect, but is not likely to adversely affect designated critical habitats and we will not discuss effects from this stressor on designated critical habitats further.

While the proposed research activities would/may overlap with the physical and biological features (i.e., water quantity, and quality and prey availability) of the designated critical habitats described in Sections 7.4.1 through 7.4.12, very few if any, effects to these habitats are expected. The proposed research activities will not significantly alter the physical or oceanographic conditions within the action area, as only very minor changes in water flow and current will be expected from vessel traffic and no changes in ocean bathymetry will occur. We do not expect the proposed research activities to affect the oceanographic features that concentrate copepod prey in the action area. In conclusion, the proposed research activities may affect but are not expected to adversely affect any of the physical, chemical, or biotic features of the designated critical habitats. Given the nature of the research activities under Permit No. 21585, it is extremely unlikely that any of the physical and biological features essential to the conservation of the aforementioned species found in this habitat will be altered proposed research activities are not likely to adversely affect the conservation value of the designated critical habitat for the aforementioned species. As such, we will not discuss these designated critical habitats further in this opinion.

8 Species and Critical Habitat Likely to be Adversely Affected

This section identifies the ESA-listed species that occur within the action area (see Figure 4, Figure 5, and Figure 6) that may be affected by the proposed issuance of Permit No. 21585 (Table 5). The regulatory status, designated critical habitat, and recovery plan references for these species are also included in Table 5.

Table 5. Threatened and endangered species that may be affected by the National Marine Fisheries Service's Permits and Conservation Division's proposed action of issuance of Permit No. 21585.

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Blue Whale (*Balaenoptera musculus)*	E – 35 FR 18319	-- --	07/1998
Fin Whale (*Balaenoptera physalus)*	E – 35 FR 18319	-- --	75 FR 47538 07/2010
Gray Whale (*Eschrichtius robustus*) – Western North Pacific Population	E – 35 FR 18319	-- --	-- --
Humpback Whale (*Megaptera novaeangliae*) – Arabian Sea DPS	E – 81 FR 62259	-- --	11/1991
Humpback Whale (*Megaptera novaeangliae*) – Cape Verde Islands/Northwest Africa DPS	E – 81 FR 62259	-- --	11/1991
Humpback Whale (*Megaptera novaeangliae*) – Central America DPS	E – 81 FR 62259	-- --	11/1991
Humpback Whale (*Megaptera novaeangliae*) – Mexico DPS	T – 81 FR 62259	-- --	11/1991
Humpback Whale (*Megaptera novaeangliae*) – Western North Pacific DPS	E – 81 FR 62259	-- --	11/1991
North Pacific Right Whale (*Eubalaena japonica*)	E – 73 FR 12024	73 FR 19000	78 FR 34347 06/2013
Southern Right Whale (*Eubalaena australis*)	E – 35 FR 8491	-- --	-- --
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18319	-- --	75 FR 81584 12/2010

DPS=Distinct Population Segment
E=Endangered
T=Threatened

9 Status of Species and Critical Habitat Likely to be Adversely Affected

This section identifies and examines the status of each species that would be affected by the proposed actions. The status includes the existing level of risk that the ESA-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which is part of the jeopardy determination as described in 50 C.F.R. §402.02. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the *Federal Register*, status reviews, recovery plans, and on this NMFS websites: https://www.fisheries.noaa.gov/topic/endangered-species-conservation, among others.

This section also examines the condition of critical habitat throughout the designated area (such as various watersheds and coastal and marine environments that make up the designated area), and discusses the condition and current function of designated critical habitat, including the essential physical and biological features that contribute to that conservation value of the critical habit

9.1 Blue Whale

The blue whale is a widely distributed baleen whale found in all major oceans (Figure 7).

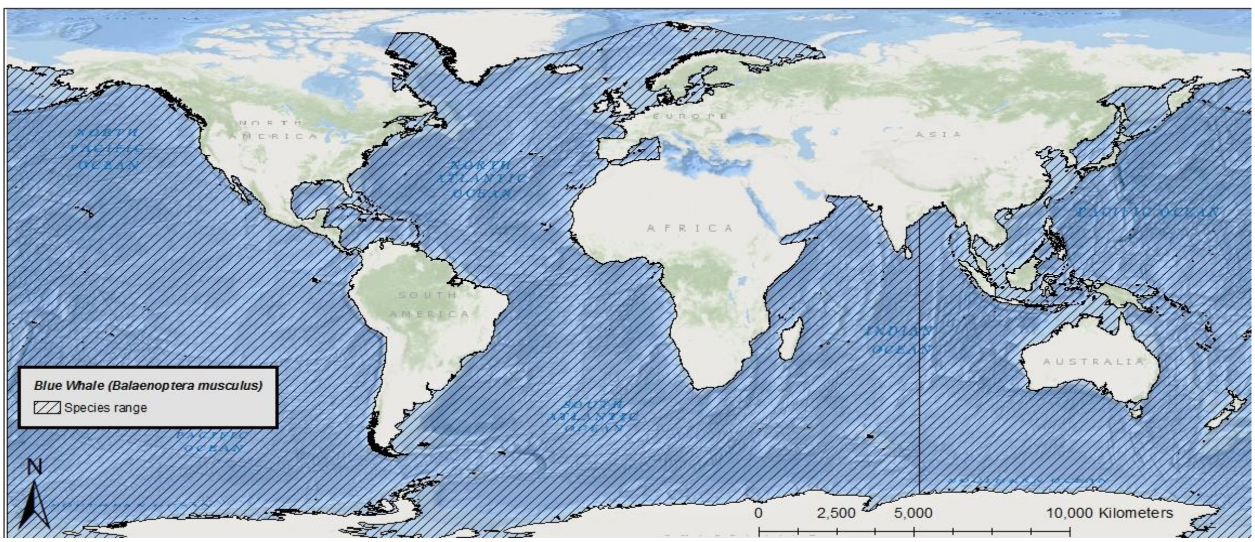

Figure 7. Map identifying the range of the endangered blue whale.

Blue whales are the largest animal on earth and distinguishable from other whales by a long-body and comparatively slender shape, a broad, flat "rostrum" when viewed from above, proportionally smaller dorsal fin, and a mottled gray color that appears light blue when seen through the water. Most experts recognize at least three subspecies of blue whale, *B. m. musculus*, which occurs in the Northern Hemisphere, *B. m. intermedia*, which occurs in the Southern Ocean, and *B. m. brevicauda*, a pygmy species found in the Indian Ocean and South Pacific Ocean. The blue whale was originally listed as endangered on December 2, 1970.

Information available from the recovery plan (NMFS 1998), recent stock assessment reports (Carretta, Forney et al. 2017, Hayes, Josephson et al. 2017, Muto, Helker et al. 2017), and status review (COSEWIC 2002) were used to summarize the life history, population dynamics, and status of the species as follows.

Life History

The average life span of blue whales is 80 to 90 years. They have a gestation period of ten to 12 months, and calves nurse for six to seven months. Blue whales reach sexual maturity between five and 15 years of age with an average calving interval of two to three years. They winter at low latitudes, where they mate, calve and nurse, and summer at high latitudes, where they feed. Blue whales forage almost exclusively on krill and can eat approximately 3,600 kilograms (7,936.6 pounds) daily. Feeding aggregations are often found at the continental shelf edge, where upwelling produces concentrations of krill at depths of 90 to 120 meters (295.3 to 393.7 feet).

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the blue whale.

The global, pre-exploitation estimate for blue whales is approximately 181,200 (IWC 2007). Current estimates indicate approximately 5,000 to 12,000 blue whales globally (IWC 2007). Blue whales are separated into populations by ocean basin in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere. There are three stocks of blue whales designated in United States waters: the Eastern North Pacific Ocean (current best estimate N=1,647, N_{min}=1,551) (VanBlaricom, Ruediger et al. 1993), Central North Pacific Ocean (N=81, N_{min}=38), and Western North Atlantic Ocean (N=400 to 600, N_{min}=440). In the Southern Hemisphere, the latest abundance estimate for Antarctic blue whales is 2,280 individuals in 1997/1998 (95 percent confidence intervals 1,160 to 4,500 (Branch 2007). While no rangewide estimate for pygmy blue whales exists (Thomas, Reeves et al. 2016), the latest estimate for pygmy blue whales off the west coast of Australia is 662 to 1,559 individuals based on passive acoustic monitoring (McCauley and Jenner 2010), or 712 to 1,754 individuals based on photographic mark-recapture (Jenner 2008).

Current estimates indicate a growth rate of just under three percent per year for the eastern North Pacific stock (Calambokidis 2009). An overall population growth rate for the species or growth rates for the two other individual U.S. stocks are not available at this time. In the Southern Hemisphere, population growth estimates are available only for Antarctic blue whales, which estimate a population growth rate of 8.2 percent per year (95 percent confidence interval 1.6 to 14.8 percent) (Branch 2007).

Little genetic data exist on blue whales globally. Data from Australia indicates that at least populations in this region experienced a recent genetic bottleneck, likely the result of commercial whaling, although genetic diversity levels appear to be similar to other, non-threatened mammal species (Attard, Beheregaray et al. 2010). Consistent with this, data from Antarctica also demonstrate this bottleneck but high haplotype diversity, which may be a consequence of the recent timing of the bottleneck and blue whales long lifespan (Sremba, Hancock-Hanser et al. 2012). Data on genetic diversity of blue whales in the Northern Hemisphere are currently unavailable. However, genetic diversity information for similar cetacean population sizes can be applied. Stocks that have a total population size of 2,000 to 2,500 individuals or greater provide for maintenance of genetic diversity resulting in long-term persistence and protection from substantial environmental variance and catastrophes. Stocks that have a total population of 500 individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Stock population at low densities (less than 100) are more likely to suffer from the ‘Allee’ effect, where inbreeding and the heightened difficulty of finding mates reduces the population growth rate in proportion with reducing density.

In general, distribution is driven largely by food requirements; blue whales are more likely to occur in waters with dense concentrations of their primary food source, krill. While they can be found in coastal waters, they are thought to prefer waters further offshore. In the North Atlantic Ocean, the blue whale range extends form the subtropics to the Greenland Sea. They are most frequently sighted in waters of eastern Canada with a majority of sightings taking place in the Gulf of St. Lawrence. In the North Pacific Ocean, blue whales range from Kamchatka to southern Japan in the west and from the Gulf of Alaska and California to Costa Rica in the east. They primarily occur off the Aleutian Islands and the Bering Sea. In the northern Indian Ocean, there is a “resident” population of blue whales with sightings being reported from the Gulf of Aden, Persian Gulf, Arabian Sea, and across the Bay of Bengal to Burma and the Strait of Malacca. In the Southern Hemisphere, distributions of subspecies *(B. m. intermedia* and *B. m. brevicauda*) can be segregated. The subspecies *B. m. intermedia* occurs in relatively high latitudes south of the “Antarctic Convergence” (located between 48 and 61° South latitude) and close to the ice edge. The subspecies *B. m. brevicauda* is typically distributed north of the Antarctic Convergence.

Vocalization and Hearing

Blue whale vocalizations tend to be long (greater than 20 seconds), low frequency (less than 100 Hertz) signals (Thomson and Richardson 1995), with a range of 12 to 400 Hertz and dominant energy in the infrasonic range of 12 to 25 Hertz (Mcdonald, Hildebrand et al. 1995, Ketten 1998, Mcdonald, Calambokidis et al. 2001, Mellinger and Clark 2003). Vocalizations are predominantly songs and calls.

Calls are short-duration sounds (two to five seconds) that are transient and frequency-modulated, having a higher frequency range and shorter duration than song units and often sweeping down in frequency (20 to 80 Hertz), with seasonally variable occurrence. Blue whale calls have high acoustic energy, with reports of source levels ranging from 180 to 195 decibels re 1 microPascal at 1 meter (Cummings and Thompson 1971, Aburto, Rountry et al. 1997, Ketten 1998, Mcdonald, Calambokidis et al. 2001, Clark and Gagnon 2004, Berchok, Bradley et al. 2006, Samaran, Guinet et al. 2010). Calling rates of blue whales tend to vary based on feeding behavior. For example, blue whales make seasonal migrations to areas of high productivity to feed, and vocalize less at the feeding grounds then during migration (Burtenshaw, Oleson et al. 2004). Stafford et al. (2005) recorded the highest calling rates when blue whale prey was closest to the surface during its vertical migration. Wiggins et al. (2005) reported the same trend of reduced vocalization during daytime foraging followed by an increase at dusk as prey moved up into the water column and dispersed. Oleson, Wiggins et al. (2007) reported higher calling rates in shallow diving (less than 30 meters [98.4 feet] whales), while deeper diving whales (greater than 50 meters [154 feet]) were likely feeding and calling less.

Although general characteristics of blue whale calls are shared in distinct regions (Thompson, Findley et al. 1996, Mcdonald, Calambokidis et al. 2001, Mellinger and Clark 2003, Rankin, Ljungblad et al. 2005), some variability appears to exist among different geographic areas (Rivers 1997). Sounds in the North Atlantic Ocean have been confirmed to have different characteristics (i.e., frequency, duration, and repetition) than those recorded in other parts of the world (Mellinger and Clark 2003, Berchok, Bradley et al. 2006, Samaran, Guinet et al. 2010). Clear differences in call structure suggestive of separate populations for the western and eastern regions of the North Pacific Ocean have also been reported (Stafford, Nieukirk et al. 2001); however, some overlap in calls from the geographically distinct regions have been observed, indicating that the whales may have the ability to mimic calls (Stafford and Moore 2005). In Southern California, blue whales produce three known call types: Type A, B, and D. B calls are stereotypic of blue whale population found in the eastern North Pacific (McDonald, Mesnick et al. 2006) and are produced exclusively by males and associated with mating behavior (Oleson, Calambokidis et al. 2007). These calls have long durations (20 seconds) and low frequencies (10 to 100 Hertz); they are produced either as repetitive sequences (song) or as singular calls. The B call has a set of harmonic tonals, and may be paired with a pulsed Type A call. D calls are produced in highest numbers during the late spring and early summer and in diminished numbers during the fall, when A-B song dominates blue whale calling (Oleson, Wiggins et al. 2007, Hildebrand, Baumann-Pickering et al. 2011, Hildebrand, Baumann-Pickering et al. 2012).

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

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) (Payne and Webb. 1971, Thompson, Findley et al. 1992, Edds-Walton 1997, Oleson, Calambokidis et al. 2007). Intense bouts of long, patterned sounds are common from fall through spring in low latitudes, but these also occur less frequently while in summer high-latitude feeding areas. Short, rapid sequences of 30 to 90 Hertz calls are associated with socialization and may be displays by males based upon call seasonality and structure. The low frequency sounds produced by blue whales can, in theory, travel long distances, and it is possible that such long distance communication occurs (Payne and Webb. 1971, Edds-Walton 1997). The long-range sounds may also be used for echolocation in orientation or navigation (Tyack 1999).

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 (Richardson, Greene et al. 1995, Ketten 1997). Based on vocalizations and anatomy, blue whales are assumed to predominantly hear low-frequency sounds below 400 Hertz (Croll, Clark et al. 2001, Stafford and Moore 2005, Oleson, Wiggins et al. 2007). In terms of functional hearing capability, blue whales belong to the low frequency group, which have a hearing range of 7 Hertz to 35 kiloHertz (NOAA 2018).

Status

The blue whale is endangered as a result of past commercial whaling. In the North Atlantic Ocean, at least 11,000 blue whales were taken from the late 19th to mid-20th centuries. In the North Pacific Ocean, at least 9,500 whales were killed between 1910 and 1965. Commercial whaling no longer occurs, but blue whales are affected by anthropogenic noise, threatened by ship strikes, entanglement in fishing gear, pollution, harassment due to whale watching, and reduced prey abundance and habitat degradation due to climate change. Because populations appear to be increasing in size, the species appears to be somewhat resilient to current threats; however, the species has not recovered to pre-exploitation levels.

Critical Habitat

No critical habitat has been designated for the blue whale.

Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover blue whale populations. These threats will be discussed in further detail in the *Environmental*

Baseline section of this opinion. See the 1998 Final Recovery Plan for the Blue Whale for complete downlisting/delisting criteria for each of the following recovery goals.

1. Determine stock structure of blue whale populations occurring in U.S. waters and elsewhere.
2. Estimate the size and monitor trends in abundance of blue whale populations.
3. Identify and protect habitat essential to the survival and recovery of blue whale populations.
4. Reduce or eliminate human-caused injury and mortality of blue whales.
5. Minimize detrimental effects of directed vessel interactions with blue whales.
6. Maximize efforts to acquire scientific information from dead stranded, and entangled blue whales.
7. Coordinate state, federal, and international efforts to implement recovery actions for blue whales.
8. Establish criteria for deciding whether to delist or downlist blue whales.

9.2 Fin Whale

The fin whale is a large, widely distributed baleen whale found in all major oceans and comprised of three subspecies: *B. p. physalus* in the Northern Hemisphere, and *B. p. quoyi* and *B. p. patachaonica* (a pygmy form) in the Southern Hemisphere (Figure 8).

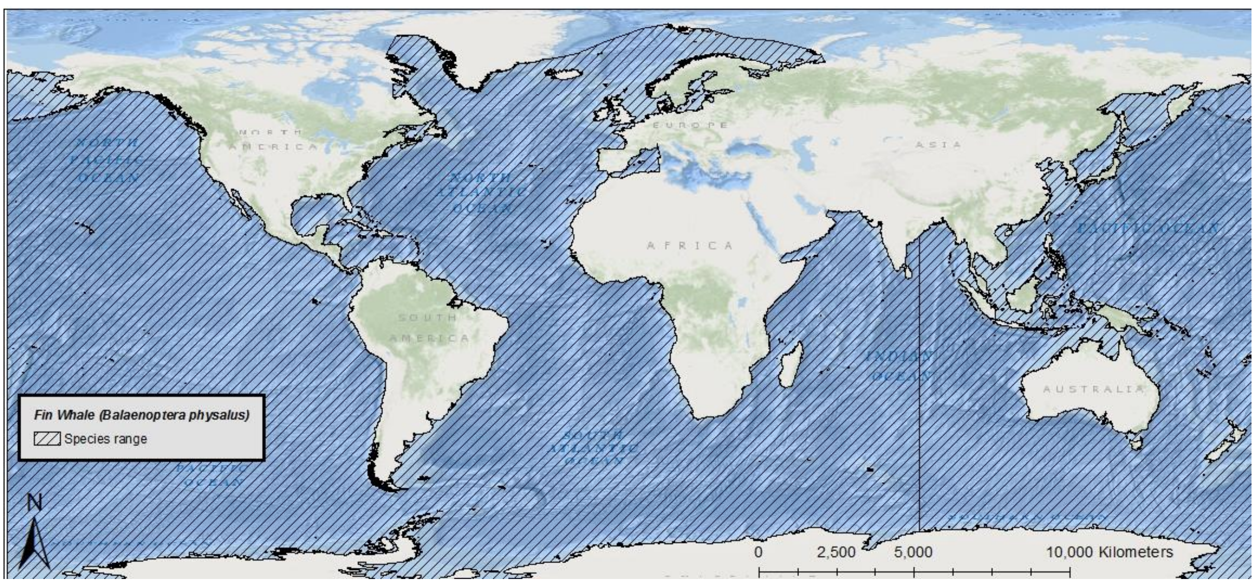

Figure 8. Map identifying the range of the endangered fin whale.

Fin whales are distinguishable from other whales by a sleek, streamlined body, with a V-shaped head, a tall falcate dorsal fin, and a distinctive color pattern of a black or dark brownish-gray body and sides with a white ventral surface. The lower jaw is gray or black on the left side and creamy white on the right side. The fin whale was originally listed as endangered on December 2, 1970.

Information available from the recovery plan (NMFS 2010), recent stock assessment reports (Carretta, Forney et al. 2017, Hayes, Josephson et al. 2017, Muto, Helker et al. 2017), and status review (NMFS 2011) were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Fin whales can live, on average, 80 to 90 years. They have a gestation period of less than one year, and calves nurse for six to seven months. Sexual maturity is reached between six and ten years of age with an average calving interval of two to three years. They mostly inhabit deep, offshore waters of all major oceans. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed, although some fin whales appear to be residential to certain areas. Fin whales eat pelagic crustaceans (mainly euphausiids or krill) and schooling fish such as capelin, herring, and sand lice.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the fin whale.

The pre-exploitation estimate for the fin whale population in the North Pacific Ocean was 42,000 to 45,000 (Ohsumi and Wada 1974). In the North Atlantic Ocean, at least 55,000 fin whales were killed between 1910 and 1989. Approximately 704,000 fin whales were killed in the Southern Hemisphere from 1904 to 1975. Of the three to seven stocks in the North Atlantic Ocean (approximately 50,000 individuals), one occurs in United States waters, where the best estimate of abundance is 1,618 individuals (N_{min}=1,234); however, this may be an underrepresentation as the entire range of stock was not surveyed (Palka 2012). There are three stocks in United States Pacific Ocean waters: Northeast Pacific [minimum 1,368 individuals], Hawaii (approximately 58 individuals [N_{min}=27]) and California/Oregon/Washington (approximately 9,029 [N_{min}=8,127] individuals) (Nadeem, Moore et al. 2016). The International Whaling Commission also recognizes the China Sea stock of fin whales, found in the Northwest Pacific Ocean, which currently lacks an abundance estimate (Reilly, Bannister et al. 2013). Abundance data for the Southern Hemisphere stock are limited; however, there were assumed to be somewhat more than 15,000 in 1983 (Thomas, Reeves et al. 2016).

Current estimates indicate approximately 10,000 fin whales in United States Pacific Ocean waters, with an annual growth rate of 4.8 percent in the Northeast Pacific stock and a stable population abundance in the California/Oregon/Washington stock (Nadeem, Moore et al. 2016). Overall population growth rates and total abundance estimates for the Hawaii stock, China Sea stock, western North Atlantic stock, and Southern Hemisphere fin whales are not available at this time.

Archer, Morin et al. (2013) recently examined the genetic structure and diversity of fin whales globally. Full sequencing of the mitochondrial DNA genome for 154 fin whales sampled in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere, resulted in 136 haplotypes, none of which were shared among ocean basins suggesting differentiation at least at this geographic scale. However, North Atlantic Ocean fin whales appear to be more closely related to the Southern Hemisphere population, as compared to fin whales in the North Pacific Ocean, which may indicate a revision of the subspecies delineations is warranted. Generally speaking, haplotype diversity was found to be high both within oceans basins, and across. Such high genetic diversity and lack of differentiation within ocean basins may indicate that despite some populations having small abundance estimates, the species may persist long-term and be somewhat protected from substantial environmental variance and catastrophes.

There are over 100,000 fin whales worldwide, occurring primarily in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere where they appear to be reproductively isolated. The availability of prey, sand lice in particular, is thought to have had a strong influence on the distribution and movements of fin whales.

Vocalization and Hearing

Fin whales produce a variety of low frequency sounds in the 10 to 200 Hertz range (Watkins 1981, Watkins, Tyack et al. 1987, Edds 1988, Thompson, Findley et al. 1992). Typical vocalizations are long, patterned pulses of short duration (0.5 to two seconds) in the 18 to 35 Hertz range, but only males are known to produce these (Patterson and Hamilton 1964, Clark, Borsani et al. 2002). The most typically recorded call is a 20 Hertz pulse lasting about one second, and reaching source levels of 189 ± 4 decibels re 1 microPascal at 1 meter (Watkins 1981, Watkins, Tyack et al. 1987, Edds 1988, Richardson, Greene et al. 1995, Charif, Mellinger et al. 2002, Clark, Borsani et al. 2002, Sirovic, Hildebrand et al. 2007). These pulses frequently occur in long sequenced patterns, are down swept (e.g., 23 to 18 Hertz), and can be repeated over the course of many hours (Watkins, Tyack et al. 1987). In temperate waters, intense bouts of these patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clark and Charif 1998). Richardson et al. (1995) reported this call occurring in short series during spring, summer, and fall, and in repeated stereotyped patterns in winter. The seasonality and stereotype nature of these vocal sequences suggest that they are male reproductive displays (Watkins 1981, Watkins, Tyack et al. 1987); a notion further supported by data linking these vocalizations to male fin whales only (Croll, Clark et al. 2002). In Southern California, the 20 Hertz pulses are the dominant fin whale call type associated both with call-counter-call between multiple animals and with singing (U.S. Navy 2010, U.S. Navy 2012). An additional fin whale sound, the 40 Hertz call described by Watkins (1981), was also frequently recorded, although these calls are not as common as the 20 Hertz fin whale pulses. Seasonality of the 40 Hertz calls differed from the 20 Hertz calls, since 40 Hertz calls were more prominent in the spring, as observed at other sites across the northeast Pacific Ocean (Sirovic, Williams et al. 2012). Source levels of Eastern Pacific Ocean fin whale

20 Hertz calls has been reported as 189 ± 5.8 decibels re 1 microPascal at 1 meter (Weirathmueller, Wilcock et al. 2013). Some researchers have also recorded moans of 14 to 118 Hertz, with a dominant frequency of 20 Hertz, tonal vocalizations of 34 to 150 Hertz, and songs of 17 to 25 Hertz (Watkins 1981, Edds 1988, Cummings and Thompson 1994). In general, source levels for fin whale vocalizations are 140 to 200 decibels re 1 microPascal at 1 meter (as compiled by Erbe 2002, see also Clark and Gagnon 2004). The source depth of calling fin whales has been reported to be about 50 meters (164 feet) (Watkins, Tyack et al. 1987). Although acoustic recordings of fin whales from many diverse regions show close adherence to the typical 20-Hertz bandwidth and sequencing when performing these vocalizations, there have been slight differences in the pulse patterns, indicative of some geographic variation (Watkins, Tyack et al. 1987, Thompson, Findley et al. 1992).

Although their function is still in doubt, low frequency fin whale vocalizations travel over long distances and may aid in long distance communication (Payne and Webb. 1971, Edds-Walton 1997). 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 humpback whales (Croll, Clark et al. 2002). These vocal bouts last for a day or longer (Tyack 1999). Also, it has been suggested that some fin whale sounds may function for long range echolocation of large-scale geographic targets such as seamounts, which might be used for orientation and navigation (Tyack 1999).

Direct studies of fin whale hearing have not been conducted, but it is assumed that fin whales can hear the same frequencies that they produce (low) and are likely most sensitive to this frequency range (Richardson, Greene et al. 1995, Ketten 1997). This suggests fin whales, like other baleen whales, are more likely to have their best hearing capacities at low frequencies, including frequencies lower than those of normal human hearing, rather than mid- to high-frequencies (Ketten 1997). In a study using computer tomography scans of a calf fin whale skull, Cranford and Krysl (2015) found sensitivity to a broad range of frequencies between 10 Hertz and 12 kiloHertz and a maximum sensitivity to sounds in the 1 to 2 kiloHertz range. In terms of functional hearing capability, fin whales belong to the low-frequency group, which have a hearing range of 7 Hertz to 35 kiloHertz (NOAA 2018).

Status

The fin whale is endangered as a result of past commercial whaling. Prior to commercial whaling, hundreds of thousands of fin whales existed. Fin whales may be killed under “aboriginal subsistence whaling” in Greenland, under Japan’s scientific whaling program, and Iceland’s formal objection to the International Whaling Commission’s ban on commercial whaling. Additional threats include ship strikes, reduced prey availability due to overfishing or climate change, and noise. The species’ overall large population size may provide some resilience to current threats, but trends are largely unknown.

Critical Habitat

No critical habitat has been designated for the fin whale.

Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover fin whale populations. These threats will be discussed in further detail in the *Environmental Baseline* section of this opinion. See the 2010 Final Recovery Plan for the fin whale for complete downlisting/delisting criteria for both of the following recovery goals.

1. Achieve sufficient and viable population in all ocean basins.
2. Ensure significant threats are addressed.

9.3 Gray Whale – Western North Pacific Population

The gray whale is a baleen whale and the only species in the family Eschrichtiidae. There are two isolated geographic distributions of gray whales in the North Pacific Ocean: the Eastern North Pacific stock, found along the west coast of North America, and the Western North Pacific or “Korean” stock, found along the coast of eastern Asia (Figure 9).

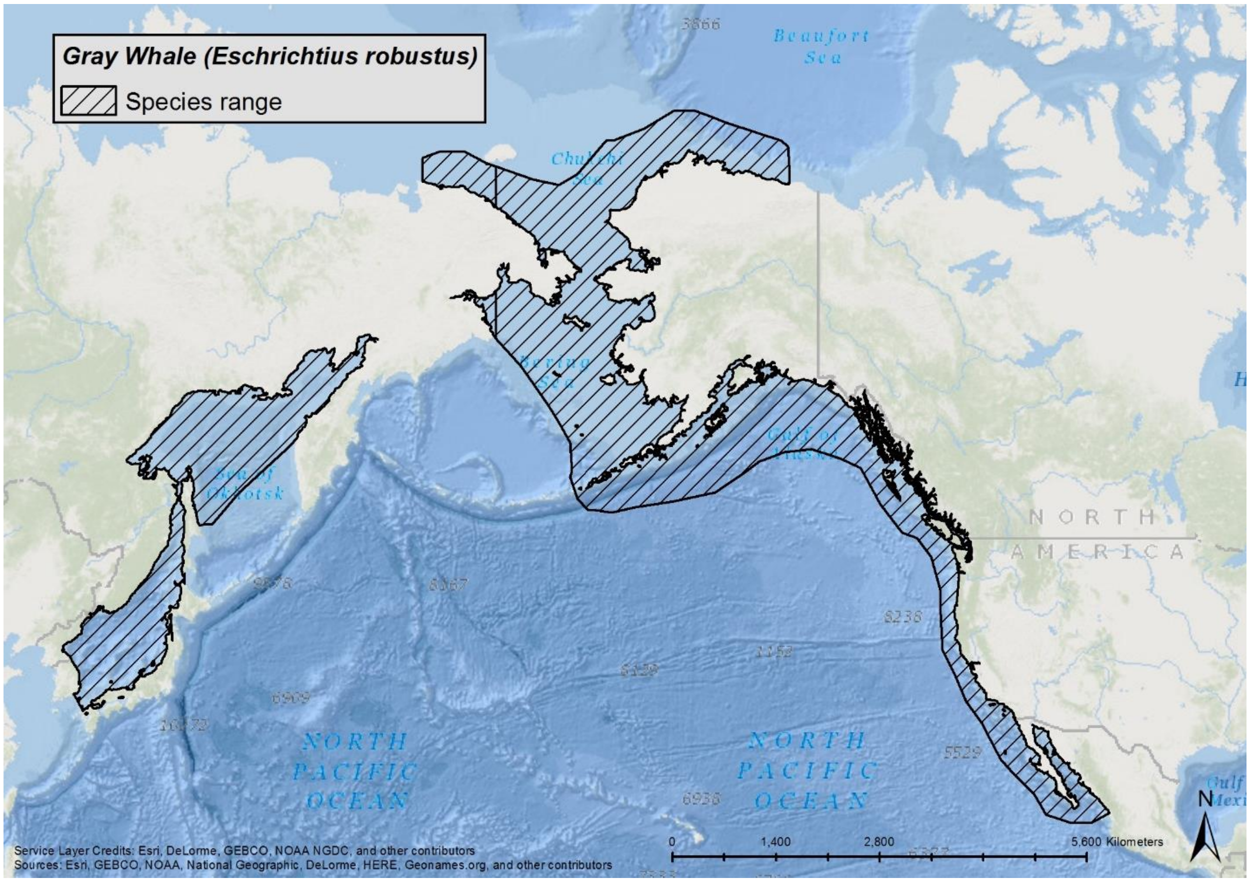

Figure 9. Map identifying the range of the gray whale.

Gray whales are distinguishable from other whales by a mottled gray body, small eyes located near the corners of their mouth, no dorsal fin, broad, paddle-shaped pectoral fins and a dorsal hump with a series of eight to 14 small bumps known as "knuckles." The gray whale was originally listed as endangered on December 2, 1970. The Eastern North Pacific stock was officially delisted on June 16, 1994 when it reached pre-exploitation numbers. The Western North Pacific population of gray whales remained listed as endangered.

Information available from the recent stock assessment reports (Carretta, Oleson et al. 2016, Muto, Helker et al. 2016, Waring, Josephson et al. 2016) were used to summarize the life history, population dynamics and status of the species as follows.

Life History

The average life span of gray whales is unknown but it is thought to be as long as 80 years. They have a gestation period of twelve to thirteen months, and calves nurse for seven to eight months. Sexual maturity is reached between six and 12 years of age with an average calving interval of two to four years (Weller, Bradford et al. 2009). Gray whales mostly inhabit shallow coastal waters in the North Pacific Ocean. Some Western North Pacific gray whales winter on the west coast of North America while others migrate south to winter in waters off Japan and China, and summer in the Okhotsk Sea off northeast Sakhalin Island, Russia, and off southeastern Kamchatka in the Bering Sea (Burdin, Sychenko et al. 2013). Gray whales travel alone or in small, unstable groups and are known as bottom feeders that eat "benthic" amphipods.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the gray whale.

Photo-identification data collected between 1994 and 2011 on the Western North Pacific population of gray whale summer feeding ground off Sakhalin Island were used to calculate an abundance estimate of 140 whales for the non-calf population size in 2012 (Cooke, Weller et al. 2013). The minimum population estimate for the Western North Pacific stock is 135 individual gray whales on the summer feeding ground off Sakhalin Island. The current best growth rate estimate for the Western North Pacific population of gray whale stock is 3.3 percent annually.

There are often observed movements between individuals from the Eastern North Pacific stock and Western North Pacific stock; however, genetic comparisons show significant mitochondrial and nuclear genetic differences between whales sampled from each stock indicating genetically distinct populations (Leduc, Weller et al. 2002). A study conducted between 1995 and 1999 using biopsy samples found that Western North Pacific population of gray whales have retained a relatively high number of mitochondrial DNA haplotypes for such a small population. Although the number of haplotypes currently found in the Western North Pacific stock is higher than might be expected, this pattern may not persist into the future. Populations reduced to small sizes, such as the Western North Pacific stock, can suffer from a loss of genetic diversity, which in turn may compromise their ability to respond to changing environmental conditions (Willi, Van Buskirk et al. 2006) and negatively influence long-term viability (Spielman, Brook et al. 2004, Frankham 2005).

Gray whales in the Western North Pacific population are thought to feed in the summer and fall in the Okhotsk Sea, primarily off Sakhalin Island, Russia and the Kamchatka peninsula in the Bering Sea, and winter in the South China Sea. However, tagging, photo-identification, and genetic studies have shown that some whales identified as members of the Western North Pacific stock have been observed in the Eastern North Pacific Ocean, which may indicate that not all gray whales share the same migratory patterns.

Vocalization and Hearing

No data are available regarding Western North Pacific population of gray whale hearing or communication. We assume that Eastern North Pacific population of gray whale communication is representative of the Western North Pacific population of gray whale and present information stemming from this population. Individuals produce broadband sounds within the 100 Hertz to 12 kiloHertz range (Thompson, Winn et al. 1979, Dahlheim, Fisher et al. 1984, Jones and Swartz

2002). The most common sounds encountered are on feeding and breeding grounds, where "knocks" of roughly 142 decibels re 1 microPascal at 1 meter (source level) have been recorded (Cummings, Thompson et al. 1968, Thomson and Richardson 1995, Jones and Swartz 2002). However, other sounds have also been recorded in Russian foraging areas, including rattles, clicks, chirps, squeaks, snorts, thumps, knocks, bellows, and sharp blasts at frequencies of 400 Hertz to 5 kiloHertz (Petrochenko, Potapov et al. 1991). Estimated source levels for these sounds ranged from 167 to 188 decibels re 1 microPascal at 1 meter (Petrochenko, Potapov et al. 1991). Low frequency (less than 1.5 kiloHertz) "bangs" and "moans" are most often recorded during migration and during ice-entrapment (Carroll, George et al. 1989, Crane and Lashkari. 1996). Sounds vary by social context and may be associated with startle responses (Rohrkasse-Charles, Würsig et al. 2011). Calves exhibit the greatest variation in frequency range used, while adults are narrowest; groups with calves were never silent while in calving grounds (Rohrkasse-Charles, Würsig et al. 2011). Based upon a single captive calf, moans were more frequent when the calf was less than a year old, but after a year, croaks were the predominant call type (Wisdom, Bowles et al. 1999).

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

Status

The Western North Pacific population of gray whale is endangered as a result of past commercial whaling and may still be hunted under "aboriginal subsistence whaling" provisions of the International Whaling Commission. Current threats include ship strikes, fisheries interactions (including entanglement), habitat degradation, harassment from whale watching, illegal whaling or resumed legal whaling, and noise.

The Western North Pacific population of gray whales has increased over the last ten years at an estimated rate of 3.3 percent. The Western North Pacific population was thought to be geographically isolated from the Eastern North Pacific population, but recent documentation of some gray whales moving between geographic areas in the Pacific Ocean indicate otherwise. Also, in recent years, gray whales have been sighted in the Eastern Atlantic Ocean and Mediterranean Sea, but it is unknown to which population those animals belong.

Critical Habitat

No critical habitat has been designated for the Western North Pacific population of gray whale. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

There is currently no Recovery Plan for the Western North Pacific population of gray whale. In general, ESA-listed species, which occur entirely outside United States jurisdiction, are not likely to benefit from recovery plans (55 FR 24296; June 15, 1990).

9.4 Humpback Whale – Arabian Sea Distinct Population Segment

The humpback whale is a widely distributed baleen whale found in all major oceans (Figure 10).

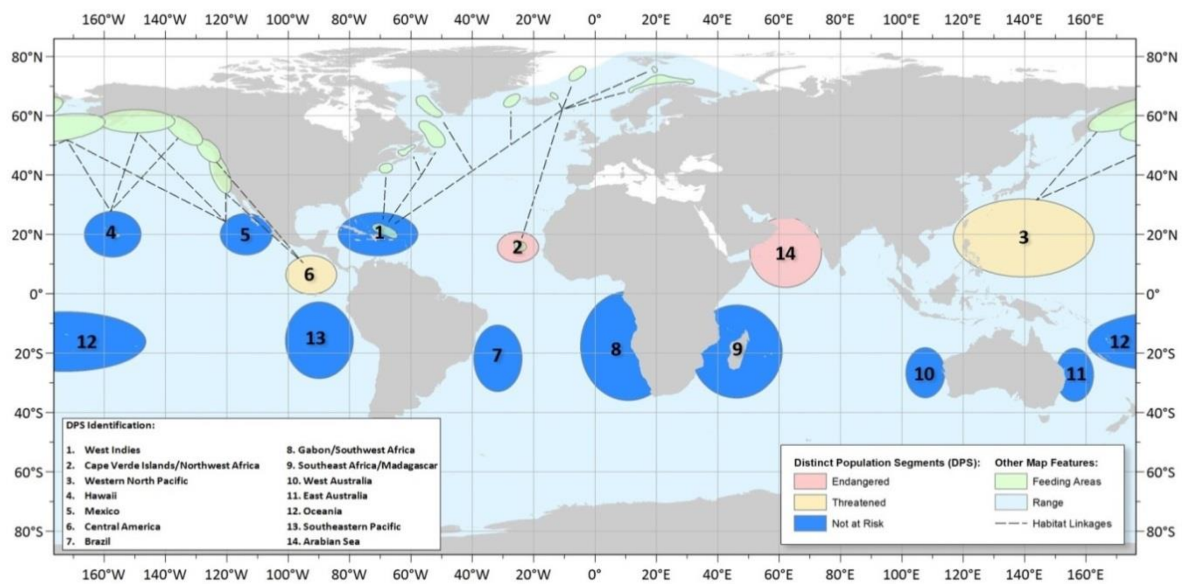

Figure 10. Map identifying 14 distinct population segments with one threatened and four endangered, based on primarily breeding location of the humpback whale, their range, and feeding areas (Bettridge et al. 2015).

Humpback whales are distinguishable from other whales by long pectoral fins and are typically dark grey with some areas of white. The humpback whale was originally listed as endangered on December 2, 1970 (35 FR 18319). Since then, NMFS has designated 14 DPSs with four identified as endangered (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) and one as threatened (Mexico) (Table 5).

Information available from the recovery plan (NMFS 1991), recent stock assessment reports (Carretta, Oleson et al. 2016, Muto, Helker et al. 2016, Waring, Josephson et al. 2016), the status review (Bettridge, Baker et al. 2015), and the final listing were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Humpback whales can live, on average, 50 years. They have a gestation period of 11 to 12 months, and calves nurse for one year. Sexual maturity is reached between five to 11 years of age with an average calving interval of two to three years. Humpback whales mostly inhabit coastal and continental shelf waters. They winter at lower latitudes, where they calve and nurse, and summer at high latitudes, where they feed. Humpback whales exhibit a wide range of foraging behaviors and feed on a range of prey types, including: small schooling fishes, euphausiids, and other large zooplankton (Bettridge, Baker et al. 2015).

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Arabian Sea DPS of humpback whales.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Arabian Sea DPS is 82. A population growth rate is currently unavailable for the Arabian Sea DPS of humpback whale.

For humpback whales, DPSs that have a total population size of 2,000 to 2,500 individuals or greater provide for maintenance of genetic diversity resulting in long-term persistence and protection from substantial environmental variance and catastrophes. Distinct population segments that have a total population of 500 individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Population at low densities (less than one hundred) are more likely to suffer from the 'Allee" effect, where inbreeding and the heightened difficulty of finding mates reduces the population growth rate in proportion with reducing density. The entire range of the Arabian Sea DPS has not been surveyed, but the most recent estimate abundance is less than 100 individuals, putting it at high risk of extinction due to lack of genetic diversity. The low abundance of this DPS suggests that the population has reached a genetic bottleneck and is at an increased risk to impacts from inbreeding, such as reduced genetic fitness and susceptibility to disease (Bettridge, Baker et al. 2015).

Vocalization and Hearing

Humpback whale vocalization is much better understood than is hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls (Dunlop, Cato et al. 2008). Males sing complex sounds while in low-latitude breeding areas in a frequency range of 20 Hertz to 4 kiloHertz with estimated source levels from 144 to 174 decibels (Winn, Perkins et al. 1970, Richardson, Jr. et al. 1995, Au, Popper et al. 2000, Frazer and Mercado Iii 2000, Au, Pack et al. 2006). Males also produce sounds associated with aggression, which are generally characterized by frequencies between 50 Hertz to 10 kHertz with most energy below 3 kiloHertz (Tyack 1983, Silber 1986). Such sounds can be heard up to 9 kilometers (4.9 nautical miles) away (Tyack 1983). Other social sounds from 50 Hertz to 10 kiloHertz (most energy below 3 kiloHertz) are also produced in breeding areas (Tyack 1983, Richardson, Jr. et al. 1995). While in northern feeding areas, both sexes vocalize in grunts (25 Hertz to 1.9 kiloHertz), pulses (25 to 89 Hertz) and songs (ranging from 30 Hertz to 8 kiloHertz but dominant frequencies of 120 Hertz to 4 kiloHertz), which can be very loud (175 to 192 decibels re 1 microPascal at 1 meter) (Payne 1985, Thompson, Cummings et al. 1986, Richardson, Jr. et al. 1995, Au, Popper et al. 2000, Erbe 2002). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson, Jr. et al. 1995). NMFS classified humpback whales in the low-frequency cetacean (i.e., baleen whale) functional hearing group. As a group, it is estimated that baleen whales can hear frequencies between 0.007 and 30 Hertz (NOAA 2013). Houser, Helweg et al. (2001) produced a mathematical model of humpback whale hearing sensitivity based on the anatomy of the humpback whale ear. Based on the model, they concluded that humpback whales would be sensitive to sound in frequencies ranging from 0.7 to 10 kiloHertz, with a maximum sensitivity between 2 to 6 kiloHertz.

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

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

“Feeding” calls, unlike song and social sounds are a highly stereotyped series of narrow-band trumpeting calls. These calls are 20 Hertz to 2 kiloHertz, less than one second in duration, and have source levels of 162 to 192 decibels re 1 microPascal at 1 meter (D'Vincent, Nilson et al. 1985, Thompson, Cummings et al. 1986). The fundamental frequency of feeding calls is approximately 500 Hertz (D'Vincent, Nilson et al. 1985, Thompson, Cummings et al. 1986). The acoustics and dive profiles associated with humpback whale feeding behavior in the northwest Atlantic Ocean has been documented with Digital Acoustic Recording Tags (DTAGs) (Stimpert, Wiley et al. 2007). Underwater lunge behavior was associated with nocturnal feeding at depth and with multiple boats of broadband click trains that were acoustically different from toothed whale echolocation: (Stimpert, Wiley et al. 2007) termed these sounds “mega-clicks” which showed relatively low received levels at the DTAGs (143 to 154 decibels re 1 microPascal at 1 meter), with the majority of acoustic energy below 2 kiloHertz.

In terms of functional hearing capability, humpback whales belong to low frequency cetaceans which have a hearing range of 7 Hertz to 22 kiloHertz (Southall, Bowles et al. 2007). Humpback whale audiograms using a mathematical model based on the internal structure of the ear estimate sensitivity is from 700 Hertz to 10 kiloHertz, with maximum relative sensitivity between 2 kiloHertz and 6 kiloHertz (Ketten and Mountain 2014). Research by Au, Darling et al. (2001) and Au, Pack et al. (2006) off Hawaii indicated the presence of high frequency harmonics in vocalizations up to and beyond 24 kiloHertz. While recognizing this was the upper limit of the recording equipment, it does not demonstrate that humpback whales can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental in the humpback whale song. The ability of humpback whales to hear frequencies around 3 kiloHertz may have been demonstrated in a playback study. Maybaum (1990) reported that humpback whales showed a mild response to a handheld sonar marine mammal detection and location device with frequency of 3.3 kiloHertz at 219 decibels re 1 microPascal at 1 meter or frequency sweep of 3.1 to 3.6 kiloHertz. In addition, the system had some low frequency components (below 1 kiloHertz) which may have been an artifact of the acoustic equipment. This possible artifact may have affected the response of the whales to both the control and sonar playback conditions.

Status

Humpback whales were originally listed as endangered as a result of past commercial whaling, and the five DPSs that remain listed (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, Arabian Sea, and Mexico) have likely not yet recovered from this. Prior to commercial whaling, hundreds of thousands of humpback whales existed. Global abundance declined to the low thousands by 1968, the last year of substantial catches (IUCN 2012). Humpback whales may be killed under “aboriginal subsistence whaling” and “scientific permit whaling” provisions of the International Whaling Commission. Additional threats include ship strikes, fisheries interactions (including entanglement), energy development, harassment from whale-watching noise, harmful algal blooms, disease, parasites, and climate change. The species’ large population size and increasing trends indicate that it is resilient to current threats, but the Arabian Sea DPS of humpback whales still faces a risk of extinction.

Critical Habitat

No critical habitat has been designated for humpback whales.

Recovery Goals

See the 1991 Final Recovery Plan for the humpback whale for the complete downlisting/delisting criteria for each of the four following recovery goals:

1. Maintain and enhance habitats used by humpback whales currently or historically.
2. Identify and reduce direct human-related injury and mortality.
3. Measure and monitor key population parameters.
4. Improve administration and coordination of recovery program for humpback whales.

9.5 Humpback Whale – Cape Verde Islands/Northwest Africa Distinct Population Segment

The humpback whale is a widely distributed baleen whale found in all major oceans (Figure 10).

Humpbacks are distinguishable from other whales by long pectoral fins and are typically dark grey with some areas of white. They humpback whale was originally listed as endangered on December 2, 1970 (35 FR 18319). Since then, NMFS has designated 14 DPSs with four identified as endangered (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) and one as threatened (Mexico) (Table 5).

Information available from the recovery plan (NMFS 1991), recent stock assessment reports (Carretta, Oleson et al. 2016, Muto, Helker et al. 2016, Waring, Josephson et al. 2016), the status review (Bettridge, Baker et al. 2015), and the final listing were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Humpback whales can live, on average, 50 years. They have a gestation period of 11 to 12 months, and calves nurse for one year. Sexual maturity is reached between five to 11 years of age with an average calving interval of two to three years. Humpbacks mostly inhabit coastal and continental shelf waters. They winter at lower latitudes, where they calve and nurse, and summer at high latitudes, where they feed. Humpback whales exhibit a wide range of foraging behaviors and feed on a range of prey types, including: small schooling fishes, euphausiids, and other large zooplankton (Bettridge, Baker et al. 2015).

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Cape Verde Islands/Northwest Africa DPS of humpback whales.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Cape Verde Islands/Northwest Africa DPS of humpback whales is unknown (81 FR 62259). A population growth rate is currently unavailable for the Cape Verde Islands/Northwest Africa DPS of humpback whales.

For humpback whales, DPSs that have a total population size of 2,000 to 2,500 individuals or greater provide for maintenance of genetic diversity resulting in long-term persistence and protection from substantial environmental variance and catastrophes. Distinct population segments that have a total population of five hundred individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Population at low densities (less than one hundred) are more likely to suffer from the 'Allee" effect, where inbreeding and the heightened difficulty of finding mates reduces the population growth rate in proportion with reducing density. The population size of the Cape Verde Islands/Northwest Africa DPS of humpback whales is unknown at this time and therefore evidence of genetic diversity (or lack of) cannot be determined (Bettridge, Baker et al. 2015).

The Cape Verde Islands/Northwest Africa DPS consists of humpback whales whose breeding range includes waters surrounding the Cape Verde Islands as well as undetermined breeding area in the eastern tropical Atlantic Ocean, and possibly the Caribbean Sea. Its feeding range includes primarily Iceland and Norway.

Vocalization and Hearing

Humpback whale vocalization is much better understood than is hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls (Dunlop, Cato et al. 2008). Males sing complex sounds while in low-latitude breeding areas in a frequency range of 20 Hertz to 4 kiloHertz with estimated source levels from 144 to 174 decibels (Winn, Perkins et al. 1970, Richardson, Jr. et al. 1995, Au, Popper et al. 2000, Frazer and Mercado Iii 2000, Au, Pack et al. 2006). Males also produce sounds associated with aggression, which are generally characterized by frequencies between 50 Hertz to 10 kiloHertz with most energy below 3 kiloHertz (Tyack 1983, Silber 1986). Such sounds can be heard up to 9 kilometers (4.9 nautical miles) away (Tyack 1983). Other social sounds from 50 Hertz to 10 kiloHertz (most energy below 3 kiloHertz) are also produced in breeding areas (Tyack 1983, Richardson, Jr. et al. 1995). While in northern feeding areas, both sexes vocalize in grunts (25 Hertz to 1.9 kiloHertz), pulses (25 to 89 Hertz) and songs (ranging from 30 Hertz to 8 kiloHertz but dominant frequencies of 120 Hertz to 4 kiloHertz), which can be very loud (175 to 192 decibels re 1 microPascal at 1 meter) (Payne 1985, Thompson, Cummings et al. 1986, Richardson, Jr. et al. 1995, Au, Popper et al. 2000, Erbe 2002). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson, Jr. et al. 1995). NMFS classified humpback whales in the low-frequency cetacean (i.e., baleen whale) functional hearing group. As a group, it is estimated that baleen whales can hear frequencies between 0.007 and 30 Hertz (NOAA 2013). Houser, Helweg et al. (2001) produced a mathematical model of humpback whale hearing sensitivity based on the anatomy of the humpback whale ear. Based on the model, they concluded that humpback whales would be sensitive to sound in frequencies ranging from 0.7 to 10 kiloHertz, with a maximum sensitivity between 2 to 6 kiloHertz.

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

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

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

In terms of functional hearing capability, humpback whales belong to low frequency cetaceans which have a hearing range of 7 Hertz to 22 kiloHertz (Southall, Bowles et al. 2007). Humpback whale audiograms using a mathematical model based on the internal structure of the ear estimate sensitivity is from 700 Hertz to 10 kiloHertz, with maximum relative sensitivity between 2 kiloHertz and 6 kiloHertz (Ketten and Mountain 2014). Research by Au, Darling et al. (2001)

and Au, Pack et al. (2006) off Hawaii indicated the presence of high frequency harmonics in vocalizations up to and beyond 24 kiloHertz. While recognizing this was the upper limit of the recording equipment, it does not demonstrate that humpback whales can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental in the humpback whale song. The ability of humpback whales to hear frequencies around 3 kiloHertz may have been demonstrated in a playback study. Maybaum (1990) reported that humpback whales showed a mild response to a handheld sonar marine mammal detection and location device with frequency of 3.3 kiloHertz at 219 decibels re 1 microPascal at 1 meter or frequency sweep of 3.1 to 3.6 kiloHertz. In addition, the system had some low frequency components (below 1 kiloHertz) which may have been an artifact of the acoustic equipment. This possible artifact may have affected the response of the whales to both the control and sonar playback conditions.

Status

Humpback whales were originally listed as endangered as a result of past commercial whaling, and the five DPSs that remain listed (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, Arabian Sea, and Mexico) have likely not yet recovered from this. Prior to commercial whaling, hundreds of thousands of humpback whales existed. Global abundance declined to the low thousands by 1968, the last year of substantial catches (IUCN 2012). Humpback whales may be killed under “aboriginal subsistence whaling” and “scientific permit whaling” provisions of the International Whaling Commission. Additional threats include ship strikes, fisheries interactions (including entanglement), energy development, harassment from whale-watching noise, harmful algal blooms, disease, parasites, and climate change. The species’ large population size and increasing trends indicate that it is resilient to current threats, but the Cape Verde Islands/Northwest Africa DPS of humpback whales still faces a risk of extinction.

Critical Habitat

No critical habitat has been designated for humpback whales.

Recovery Goals

See the 1991 Final Recovery Plan for the humpback whale for the complete downlisting/delisting criteria for each of the four following recovery goals:

1. Maintain and enhance habitats used by humpback whales currently or historically.
2. Identify and reduce direct human-related injury and mortality.
3. Measure and monitor key population parameters.
4. Improve administration and coordination of recovery program for humpback whales.

9.6 Humpback Whale – Central America Distinct Population Segment

The humpback whale is a widely distributed baleen whale found in all major oceans (Figure 10).

Humpback whales are distinguishable from other whales by long pectoral fins and are typically dark grey with some areas of white. They humpback whale was originally listed as endangered on December 2, 1970 (35 FR 18319). Since then, NMFS has designated 14 DPSs with four identified as endangered (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) and one as threatened (Mexico) (Table 5).

Information available from the recovery plan (NMFS 1991), recent stock assessment reports (Carretta, Oleson et al. 2016, Muto, Helker et al. 2016, Waring, Josephson et al. 2016), the status review (Bettridge, Baker et al. 2015), and the final listing were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Humpback whales can live, on average, 50 years. They have a gestation period of 11 to 12 months, and calves nurse for one year. Sexual maturity is reached between five to 11 years of age with an average calving interval of two to three years. Humpback whales mostly inhabit coastal and continental shelf waters. They winter at lower latitudes, where they calve and nurse, and summer at high latitudes, where they feed. Humpback whales exhibit a wide range of foraging behaviors and feed on a range of prey types, including: small schooling fishes, euphausiids, and other large zooplankton (Bettridge, Baker et al. 2015).

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Central America DPS of humpback whales.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Central America DPS is 411. A population growth rate is currently unavailable for the Central America DPS of humpback whales.

For humpback whales, DPSs that have a total population size of 2,000 to 2,500 individuals or greater provide for maintenance of genetic diversity resulting in long-term persistence and protection from substantial environmental variance and catastrophes. Distinct population segments that have a total population of 500 individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Population at low densities (less than one hundred) are more likely to suffer from the 'Allee" effect, where inbreeding and the heightened difficulty of finding mates reduces the population growth rate in proportion with reducing density. The Central America DPS has just below 500 individuals and so may be subject to genetic risks due to inbreeding and moderate environmental variance (Bettridge, Baker et al. 2015).

The Central America DPS is composed of humpback whales that breed along the Pacific coast of Costa Rica, Panama, Guatemala, El Salvador, Honduras, and Nicaragua. This DPS feeds almost exclusively offshore of California and Oregon in the eastern Pacific Ocean, with only a few individuals identified at the northern Washington – southern British Columbia feeding grounds.

Vocalization and Hearing

Humpback whale vocalization is much better understood than is hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls (Dunlop, Cato et al. 2008). Males sing complex sounds while in low-latitude breeding areas in a frequency range of 20 Hertz to 4 kiloHertz with estimated source levels from 144 to 174 decibels (Winn, Perkins et al. 1970, Richardson, Jr. et al. 1995, Au, Popper et al. 2000, Frazer and Mercado Iii 2000, Au, Pack et al. 2006). Males also produce sounds associated with aggression, which are generally characterized by frequencies between 50 Hertz to 10 kiloHertz with most energy below 3 kiloHertz (Tyack 1983, Silber 1986). Such sounds can be heard up to 9 kilometers (4.9 nautical miles) away (Tyack 1983). Other social sounds from 50 Hertz to 10 kiloHertz (most energy below 3 kiloHertz) are also produced in breeding areas (Tyack 1983, Richardson, Jr. et al. 1995). While in northern feeding areas, both sexes vocalize in grunts (25 Hertz to 1.9 kiloHertz), pulses (25 to 89 Hertz) and songs (ranging from 30 Hertz to 8 kiloHertz but dominant frequencies of 120 Hertz to 4 kiloHertz), which can be very loud (175 to 192 dB re: 1 μPa at 1 m) (Payne 1985, Thompson, Cummings et al. 1986, Richardson, Jr. et al. 1995, Au, Popper et al. 2000, Erbe 2002). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson, Jr. et al. 1995). NMFS classified humpback whales in the low-frequency cetacean (i.e., baleen whale) functional hearing group. As a group, it is estimated that baleen whales can hear frequencies between 0.007 and 30 Hertz (NOAA 2013). Houser, Helweg et al. (2001) produced a mathematical model of humpback whale hearing sensitivity based on the anatomy of the humpback whale ear. Based on the model, they concluded that humpback whales will be sensitive to sound in frequencies ranging from 0.7 to 10 kiloHertz, with a maximum sensitivity between 2 to 6 kiloHertz.

Humpback whales are known to produce three classes of vocalizations: (1) “songs” in the late fall, winter, and spring by solitary males; (2) social sounds made by calves (Zoidis, Smultea et al. 2008) or within groups on the wintering (calving) grounds; and (3) social sounds made on the feeding grounds (Thomson and Richardson 1995). The best-known types of sounds produced by humpback whales are songs, which are thought to be reproductive displays used on breeding grounds and sung only by adult males (Schevill, Watkins et al. 1964, Helweg, Frankel et al. 1992, Gabriele and Frankel. 2002, Clark and Clapham 2004, Smith, Goldizen et al. 2008). Singing is most common on breeding grounds during the winter and spring months, but is occasionally heard in other regions and seasons (Mcsweeney, Chu et al. 1989, Gabriele and Frankel. 2002, Clark and Clapham 2004). Au, Mobley et al. (2000) noted that humpback whales off Hawaii tended to sing louder at night compared to the day. There is a geographical variation in humpback whale song, with different populations singing a basic form of a song that is unique to their own group. However, the song evolves over the course of a breeding season but remains nearly unchanged from the end of one season to the start of the next (Payne, Tyack et al. 1983).

The song is an elaborate series of patterned vocalizations that are hierarchical in nature, with a series of songs ('song sessions') sometimes lasting for hours (Payne and Mcvay 1971). Components of the song range from below 20 Hertz up to 4 kiloHertz, with source levels measured between 151 and 189 decibels re: 1 μPa-m and high frequency harmonics extending beyond 24 kiloHertz (Winn, Perkins et al. 1970, Au, Pack et al. 2006).

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

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

In terms of functional hearing capability, humpback whales belong to low frequency cetaceans which have a hearing range of 7 Hertz to 22 kiloHertz (Southall, Bowles et al. 2007). Humpback whale audiograms using a mathematical model based on the internal structure of the ear estimate sensitivity is from 700 Hertz to 10 kiloHertz, with maximum relative sensitivity between 2 kiloHertz and 6 kiloHertz (Ketten and Mountain 2014). Research by Au, Darling et al. (2001) and Au, Pack et al. (2006) off Hawaii indicated the presence of high frequency harmonics in vocalizations up to and beyond 24 kiloHertz. While recognizing this was the upper limit of the recording equipment, it does not demonstrate that humpback whales can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental in the humpback whale song. The ability of humpback whales to hear frequencies around 3 kiloHertz may have been demonstrated in a playback study. Maybaum (1990) reported that humpback whales showed a mild response to a handheld sonar marine mammal detection and location device with frequency of 3.3 kiloHertz at 219 decibels re: 1 μPa-m or frequency sweep of 3.1 to 3.6 kiloHertz. In addition, the system had some low frequency components (below 1 kiloHertz) which may have been an artifact of the acoustic equipment. This possible artifact may have affected the response of the whales to both the control and sonar playback conditions.

Status

Humpback whales were originally listed as endangered because of past commercial whaling, and the five DPSs that remain listed (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, Arabian Sea, and Mexico) have likely not yet recovered from this. Prior to commercial whaling, hundreds of thousands of humpback whales existed. Global abundance declined to the low thousands by 1968, the last year of substantial catches (IUCN 2012). Humpback whales may be killed under "aboriginal subsistence whaling" and "scientific permit whaling" provisions of the International Whaling Commission. Additional threats include ship strikes, fisheries interactions (including entanglement), energy development, harassment from whale-watching noise, harmful algal blooms, disease, parasites, and climate change. The species' large population size and increasing trends indicate that it is resilient to current threats, but the Central America DPS still faces a risk of extinction.

Critical Habitat

No critical habitat has been designated for humpback whales.

Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover humpback whale populations. These threats will be discussed in further detail in the *Environmental Baseline* section of this opinion. See the 1991 Final Recovery Plan for the humpback whale for the complete downlisting/delisting criteria for each of the four following recovery goals:

1. Maintain and enhance habitats used by humpback whales currently or historically.
2. Identify and reduce direct human-related injury and mortality.
3. Measure and monitor key population parameters.
4. Improve administration and coordination of recovery program for humpback whales.

9.7 Humpback Whale – Mexico Distinct Population Segment

The humpback whale is a widely distributed baleen whale found in all major oceans (Figure 10).

Humpback whales are distinguishable from other whales by long pectoral fins and are typically dark grey with some areas of white. They humpback whale was originally listed as endangered on December 2, 1970 (35 FR 18319). Since then, NMFS has designated 14 DPSs with four identified as endangered (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) and one as threatened (Mexico) (Table 5).

Information available from the recovery plan (NMFS 1991), recent stock assessment reports (Carretta, Oleson et al. 2016, Muto, Helker et al. 2016, Waring, Josephson et al. 2016), the status review (Bettridge, Baker et al. 2015), and the final listing were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Humpback whales can live, on average, 50 years. They have a gestation period of 11 to 12 months, and calves nurse for one year. Sexual maturity is reached between five to 11 years of age with an average calving interval of two to three years. Humpback whales mostly inhabit coastal and continental shelf waters. They winter at lower latitudes, where they calve and nurse, and summer at high latitudes, where they feed. Humpback whales exhibit a wide range of foraging behaviors and feed on a range of prey types, including: small schooling fishes, euphausiids, and other large zooplankton (Bettridge, Baker et al. 2015).

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Mexico DPS of humpback whales.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Mexico DPS is unavailable. A population growth rate is currently unavailable for the Mexico DPS of humpback whales.

For humpback whales, DPSs that have a total population size of 2,000 to 2,500 individuals or greater provide for maintenance of genetic diversity resulting in long-term persistence and protection from substantial environmental variance and catastrophes. Distinct population segments that have a total population of 500 individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Population at low densities (less than one hundred) are more likely to suffer from the 'Allee" effect, where inbreeding and the heightened difficulty of finding mates reduces the population growth rate in proportion with reducing density. The Mexico DPS is estimated to have more than 2,000 individuals and thus, should have enough genetic diversity for long-term persistence and protection from substantial environmental variance and catastrophes (Bettridge, Baker et al. 2015).

The Mexico DPS is composed of humpback whales that breed along the Pacific coast of mainland Mexico, and the Revillagigedos Islands, and transit through the Baja California Peninsula coast. This DPS feeds across a broad geographic range from California to the Aleutian Islands, with concentrations in California-Oregon, northern Washington-southern British Columbia, northern and western Gulf of Alaska, and Bering Sea feeding grounds (81 FR 62259).

Vocalization and Hearing

Humpback whale vocalization is much better understood than is hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls (Dunlop, Cato et al. 2008). Males sing complex sounds while in low-latitude breeding areas in a frequency range of 20 Hertz to 4 kiloHertz with estimated source levels from 144 to 174 decibels (Winn, Perkins et al. 1970, Richardson, Jr. et al. 1995, Au, Popper et al. 2000, Frazer and Mercado Iii 2000, Au, Pack et al. 2006). Males also produce sounds associated with aggression, which are generally characterized by frequencies between 50 Hertz to 10 kiloHertz with most energy below 3 kiloHertz (Tyack 1983, Silber 1986). Such sounds can be heard up to 9 kilometer (4.9 nautical miles) away (Tyack 1983). Other social sounds from 50 Hertz to 10 kiloHertz (most energy below 3 kiloHertz) are also produced in breeding areas (Tyack 1983, Richardson, Jr. et al.

1995). While in northern feeding areas, both sexes vocalize in grunts (25 Hertz to 1.9 kiloHertz), pulses (25 to 89 Hertz) and songs (ranging from 30 Hertz to 8 kiloHertz but dominant frequencies of 120 Hertz to 4 kiloHertz), which can be very loud (175 to 192 decibels re 1 microPascal at 1 meter) (Payne 1985, Thompson, Cummings et al. 1986, Richardson, Jr. et al. 1995, Au, Popper et al. 2000, Erbe 2002). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson, Jr. et al. 1995). NMFS classified humpback whales in the low-frequency cetacean (i.e., baleen whale) functional hearing group. As a group, it is estimated that baleen whales can hear frequencies between 0.007 and 30 Hertz (NOAA 2013). Houser, Helweg et al. (2001) produced a mathematical model of humpback whale hearing sensitivity based on the anatomy of the humpback whale ear. Based on the model, they concluded that humpback whales would be sensitive to sound in frequencies ranging from 0.7 to 10 kiloHertz, with a maximum sensitivity between 2 to 6 kiloHertz.

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

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

“Feeding” calls, unlike song and social sounds are a highly stereotyped series of narrow-band trumpeting calls. These calls are 20 Hertz to 2 kiloHertz, less than one second in duration, and have source levels of 162 to 192 decibels re 1 microPascal at 1 meter (D'Vincent, Nilson et al. 1985, Thompson, Cummings et al. 1986). The fundamental frequency of feeding calls is approximately 500 kiloHertz (D'Vincent, Nilson et al. 1985, Thompson, Cummings et al. 1986).

The acoustics and dive profiles associated with humpback whale feeding behavior in the northwest Atlantic Ocean has been documented with DTAGs (Stimpert, Wiley et al. 2007). Underwater lunge behavior was associated with nocturnal feeding at depth and with multiple boats of broadband click trains that were acoustically different from toothed whale echolocation: Stimpert, Wiley et al. (2007) termed these sounds “mega-clicks” which showed relatively low received levels at the DTAGs (143 to 154 decibels re 1 microPascal at 1 meter), with the majority of acoustic energy below 2 kiloHertz.

In terms of functional hearing capability, humpback whales belong to low frequency cetaceans which have a hearing range of 7 Hertz to 22 kiloHertz (Southall, Bowles et al. 2007). Humpback whale audiograms using a mathematical model based on the internal structure of the ear estimate sensitivity is from 700 Hertz to 10 kiloHertz, with maximum relative sensitivity between 2 kiloHertz and 6 kiloHertz (Ketten and Mountain 2014). Research by Au, Darling et al. (2001) and Au, Pack et al. (2006) off Hawaii indicated the presence of high frequency harmonics in vocalizations up to and beyond 24 kiloHertz. While recognizing this was the upper limit of the recording equipment, it does not demonstrate that humpback whales can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental in the humpback whale song. The ability of humpback whales to hear frequencies around 3 kiloHertz may have been demonstrated in a playback study. Maybaum (1990) reported that humpback whales showed a mild response to a handheld sonar marine mammal detection and location device with frequency of 3.3 kiloHertz at 219 decibels re 1 microPascal at 1 meter or frequency sweep of 3.1 to 3.6 kiloHertz. In addition, the system had some low frequency components (below 1 kiloHertz) which may have been an artifact of the acoustic equipment. This possible artifact may have affected the response of the whales to both the control and sonar playback conditions.

Status

Humpback whales were originally listed as endangered because of past commercial whaling, and the five DPSs that remain listed (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, Arabian Sea, and Mexico) have likely not yet recovered from this. Prior to commercial whaling, hundreds of thousands of humpback whales existed. Global abundance declined to the low thousands by 1968, the last year of substantial catches (IUCN 2012). Humpback whales may be killed under “aboriginal subsistence whaling” and “scientific permit whaling” provisions of the International Whaling Commission. Additional threats include ship strikes, fisheries interactions (including entanglement), energy development, harassment from whale-watching noise, harmful algal blooms, disease, parasites, and climate change. The species’ large population size and increasing trends indicate that it is resilient to current threats, but the Mexico DPS still faces a risk of becoming endangered within the foreseeable future throughout all or a significant portion of its range.

Critical Habitat

No critical habitat has been designated for humpback whales.

Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover humpback whale populations. These threats will be discussed in further detail in the *Environmental Baseline* section of this opinion. See the 1991 Final Recovery Plan for the humpback whale for the complete downlisting/delisting criteria for each of the four following recovery goals:

1. Maintain and enhance habitats used by humpback whales currently or historically.
2. Identify and reduce direct human-related injury and mortality.
3. Measure and monitor key population parameters.
4. Improve administration and coordination of recovery program for humpback whales.

9.8 Humpback Whale – Western North Pacific Distinct Population Segment

The humpback whale is a widely distributed baleen whale found in all major oceans (Figure 10).

Humpback whales are distinguishable from other whales by long pectoral fins and are typically dark grey with some areas of white. They humpback whale was originally listed as endangered on December 2, 1970 (35 FR 18319). Since then, NMFS has designated 14 DPSs with four identified as endangered (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) and one as threatened (Mexico) (Table 5).

Information available from the recovery plan (NMFS 1991), recent stock assessment reports (Carretta, Oleson et al. 2016, Muto, Helker et al. 2016, Waring, Josephson et al. 2016), the status review (Bettridge, Baker et al. 2015), and the final listing were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Humpback whales can live, on average, 50 years. They have a gestation period of 11 to 12 months, and calves nurse for one year. Sexual maturity is reached between five to 11 years of age with an average calving interval of two to three years. Humpback whales mostly inhabit coastal and continental shelf waters. They winter at lower latitudes, where they calve and nurse, and summer at high latitudes, where they feed. Humpback whales exhibit a wide range of foraging behaviors and feed on a range of prey types, including: small schooling fishes, euphausiids, and other large zooplankton (Bettridge, Baker et al. 2015).

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Western North Pacific DPS of humpback whales.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Western North Pacific DPS is 1,059. A population growth rate is currently unavailable for the Western North Pacific DPS of humpback whales.

For humpback whales, DPSs that have a total population size of 2,000 to 2,500 individuals or greater provide for maintenance of genetic diversity resulting in long-term persistence and protection from substantial environmental variance and catastrophes. Distinct population segments that have a total population of 500 individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Population at low densities (less than one hundred) are more likely to suffer from the 'Allee" effect, where inbreeding and the heightened difficulty of finding mates reduces the population growth rate in proportion with reducing density. The Western North Pacific DPS has less than 2,000 individuals total, and is made up of two sub-populations, Okinawa/Philippines and the Second West Pacific. Thus, while its genetic diversity may be protected from moderate environmental variance, it could be subject to extinction due to genetic risks due to low abundance (Bettridge, Baker et al. 2015).

The Western North Pacific DPS is composed of humpback whales that breed/winter in the area of Okinawa and the Philippines, another unidentified breeding area (inferred from sightings of whales in the Aleutian Islands area feeding grounds), and those transiting from the Ogasawara area. These whales migrate to feeding grounds in the northern Pacific Ocean, primarily off the Russian coast.

Vocalization and Hearing

Humpback whale vocalization is much better understood than is hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls (Dunlop, Cato et al. 2008). Males sing complex sounds while in low-latitude breeding areas in a frequency range of 20 Hertz to 4 kiloHertz with estimated source levels from 144 to 174 decibels (Winn, Perkins et al. 1970, Richardson, Jr. et al. 1995, Au, Popper et al. 2000, Frazer and Mercado Iii 2000, Au, Pack et al. 2006). Males also produce sounds associated with aggression, which are generally characterized by frequencies between 50 Hertz to 10 kiloHertz with most energy below 3 kiloHertz (Tyack 1983, Silber 1986). Such sounds can be heard up to 9 kilometer (4.9 nautical miles) away (Tyack 1983). Other social sounds from 50 Hertz to 10 kiloHertz (most energy below 3 kiloHertz) are also produced in breeding areas (Tyack 1983, Richardson, Jr. et al. 1995). While in northern feeding areas, both sexes vocalize in grunts (25 Hertz to 1.9 kiloHertz), pulses (25 to 89 Hertz) and songs (ranging from 30 Hertz to 8 kiloHertz but dominant frequencies of 120 Hertz to 4 kiloHertz), which can be very loud (175 to 192 decibels re 1 microPascal at 1 meter) (Payne 1985, Thompson, Cummings et al. 1986, Richardson, Jr. et al. 1995, Au, Popper et al. 2000, Erbe 2002). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson, Jr. et al. 1995). NMFS classified humpback whales in the low-frequency cetacean (i.e., baleen whale) functional hearing group. As a group, it is estimated that baleen whales can hear frequencies between 0.007 and 30

Hertz (NOAA 2013). Houser, Helweg et al. (2001) produced a mathematical model of humpback whale hearing sensitivity based on the anatomy of the humpback whale ear. Based on the model, they concluded that humpback whales would be sensitive to sound in frequencies ranging from 0.7 to 10 kiloHertz, with a maximum sensitivity between 2 to 6 kiloHertz.

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

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

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

In terms of functional hearing capability, humpback whales belong to low frequency cetaceans which have a hearing range of 7 Hertz to 22 kiloHertz (Southall, Bowles et al. 2007). Humpback whale audiograms using a mathematical model based on the internal structure of the ear estimate sensitivity is from 700 Hertz to 10 kiloHertz, with maximum relative sensitivity between 2 kiloHertz and 6 kiloHertz (Ketten and Mountain 2014). Research by Au, Darling et al. (2001) and Au, Pack et al. (2006) off Hawaii indicated the presence of high frequency harmonics in vocalizations up to and beyond 24 kiloHertz. While recognizing this was the upper limit of the recording equipment, it does not demonstrate that humpback whales can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental in the humpback whale song. The ability of humpback whales to hear frequencies around 3 kiloHertz may have been demonstrated in a playback study. Maybaum (1990) reported that humpback whales showed a mild response to a handheld sonar marine mammal detection and location device with frequency of 3.3 kiloHertz at 219 decibels re 1 microPascal at 1 meter or frequency sweep of 3.1 to 3.6 kiloHertz. In addition, the system had some low frequency components (below 1 kiloHertz) which may have been an artifact of the acoustic equipment. This possible artifact may have affected the response of the whales to both the control and sonar playback conditions.

Status

Humpback whales were originally listed as endangered as a result of past commercial whaling, and the five DPSs that remain listed (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, Arabian Sea, and Mexico) have likely not yet recovered from this. Prior to commercial whaling, hundreds of thousands of humpback whales existed. Global abundance declined to the low thousands by 1968, the last year of substantial catches (IUCN 2012). Humpback whales may be killed under “aboriginal subsistence whaling” and “scientific permit whaling” provisions of the International Whaling Commission. Additional threats include ship strikes, fisheries interactions (including entanglement), energy development, harassment from whale-watching noise, harmful algal blooms, disease, parasites, and climate change. The species’ large population size and increasing trends indicate that it is resilient to current threats, but the Western North Pacific DPS of humpback whales still faces a risk of extinction.

Critical Habitat

No critical habitat has been designated for humpback whales.

Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover humpback whale populations. These threats will be discussed in further detail in the *Environmental Baseline* section of this opinion. See the 1991 Final Recovery Plan for the humpback whale for the complete downlisting/delisting criteria for each of the four following recovery goals:

1. Maintain and enhance habitats used by humpback whales currently or historically.
2. Identify and reduce direct human-related injury and mortality.
3. Measure and monitor key population parameters.
4. Improve administration and coordination of recovery program for humpback whales.

9.9 North Pacific Right Whale

North Pacific right whales are found in temperate and sub-polar waters of the North Pacific Ocean (Figure 11).

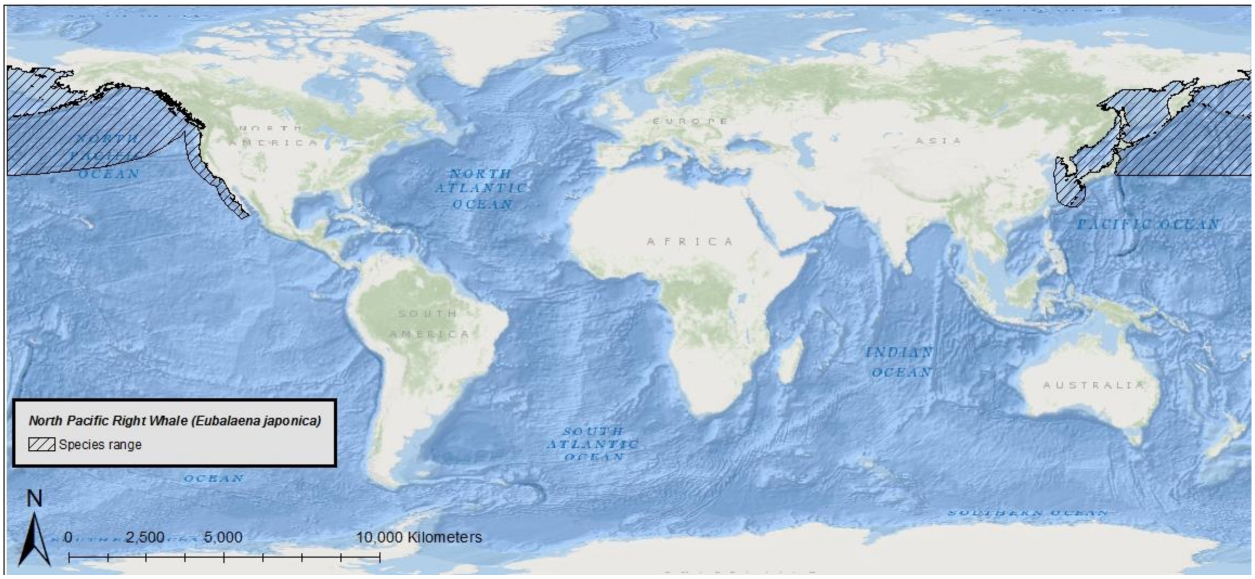

Figure 11. Map identifying the range of the endangered North Pacific right whale.

The North Pacific right whale is a baleen whale found only in the North Pacific Ocean and is distinguishable by a stocky body, lack of dorsal fin, generally black coloration, and callosities on the head region. The species was originally listed with the North Atlantic right whale (i.e., "Northern" right whale) as endangered on December 2, 1970. The North Pacific right whale was listed separately as endangered on March 6, 2008.

Information available from the recovery plan (NMFS 2013) recent stock assessment reports (Muto, Helker et al. 2017), and status review (NMFS 2012, NMFS 2017) were used to summarize the life history, population dynamics and status of the species as follows.

Life History

North Pacific right whales can live, on average, 50 or more years. They have a gestation period of approximately one year, and calves nurse for approximately one year. Sexual maturity is reached between nine and ten years of age. The reproduction rate of North Pacific right whales remains unknown. However, it is likely low due to a male-biased sex ratio that may make it difficult for females to find viable mates. North Pacific right whales mostly inhabit coastal and continental shelf waters. Little is known about their migration patterns, but they have been observed in lower latitudes during winter (Japan, California, and Mexico) where they likely calve and nurse. In the summer, they feed on large concentrations of copepods in Alaskan waters. North Pacific right whales are unique compared to other baleen whales in that they are skim feeders meaning that they continuously filtering through their baleen while moving through a patch of zooplankton.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the North Pacific right whale.

The North Pacific right whale remains one of the most endangered whale species in the world. Their abundance likely numbers fewer than 1,000 individuals. There are two currently recognized stocks of North Pacific right whales, a Western North Pacific stock that feeds primarily in the Sea of Okhotsk, and an Eastern North Pacific stock that feeds in eastern north Pacific Ocean waters off Alaska, Canada, and Russia. Several lines of evidence indicate a total population size of less than 100 for the Eastern North Pacific stock. Based on photo-identification from 1998 through 2013 (Wade, Kennedy et al. 2011) estimated 31 individuals, with a minimum population estimate of 26 individuals (Muto, Helker et al. 2017). Genetic data have identified 23 individuals based on samples collected between 1997 and 2011 (Leduc, Taylor et al. 2012). The Western North Pacific stock is likely more abundant and was estimated to consist of 922 whales (95 percent confidence intervals 404 to 2,108) based on data collected in 1989, 1990, and 1992 (IWC 2001, Thomas, Reeves et al. 2016). The population estimate for the Western North Pacific stock is likely in the low hundreds (Brownell Jr., Clapham et al. 2001). While there have been several sightings of Western North Pacific right whales in recent years, with one sighting identifying at least 77 individuals, these data have yet to be compiled to provide a more recent abundance estimate (Thomas, Reeves et al. 2016). There is currently no information on the population trend of North Pacific right whales.

As a result of past commercial whaling, the remnant population of North Pacific right whales has been left vulnerable to genetic drift and inbreeding due to low genetic variability. This low diversity potentially affects individuals by depressing fitness, lowering resistance to disease and parasites, and diminishing the whales' ability to adapt to environmental changes. At the population level, low genetic diversity can lead to slower growth rates, lower resilience, and poorer long-term fitness (Lacy 1997). Marine mammals with an effective population size of a few dozen individuals likely can resist most of the deleterious consequences of inbreeding (Lande 1991). It has also been suggested that if the number of reproductive animals is fewer than fifty, the potential for impacts associated with inbreeding increases substantially. Rosenbaum, Brownell et al. (2000) found that historic genetic diversity of North Pacific right whales was relatively high compared to North Atlantic right whales, but samples from extant individuals showed very low genetic diversity, with only two matrilineal haplotypes among the five samples in their dataset.

The North Pacific right whale inhabits the Pacific Ocean, particularly between 20 and 60° North latitude. Prior to exploitation by commercial whalers, concentrations of North Pacific right whales were found in the Gulf of Alaska, Aleutian Islands, south central Bering Sea, Sea of Okhotsk, and Sea of Japan. There has been little recent sighting data of North Pacific right whales occurring in the central North Pacific and Bering Sea. However, since 1996, North Pacific right whales have been consistently observed in Bristol Bay and the southeastern Bering Sea during summer months. In the Western North Pacific Ocean where the population is thought to be somewhat larger, North Pacific right whales have been sighted in the Sea of Okhotsk and other areas off the coast of Japan, Russia, and South Korea (Thomas, Reeves et al. 2016). Although North Pacific right whales are typically found in higher latitudes, they are thought to migrate to more temperate waters during winter to reproduce, and have been sighted as far south as Hawaii and Baja California.

Vocalization and Hearing

Given their extremely small population size and remote location, little is known about North Pacific right whale vocalizations (Marques, Munger et al. 2011). However, data from other right whales is informative. Right whales vocalize to communicate over long distances and for social interaction, including communication apparently informing others of prey path presence (Biedron, Clark et al. 2005, Tyson and Nowacek 2005). Vocalization patterns amongst all right whale species are generally similar, with six major call types: scream, gunshot, blow, up call, warble, and down call (McDonald and Moore 2002, Parks and Tyack 2005). A large majority of vocalizations occur in the 300 to 600 Hertz range with up and down sweeping modulations (Vanderlaan, Hay et al. 2003). Vocalizations below 200 Hertz and above 900 Hertz were rare (Vanderlaan, Hay et al. 2003). Calls tend to be clustered, with periods of silence between clusters (Vanderlaan, Hay et al. 2003). Gunshot bouts last 1.5 hours on average and up to seven hours (Parks, Hotchkin et al. 2012). Blows are associated with ventilation and are generally inaudible underwater (Parks and Clark 2007). Up calls are 100 to 400 Hertz (Gillespie and Leaper 2001). Gunshots appear to be largely or exclusively male vocalization (Parks, Hamilton et al. 2005).

Smaller groups vocalize more than larger groups and vocalization is more frequent at night (Matthews, Brown et al. 2001). Moans are usually produced within 10 meters (33 feet) of the surface (Matthews, Brown et al. 2001). Up calls were detected year-round in Massachusetts Bay except July and August and peaking in April (Mussoline, Risch et al. 2012). Individuals remaining in the Gulf of Maine through winter continue to call, showing a strong diel pattern of up call and gunshot vocalizations from November through January possibly associated with mating (Bort, Todd et al. 2011, Morano, Rice et al. 2012, Mussoline, Risch et al. 2012). Estimated source levels of gunshots in non-surface active groups are 201 decibels re 1 microPascal peak-to-peak (Hotchkin, Parks et al. 2011). While in surface active groups, females produce scream calls and males produce up calls and gunshot calls as threats to other males; calves (at least female calves) produce warble sounds similar top their mothers' screams (Parks, Kristrup et al. 2003, Parks and Tyack 2005). Source levels for these calls in surface active groups range from 137 to 162 decibels re 1 microPascal at 1 meter (root mean square), except for gunshots, which are 174 to 192 decibels re 1 microPascal at 1 meter (root mean square) (Parks and Tyack 2005). Up calls may also be used to reunite mothers with calves (Parks and Clark 2007). North Atlantic right whales shift calling frequencies, particularly of up calls, as well as increase call amplitude over both long and short term periods due to exposure to vessel noise (Parks, Clark et al. 2005, Parks, Parks et al. 2006, Parks and Clark 2007, Parks, Clark et al. 2007, Parks, Johnson et al. 2010, Parks, Johnson et al. 2011, Parks, Johnson et al. 2012), particularly the peak frequency (Parks, Urazghildiiev et al. 2009). North Atlantic right whales respond to anthropogenic sound designed to alert whales to vessel presence by surfacing (Nowacek, Tyack et al. 2003, Nowacek, Johnson et al. 2004).

There is no direct data on the hearing range of North Pacific right whales. However, based on anatomical modeling, the hearing range for North Atlantic right whales is predicted to be from 10 Hertz to 22 kiloHertz with functional ranges probably between 15 Hertz to 18 kiloHertz (Parks, Ketten et al. 2007).

Status

The North Pacific right whale is endangered because of past commercial whaling. Prior to commercial whaling, abundance has been estimated to have been more than 11,000 individuals. Current threats to the survival of this species include hunting, ship strikes, climate change, and fisheries interactions (including entanglement). The resilience of North Pacific right whales to future perturbations is low due to its small population size and continued threats. Recovery is not anticipated in the foreseeable future (several decades to a century or more) due to small population size and lack of available current information.

Critical Habitat

In 2008, NMFS designated critical habitat for the North Pacific right whale, which includes an area in the Southeast Bering Sea and an area south of Kodiak Island in the Gulf of Alaska (Figure 12). These areas are influenced by large eddies, submarine canyons, or frontal zones which enhance nutrient exchange and act to concentrate prey. These areas are adjacent to major ocean currents and are characterized by relatively low circulation and water movement. Both critical habitat areas support feeding by North Pacific right whales because they contain the designated physical and biological features (previously referred to as primary constituent elements), which include: nutrients, physical oceanographic processes, certain species of zooplankton, and a long photoperiod due to the high latitude. Consistent North Pacific right whale sightings are a proxy for locating these elements.

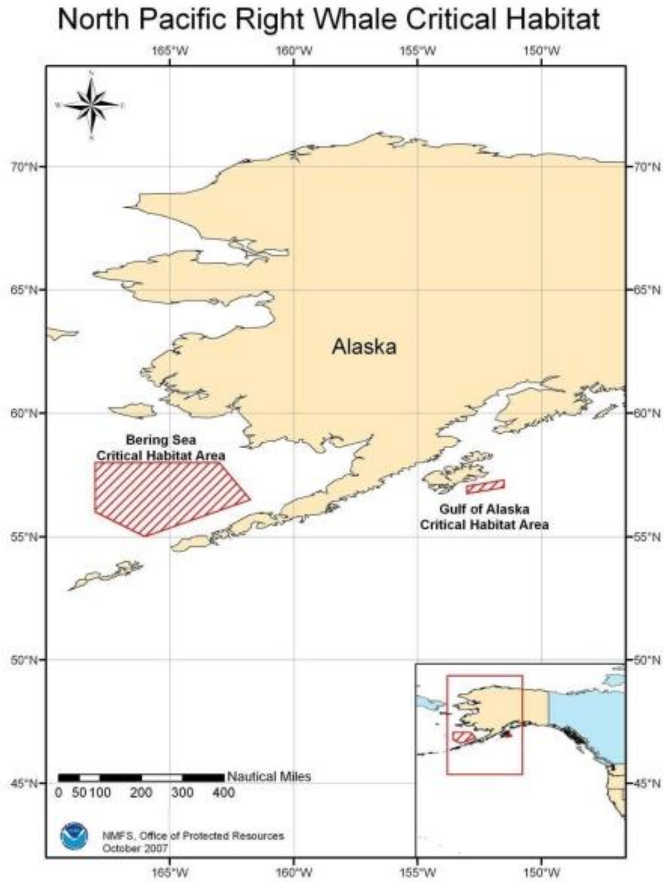

Figure 12. Map identifying designated critical habitat for the North Pacific right whale in the Southeast Bering Sea and south of Kodiak Island in the Gulf of Alaska.

Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover North Pacific right whale populations. These threats will be discussed in further detail in the *Environmental Baseline* (Section 10) section of this opinion. See the 2013 Final Recovery Plan for the North Pacific right whale for complete downlisting/delisting criteria for both of the following recovery goals.

1. Achieve sufficient and viable populations in all ocean basins.
2. Ensure significant threats are addressed.

9.10 Southern Right Whale

Southern right whales are a large baleen whale species distributed in the Southern Hemisphere worldwide from 20 to 60° South (Figure 13).

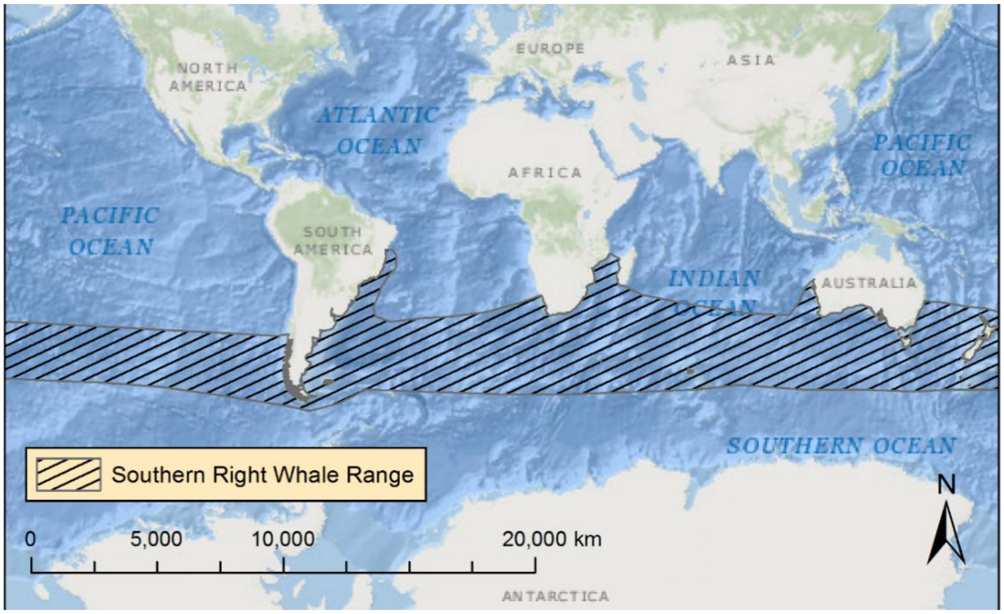

Figure 13. Map identifying the range of the endangered Southern right whale.

Southern right whales have a stocky, black body lacking a dorsal fin and a large head covered in callosities. They range in length between 13 to 17 meters (43 to 56 feet), and weigh up to 54,431 kilograms (120,000 pounds). The Southern right whale was listed as endangered under the Endangered Species Preservation Act on June 2, 1970, and this listing was carried over when the ESA was enacted.

We used information available in the 2015 Status Review (NMFS 2015) and the International Whaling Commission's 2012 Report on the Assessment of Southern Right Whales (IWC 2012) to summarize the life history, population dynamics, and status of this species, as follows.

Life History

The lifespan of Southern right whales is currently unknown but likely similar to North Pacific and North Atlantic right whales, who are believed to live to around 50 years old. Females usually give birth to their first calf between eight and ten years old and gestation takes approximately one year. Offspring wean at approximately one year of age, and females reproduce every three to four years. Southern right whales feed during austral summer in high latitude feeding grounds in the Southern Ocean, where they use their baleen to "skim" copepods and krill from the water. Mating likely occurs in winter in the low latitude breeding and calving grounds.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Southern right whale.

In 2010, there were an estimated 15,000 Southern right whales worldwide; this is over twice the species estimate of 7,000 in 1997. The population structure for Southern right whales is uncertain, but some separation to the population level exists. Breeding populations can be delineated based on geographic region: South Africa, Argentina, Brazil, Peru and Chile, Australia, and New Zealand. Population estimates for all of the breeding populations are not available. There are about 3,500 Southern right whales in the Australia breeding population, about 4,000 in Argentina, 4,100 in South Africa, and 2,169 in New Zealand. Other smaller Southern right whale populations occur off Tristan da Cunha, South Georgia, Namibia, Mozambique and Uruguay, but not much is known about the population abundance of these groups.

The Australia, South Africa and Argentina breeding stocks of Southern right whales are increasing at an estimated seven percent annually. The Brazil breeding population is increasing, while the status of the Peru and Chile breeding population is unknown (NMFS 2015). The New Zealand breeding population is showing signs of recovery; recent population modeling estimates the population growth rate at 5.6 percent (Davidson 2016). Juveniles in New Zealand show high apparent annual survival rates, between 0.87 and 0.95 percent (Carroll, Fewster et al. 2016).

Mitochondrial DNA analysis of Southern right whales indicates at least 37 unique haplotypes and greater genetic diversity in the South Atlantic Ocean than in the Indo-Pacific Oceans (Patenaude, Portway et al. 2007). Females exhibit high site fidelity to calving grounds, restricting gene flow and establishing geographic breeding populations. Recent genetic testing reveals the possibility that individuals from different ocean basins are mixing on the Antarctic feeding grounds (Kanda, Goto et al. 2014).

Southern right whales are found in the Southern Hemisphere from temperate to polar waters, favoring shallow waters less than 20 meters (65.6 feet) deep. Southern right whales migrate between winter breeding areas in coastal waters of the South Atlantic, Pacific, and Indian Oceans from May to December and offshore summer (January through April) foraging locations in the Subtropical and Antarctic Convergence zones.

Vocalization and Hearing

Data on Southern right whale vocalizations indicates that they exhibit similar acoustic behavior to other right whales (Clark 1982, Matthews, Brown et al. 2001). Right whales vocalize to communicate over long distances and for social interaction, including communication apparently informing others of prey path presence (Biedron, Clark et al. 2005, Tyson and Nowacek 2005). Vocalization patterns amongst all right whale species are generally similar, with six major call types: scream, gunshot, blow, up call, warble, and down call (McDonald and Moore 2002, Parks and Tyack 2005). A large majority of vocalizations occur in the 300 to 600 Hertz range with up and down sweeping modulations (Vanderlaan, Hay et al. 2003). Vocalizations below 200 Hertz and above 900 Hertz were rare (Vanderlaan, Hay et al. 2003). Calls tend to be clustered, with periods of silence between clusters (Vanderlaan, Hay et al. 2003). Gunshot bouts last 1.5 hours on average and up to seven hours (Parks, Hotchkin et al. 2012). Blows are associated with ventilation and are generally inaudible underwater (Parks and Clark 2007). Up calls are 100 to

400 Hertz (Gillespie and Leaper 2001). Gunshots appear to be largely or exclusively male vocalization (Parks, Hamilton et al. 2005).

Smaller groups vocalize more than larger groups and vocalization is more frequent at night (Matthews, Brown et al. 2001). Moans are usually produced within 10 meters (33 feet) of the surface (Matthews, Brown et al. 2001). Up calls were detected year-round in Massachusetts Bay except July and August and peaking in April (Mussoline, Risch et al. 2012). Individuals remaining in the Gulf of Maine through winter continue to call, showing a strong diel pattern of up call and gunshot vocalizations from November through January possibly associated with mating (Bort, Todd et al. 2011, Morano, Rice et al. 2012, Mussoline, Risch et al. 2012). Estimated source levels of gunshots in non-surface active groups are 201 decibels re 1 microPascal peak-to-peak (Hotchkin, Parks et al. 2011). While in surface active groups, females produce scream calls and males produce up calls and gunshot calls as threats to other males; calves (at least female calves) produce warble sounds similar top their mothers' screams (Parks, Kristrup et al. 2003, Parks and Tyack 2005). Source levels for these calls in surface active groups range from 137 to 162 decibels re 1 microPascal at 1 meter (root mean sqaure), except for gunshots, which are 174 to 192 decibels re 1 microPascal at 1 meter (root mean sqaure) (Parks and Tyack 2005). Up calls may also be used to reunite mothers with calves (Parks and Clark 2007). North Atlantic right whales shift calling frequencies, particularly of up calls, as well as increase call amplitude over both long and short term periods due to exposure to vessel noise (Parks, Clark et al. 2005, Parks, Parks et al. 2006, Parks and Clark 2007, Parks, Clark et al. 2007, Parks, Johnson et al. 2010, Parks, Johnson et al. 2011, Parks, Johnson et al. 2012), particularly the peak frequency (Parks, Urazghildiiev et al. 2009). North Atlantic right whales respond to anthropogenic sound designed to alert whales to vessel presence by surfacing (Nowacek, Tyack et al. 2003, Nowacek, Johnson et al. 2004).

There is no direct data on the hearing range of Southern right whales. However, based on anatomical modeling, the hearing range for North Atlantic right whales is predicted to be from 10 Hertz to 22 kiloHertz with functional ranges probably between 15 Hertz to 18 kiloHertz (Parks, Ketten et al. 2007).

Status

Southern right whales underwent severe decline due to whaling during the 18th and 19th centuries (NMFS 2015). In general, Southern right whale populations appear to be increasing at a robust rate. Nonetheless, the current population estimate (15,000) is still much less than the estimated 60,000 pre-whaling estimate (NHT 2005). Southern right whales are currently subject to many of the same anthropogenic threats other large whales face. In the Southern Hemisphere, Southern right whales are by far the most vessel struck cetacean, with at least 56 reported instances; nearly four-fold higher than the second most struck large whale (Van Waerebeek, Baker et al. 2007). Additional threats include declines in water quality, pollutant exposure and near shore habitat degradation from development. Reproductive success is influenced by krill availability on the feeding grounds; therefore, climatic shifts that change krill abundance may hinder the recovery of Southern right whales (Seyboth, Groch et al. 2016). Because populations appear to be increasing in size, the species appears to be somewhat resilient to current threats, but it has not recovered to pre-exploitation abundance.

Critical Habitat

No critical habitat has been designated for the Southern right whale. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Southern right whale. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296; June 15, 1990).

9.11 Sperm Whale

The sperm whale is a widely distributed species found in all major oceans (Figure 14).

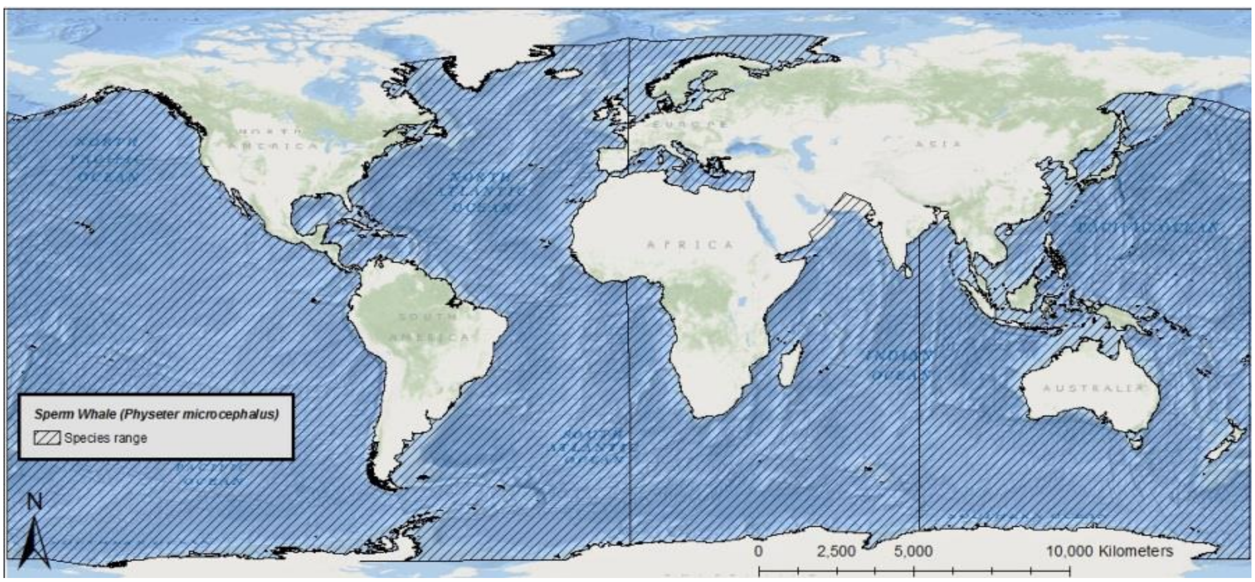

Figure 14. Map identifying the range of the endangered sperm whale.

Sperm whales are the largest toothed whale and distinguishable from other whales by its extremely large heard, which takes up to 25 to 35 percent of its total body length and a single blowhole asymmetrically situated on the left side of the head near the tip. The sperm whale was originally listed as endangered on December 2, 1970.

Information available from the recovery plan (NMFS 2010), recent stock assessment reports (Carretta, Forney et al. 2017, Hayes, Josephson et al. 2017, Muto, Helker et al. 2017), and status review (NMFS 2015) were used to summarize the life history, population dynamics, and status of the species as follows.

Life History

The average lifespan of sperm whales is estimated to be at least 50 years (Whitehead 2009). They have a gestation period of one to one and a half years, and calves nurse for approximately two years. Sexual maturity is reached between seven and 13 years of age for females with an average calving interval for four to six years. Male sperm whales reach full sexual maturity in their twenties. Sperm whales mostly inhabit areas with a water depth of 600 meters (1,968 feet) or more, and are uncommon in waters less than 300 meters (984 feet) deep. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed primarily on squid; other prey includes octopus and demersal fish (including teleosts and elasmobranchs).

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the sperm whale.

The sperm whale is the most abundant of the large whale species, with total abundance estimates between 200,000 and 1,500,000. The most recent estimate indicated a global population of between 300,000 and 450,000 individuals (Whitehead 2009). The higher estimates may be approaching population sizes prior to commercial whaling. There are no reliable estimates for sperm whale abundance across the entire Atlantic Ocean. However, estimates are available for two to three U.S. stocks in the Atlantic Ocean, the Northern Gulf of Mexico stock, estimated to consists of 763 individuals (N_{min}=560) and the North Atlantic stock, underestimated to consist of 2,288 individuals (N_{min}=1,815). There are insufficient data to estimate abundance for the Puerto Rico and U.S. Virgin Islands stock. In the northeast Pacific Ocean, the abundance of sperm whales was estimated to be between 26,300 and 32,100 in 1997. In the northeast Pacific Ocean, the abundance of sperm whales was estimated to be between 26,300 and 32,100 in 1997. In the eastern tropical Pacific Ocean, the abundance of sperm whales was estimated to be 22,700 (95 percent confidence intervals 14,800 to 34,600) in 1993. Population estimates are also available for two to three U.S. stocks that occur in the Pacific Ocean, the California/Oregon/Washington stock, estimated to consist of 2,106 individuals (N_{min}=1,332), and the Hawaii stock, estimated to consist of 3,354 individuals (N_{min}=2,539). There are insufficient data to estimate the population abundance of the North Pacific stock. We are aware of no reliable abundance estimates specifically for sperm whales in the South Pacific Ocean, and there is insufficient data to evaluate trends in abundance and growth rates of sperm whale populations at this time. There is insufficient data to evaluate trends in abundance and growth rates of sperm whales at this time.

Ocean-wide genetic studies indicate sperm whales have low genetic diversity, suggesting a recent bottleneck, but strong differentiation between matrilineally related groups (Lyrholm and Gyllensten 1998). Consistent with this, two studies of sperm whales in the Pacific Ocean indicate low genetic diversity (Mesnick, Taylor et al. 2011, Rendell, Mesnick et al. 2012). Furthermore, sperm whales from the Gulf of Mexico, the western North Atlantic Ocean, the North Sea, and the

Mediterranean Sea all have been shown to have low levels of genetic diversity (Engelhaupt, Hoelzel et al. 2009). As none of the stocks for which data are available have high levels of genetic diversity, the species may be at some risk to inbreeding and ‘Allee’ effects, although the extent to which is currently unknown. Sperm whales have a global distribution and can be found in relatively deep waters in all ocean basins. While both males and females can be found in latitudes less than 40°, only adult males venture into the higher latitudes near the poles.

Vocalization and Hearing

Sound production and reception by sperm whales are better understood than in most cetaceans. Recordings of sperm whale vocalizations reveal that they produce a variety of sounds, such as clicks, gunshots, chirps, creaks, short trumpets, pips, squeals, and clangs (Goold 1999). Sperm whales typically produce short duration repetitive broadband clicks with frequencies below 100 Hertz to greater than 30 kiloHertz (Watkins 1977) and dominant frequencies between 1 to 6 kiloHertz and 10 to 16 kiloHertz. Another class of sound, “squeals,” are produced with frequencies of 100 Hertz to 20 kiloHertz (e.g., Weir, Frantzis et al. 2007). The source levels of clicks can reach 236 dB re: 1 µPa at 1 meter, although lower source level energy has been suggested at around 171 decibels re 1 microPascal at 1 meter (Weilgart and Whitehead 1993, Goold and Jones 1995, Weilgart and Whitehead 1997, Mohl, Wahlberg et al. 2003). Most of the energy in sperm whale clicks is concentrated at around 2 to 4 kiloHertz and 10 to 16 kiloHertz (Weilgart and Whitehead 1993, Goold and Jones 1995). The clicks of neonate sperm whales are very different from typical clicks of adults in that they are of low directionality, long duration, and low frequency (between 300 Hertz and 1.7 kiloHertz) with estimated source levels between 140 to 162 decibels re 1 microPascal at 1 meter (Madsen, Carder et al. 2003). The highly asymmetric head anatomy of sperm whales is likely an adaptation to produce the unique clicks recorded from these animals (Norris and Harvey 1972).

Long, repeated clicks are associated with feeding and echolocation (Whitehead and Weilgart 1991, Weilgart and Whitehead 1993, Goold and Jones 1995, Weilgart and Whitehead 1997, Miller, Johnson et al. 2004). Creaks (rapid sets of clicks) are heard most frequently when sperm whales are foraging and engaged in the deepest portion of their dives, with inter-click intervals and source levels being altered during these behaviors (Miller, Johnson et al. 2004, Laplanche, Adam et al. 2005). Clicks are also used during social behavior and intragroup interactions (Weilgart and Whitehead 1993). When sperm whales are socializing, they tend to repeat series of group-distinctive clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill 1977). Codas are shared between individuals in a social unit and are considered to be primarily for intragroup communication (Weilgart and Whitehead 1997, Rendell and Whitehead 2004). Research in the South Pacific Ocean suggests that in breeding areas the majority of codas are produced by mature females (Marcoux, Whitehead et al. 2006). Coda repertoires have also been found to vary geographically and are categorized as dialects (Weilgart and Whitehead 1997, Pavan, Hayward et al. 2000). For example, significant differences in coda repertoire have been observed between sperm whales in the Caribbean Sea and those in the

Pacific Ocean (Weilgart and Whitehead 1997). Three coda types used by male sperm whales have recently been described from data collected over multiple years: these codas are associated with dive cycles, socializing, and alarm (Frantzis and Alexiadou 2008).

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 to 60 kiloHertz and highest sensitivity to frequencies between 5 to 20 kiloHertz. Other hearing information consists of indirect data. For example, the anatomy of the sperm whale's inner and middle ear indicates an ability to best hear high-frequency to ultrasonic hearing (Ketten 1992). The sperm whale may also possess better low-frequency hearing than other odontocetes, although not as low as many baleen whales (Ketten 1992). Reactions to anthropogenic sounds can provide indirect evidence of hearing capability, and several studies have made note of changes seen in sperm whale behavior in conjunction with these sounds. For example, sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins and Schevill 1975, Watkins, Moore et al. 1985). In the Caribbean Sea, Watkins, Moore et al. (1985) observed that sperm whales exposed to 3.25 to 8.4 kiloHertz pulses (presumed to be from submarine sonar) interrupted their activities and left the area. Similar reactions were observed from artificial sound generated by banging on a boat hull (Watkins, Moore et al. 1985). André, Terada et al. (1997) reported that foraging whales exposed to a 10 kiloHertz pulsed signal did not ultimately exhibit any general avoidance reactions: when resting at the surface in a compact group, sperm whales initially reacted strongly, and then ignored the signal completely (André, Terada et al. 1997). Thode, Straley et al. (2007) observed that the acoustic signal from the cavitation of a fishing vessel's propeller (110 decibels re: 1 μPa^2-s between 250 Hertz and one kiloHertz) interrupted sperm whale acoustic activity and resulted in the animals converging on the vessel. Sperm whales have also been observed to 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, Tershy et al. 1999). Nonetheless, sperm whales are considered to be part of the mid-frequency marine mammal hearing group, with a hearing range between 150 Hertz and 160 kiloHertz (NOAA 2018).

Status

The sperm whale is endangered as a result of past commercial whaling. Although the aggregate abundance worldwide is probably at least several hundred thousand individuals, the extent of depletion and degree of recovery of populations are uncertain. Commercial whaling is no longer allowed, however, illegal hunting may occur at biologically unsustainable levels. Continued threats to sperm whale populations include ship strikes, entanglement in fishing gear, competition for resources due to overfishing, population, loss of prey and habitat due to climate change, and noise. The species' large population size shows that it is somewhat resilient to current threats.

Critical Habitat

No critical habitat has been designated for the sperm whale.

Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover sperm whale populations. These threats will be discussed in further detail in the *Environmental Baseline* section of this opinion. See the 2010 Final Recovery Plan for the sperm whale for complete downlisting/delisting criteria for both of the following recovery goals.

1. Achieve sufficient and viable populations in all ocean basins.
2. Ensure significant threats are addressed.

10 ENVIRONMENTAL BASELINE

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 C.F.R. §402.02).

A number of human activities have contributed to the status of populations of ESA-listed cetaceans in the action areas. Some human activities are ongoing and appear to continue to affect cetacean populations in the action areas for this consultation. Some of these activities, most notably commercial whaling, occurred extensively in the past and continue at low levels that no longer appear to significantly affect cetacean populations, although the effects of past reductions in numbers persist today. The following discussion summarizes these impacts, which include climate change, whaling, vessel strikes, whale watching, sound, military activities, fisheries, pollution, and scientific research.

10.1 Climate Change

According to the Fourth National Climate Assessment, "Global climate is changing rapidly compared to the pace of natural variations in climate that have occurred throughout Earth's history" (Hayhoe et al. 2018). The globally-averaged combined land and ocean surface temperature data, as calculated by a linear trend, show a warming of approximately 1.0 degrees Celsius over the period 1901 through 2016 (Hayhoe et al. 2018). Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850 (IPCC 2014). Burning fossil fuels has increased atmospheric carbon dioxide concentrations by 35 percent with respect to pre-industrial levels, with consequent climatic disruptions that include a higher rate of global warming than occurred at the last global-scale state shift (the last glacial-interglacial transition, approximately 12,000 years ago) (Barnosky, Hadly et al. 2012). Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90 percent of the energy accumulated between 1971 and 2010 (IPCC 2014). It is estimated that the upper ocean (0 to 700 meters [0 to 2,296.6 feet]) warmed from 1971 through 2010 and it likely warmed between the 1870s and 1971 (IPCC 2014). On a global scale, ocean warming is greatest near the surface, and the upper 75 meters (246.1 feet) warmed by 0.11 degrees Celsius per decade over the period of 1971 through 2010 (IPCC 2014). Consequences of climate change include increased ocean stratification, decreased sea-ice extent, altered patterns of ocean circulation, and decreased ocean oxygen levels (Doney, Ruckelshaus et al. 2012). Further, ocean acidity has increased by 26 percent since the beginning of the industrial era (IPCC 2014) and this rise has been linked to climate change. Climate change is also expected to increase the frequency of extreme weather and climate events including, but not limited to, cyclones, heat waves, and droughts (IPCC 2014). Climate change has the potential to impact species abundance, geographic distribution, migration patterns, timing of seasonal activities (IPCC 2014), and species viability into the future. Though predicting the precise consequences of climate change on highly mobile marine species, such as many of those considered in this opinion, is difficult (Simmonds and Isaac 2007), recent research has indicated a range of consequences already occurring.

This climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine ecosystems in the near future. It is most likely to have the most pronounced effects on species whose populations are already in tenuous positions (Isaac 2008). As such, we expect the extinction risk of ESA-listed species to rise with global warming. Primary effects of climate change on individual species include habitat loss or alteration, distribution changes, altered and/or reduced distribution and abundance of prey, changes in abundance of competitors and/or predators, shifts in the timing of seasonal activities of species, and geographic isolation or extirpation of populations that are unable to adapt. Secondary effects include increased stress, disease susceptibility, and predation. Cetaceans with restricted distributions linked to water temperature may be particularly exposed to range restriction (Learmonth, Macleod et al. 2006, Issac 2009). MacLeod (2009) estimated that, based on expected shifts in water temperature, the ranges of 88 percent of cetaceans would be affected, 47 percent would be negatively affected, and 21 percent would be put at risk of extinction. Blue, fin, humpback, killer, and sperm whales all have a fairly global, cosmopolitan distribution, and so are not predicted to significantly alter their ranges. However, even if these species ranges are not expected to shift, changes in other aspects of their ecology such as the arrival at and departure from feeding grounds and diet may still occur (Ramp, Delarue et al. 2015). Having northern distributions, beluga, bowhead, North Atlantic right, and North Pacific right whales are expected to be negatively impacted. No prediction is available for sei whales. False killer whales have an oceanic distribution and favor warmer waters, and as such are expected to experience favorable conditions with climate change. Gray whales tend to be distributed along the continental shelf and are predicted to be relatively unaffected.

In addition to the listed species above, Hazen et al. (2012) examined top predator distribution and diversity in the Pacific Ocean in light of rising sea surface temperatures using a database of electronic tags and output from a global climate model. He predicted up to a 35 percent change in core habitat area for some key marine predators in the Pacific Ocean, with some species predicted to experience gains in available core habitat and some predicted to experience losses. Notably, blue whales are predicted to experience losses in available core habitat. Similarly, climate-mediated changes in important prey species populations are likely to affect predator populations. For example, blue whales, as predators that specialize in eating krill, are likely to change their distribution in response to changes in the distribution of krill (Payne, Nicholas et al. 1986, Payne, Wiley et al. 1990, Clapham, Young et al. 1999). Pecl and Jackson (2008) predicted climate change will likely result in squid that hatch out smaller and earlier, undergo faster growth over shorter life-spans, and mature younger at a smaller size. This could have significant negative consequences for species such as sperm whales, whose diets can be dominated by cephalopods. For ESA-listed species that undergo long migrations, if either prey availability or habitat suitability is disrupted by changing ocean temperature regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott. 2009).

Previous warming events (e.g., El Niño, the 1977 through 1998 warm phase of the Pacific Decadal Oscillation) may illustrate the potential consequences of climate change. Off the U.S. west coast, past warming events have reduced nutrient input and primary productivity in the California Current, which also reduced productivity of zooplankton through upper-trophic level consumers (Veit, Pyle et al. 1996, Sydeman, Mills et al. 2009, Doney, Ruckelshaus et al. 2012). In the past, warming events have resulted in reduced food supplies for marine mammals along the U.S. west coast (Feldkamp, DeLong et al. 1991, Hayward 2000, Le Boeuf and Crocker 2005). Some marine mammal distributions may have shifted northward in response to persistent prey occurrence in more northerly waters during El Niño events (Shane 1994, Shane 1995, Benson, Croll et al. 2002, Lusseau, Williams et al. 2004, Norman, C. E. Bowlby et al. 2004, Danil and Chivers 2005). Low reproductive success and body condition in humpback whales may have resulted from the 1997/1998 El Niño (Cerchio, Jacobsen et al. 2005).

This is not an exhaustive review of all available literature regarding the potential impacts of climate change to the species considered in this opinion. However, this review provides some examples of impacts that may occur. While it is difficult to accurately predict the consequences of climate change to the species considered in this opinion, a range of consequences are expected, ranging from beneficial to catastrophic.

10.2 Oceanic Temperature Regimes

Oceanographic conditions in the Atlantic and Pacific Oceans can be altered due to periodic shifts in atmospheric patterns caused by the Southern oscillation in the Pacific Ocean, which leads to El Niño and La Niña events, the Pacific decadal oscillation, and the North Atlantic oscillation. These climatic events can alter habitat conditions and prey distribution for ESA-listed species in the action area (Beamish 1993, Mantua, Hare et al. 1997, Hare and Mantua 2001) (Benson and Trites 2002, Stabeno, Bond et al. 2004, Mundy 2005, Mundy and Cooney 2005). For example, decade-scale climatic regime shifts have been related to changes in zooplankton in the North Atlantic Ocean (Fromentin and Planque 1996), and decadal trends in the North Atlantic oscillation (Hurrell 1995) can affect the position of the Gulf Stream (Taylor, Jordon et al. 1998) and other circulation patterns in the North Atlantic Ocean that act as migratory pathways for various marine species, especially fish.

The North Atlantic oscillation is a large-scale, dynamic phenomenon that exemplifies the relationship between the atmosphere and the ocean. The North Atlantic oscillation has global significance as it affects sea surface temperatures, wind conditions, and ocean circulation of the North Atlantic Ocean (Stenseth, Mysterud et al. 2002). The North Atlantic oscillation is an alteration in the intensity of the atmospheric pressure difference between the semi-permanent high-pressure center over the Azores Islands and the sub-polar low-pressure center over Iceland (Stenseth, Mysterud et al. 2002). Sea-level atmospheric pressure in the two regions tends to vary in a "see-saw" pattern – when the pressure increases in Iceland it decreases in the Azores and vice-versa (i.e., the two systems tend to intensity or weaken in synchrony). The North Atlantic oscillation is the dominant mode of decadal-scale variability in weather and climate in the North Atlantic Ocean region (Hurrell 1995).

Since ocean circulation is wind and density driven, it is not surprising to find that the North Atlantic oscillation appears to have a direct effect on the position and strength of important North Atlantic Ocean currents. The North Atlantic oscillation influences the latitude of the Gulf Stream Current and accounts for a great deal of the interannual variability in the location of the current; in years after a positive North Atlantic oscillation index, the north wall of the Gulf Stream (south of New England) is located farther north (Taylor, Jordon et al. 1998). Not only is the location of the Gulf Stream Current and its end-member, the North Atlantic Current, affected by the North Atlantic oscillation, but the strength of these currents is also affected. During negative North Atlantic oscillation years, the Gulf Stream System (i.e., Loop, Gulf Stream, and North Atlantic Currents) not only shifted southward but weakened, as witnessed during the predominantly negative North Atlantic oscillation phase of the 1960s; during the subsequent 25-year period of predominantly positive North Atlantic oscillation, the currents intensified to a record peak in transport rate, reflecting an increase of 25 to 33 percent (Curry and McCartney 2001). The location and strength of the Gulf Stream System are important, as this major current system is an essential part of the North Atlantic climate system, moderating temperatures and weather from the U.S. to Great Britain and even the Mediterranean Sea region. Pershing et al. (Pershing, Greene et al. 2001) also found that the upper slope-water system off the east coast of the U.S. was affected by the North Atlantic oscillation and was driven by variability in temperature and transport of the Labrador Current. During low North Atlantic oscillation periods, especially that seen in the winter of 1996, the Labrador Current intensified, which led to the advance of cold slope water along the continental shelf as far south as the mid-Atlantic Bight in 1998 (Pershing, Greene et al. 2001, Greene and Pershing 2003). Variability in the Labrador Current intensity is linked to the effects of winter temperatures in Greenland and its surroundings (e.g., Davis Strait, Denmark Strait), on sea-ice formation, and the relative balance between the formation of deep and intermediate water masses and surface currents.

A strong association has been established between the variability of the North Atlantic oscillation and changes affecting various trophic groups in North Atlantic marine ecosystems on both the eastern and western sides of the basin (Fromentin and Planque 1996, Drinkwater, Belgrano et al. 2003). For example, the temporal and spatial patterns of *Calanus* copepods (zooplankton) were the first to be linked to the phases of the North Atlantic oscillation (Fromentin and Planque 1996, Stenseth, Mysterud et al. 2002). When the North Atlantic oscillation index was positive, the abundance of *Calanus* copepods in the Gulf of Maine increased, with the inverse true in years when the North Atlantic oscillation index was negative (Conversi, Piontkovski et al. 2001, Greene, Pershing et al. 2003). This pattern is opposite off the European coast (Fromentin and Planque 1996). Such a shift in copepod patterns has a tremendous significance to upper-trophic-level species, including the North Atlantic right whale, which feeds principally on *Calanus finmarchicus*. North Atlantic right whale calving rates are linked to the abundance of *Calanus finmarchicus*; when the abundance is high, the calving rate remains stable but fell in the late 1990s when the abundance of its favored copepod also declined (Greene, Pershing et al. 2003). When the North Atlantic oscillation index is low with subsequently warmer water temperatures off Labrador and the Scotian Shelf, recruitment of cod is higher; direct links to the North Atlantic oscillation phase have also been found for recruitment in the North Atlantic of herring, two tuna species, Atlantic salmon, and swordfish (Drinkwater, Belgrano et al. 2003).

The Pacific decadal oscillation is the leading mode of variability in the North Pacific and operates over longer periods than either El Niño or La Niña/Southern Oscillation events and is capable of altering sea surface temperature, surface winds, and sea level pressure (Mantua and Hare 2002, Stabeno, Bond et al. 2004). During positive Pacific decadal oscillations, the northeastern Pacific experiences above average sea surface temperatures while the central and western Pacific Ocean undergoes below-normal sea surface temperatures (Royer 2005). Warm Pacific decadal oscillation regimes, as occurs in El Niño events, tends to decrease productivity along the U.S. west coast, as upwelling typically diminishes (Hare, Mantua et al. 1999, Childers, Whitledge et al. 2005). Recent sampling of oceanographic conditions just south of Seward, Alaska has revealed anomalously cold conditions in the Gulf of Alaska from 2006 through 2009, suggesting a shift to a colder Pacific decadal oscillation phase. More research needs to be done to determine if the region is indeed shifting to a colder Pacific decadal oscillation phase in addition to what effects these phase shifts have on the dynamics of prey populations important to ESA-listed cetaceans throughout the Pacific action area. A shift to a colder decadal oscillation phase would be expected to impact prey populations, although the magnitude of this effect is uncertain.

The Indian Ocean Dipole, which is also known as the Indian Niño, is an irregular oscillation of sea surface temperature in which the western Indian Ocean becomes alternately warmer and then colder than the eastern part of the ocean (Saji, Goswami et al. 1999). The Indian Ocean dipole, only identified recently in 1999, is one aspect of the general cycle of global climate, interacting with similar phenomena like the El Niño Southern Oscillation in the Pacific Ocean. As in the Pacific decadal oscillation and North Atlantic oscillation, the Indian Ocean dipole fluctuates between phases of positive, negative, and neutral conditions. During a positive Indian Ocean dipole, the western Indian Ocean experiences higher than normal sea surface temperature and greater precipitation while cooler sea surface temperature occur in the eastern Indian Ocean, often leading to droughts on land in the region (Saji, Goswami et al. 1999). The negative phase of the Indian Ocean dipole brings about the opposite conditions, with warmer sea surface temperatures and greater precipitation in the eastern Indian Ocean and cooler and drier conditions in the western Indian Ocean. The Indian Ocean dipole also affects the strength of monsoons over the Indian subcontinent. An average of four positive and negative Indian Ocean dipole events occurs during each 30-year period, with each Indian Ocean dipole event lasting about six months. However, since 1980 there have been 12 positive Indian Ocean dipoles with no negative Indian Ocean dipole events from 1992 until late in 2010, when a strong negative event began (Nakamura, Kayanne et al. 2009). This strong negative Indian Ocean dipole event coupled with a strong La Niña event in the western Pacific Ocean to cause catastrophic flooding in parts of Australia. In 1998, an El Niño even interacted with a positive Indian Ocean dipole event with devastating effect on Western Indian Ocean corals: 75 to 99 percent of live corals were lost in the western Indian Ocean during this event (Graham, Wilson et al. 2006).

In addition to period variation in weather and climate patterns that affect oceanographic conditions in the action area, longer terms trends in climate change and/or variability also have the potential to alter habitat conditions suitable for ESA-listed species in the action area on a much longer time scale. For example, from 1906 through 2006, global surface temperatures have risen 0.74° C and this trend is continuing at an accelerating pace. Twelve of the warmest years on record since 1850 have occurred since 1995 (Poloczanska, Limpus et al. 2009). Possible effects of this trend in climate change and/or variability for ESA-listed marine species in the action area include the alteration of community composition and structure, changes to migration patterns or community structure, changes to species abundance, increased susceptibility to disease and contaminants, altered timing of breeding and nesting, and increased stress levels (Macleod, Bannon et al. 2005, Robinson, Learmonth et al. 2005, Kintisch 2006, Learmonth, Macleod et al. 2006, Mcmahon and Hays 2006). Climate change can influence reproductive success by altering prey availability, as evidenced by the low success of Northern elephant seals (*Mirounga angustirostris*) during El Niño periods (McMahon and Burton 2005) as well as data suggesting that sperm whale females have lower rates of conception following periods of unusually warm sear surface temperature (Whitehead, Christal et al. 1997). However, gaps in information and the complexity of climatic interactions complicate the ability to predict the effects that climate change and/or variability may have to these species from year to year in the action area (Kintisch 2006, Simmonds and Isaac 2007).

10.3 Whaling and Subsistence Harvesting

Large whale population numbers in the action area have historically been impacted by aboriginal hunting and early commercial exploitation, and some stocks were already reduced by 1864 (the beginning of the era of modern commercial whaling using harpoon guns as opposed to harpoons simply thrown by men). From 1864 through 1985, at least 2.4 million baleen whales (excluding minke whales [*Balaenoptera acutorostrata*]) and sperm whales were killed (Gambell 1999). The large number of baleen whales harvested during the 1930s and 1940s has been shown to correspond to increased cortisol levels in earplugs collected from baleen whales, suggesting that anthropogenic activities, such as those associated with whaling, may contribute to increased stress levels in whales (Trumble et al 2018). Prior to current prohibitions on whaling most large whale species were significantly depleted to the extent it was necessary to list them as endangered under the Endangered Species Preservation Act of 1966. In 1982, the International Whaling Commission issued a moratorium on commercial whaling beginning in 1986. There is currently no legal commercial whaling by International Whaling Commission Member Nations party to the moratorium; however, whales are still killed commercially by countries that field objections to the moratorium (i.e., Iceland and Norway). Presently three types of whaling take place: (1) aboriginal subsistence whaling to support the needs of indigenous people; (2) special permit whaling; and (3) commercial whaling conducted either under objection or reservation to the moratorium. The reported catch and catch limits of large whale species from aboriginal subsistence whaling, special permit whaling, and commercial whaling can be found on the International Whaling Commission's website at: https://iwc.int/whaling. Additionally, the Japanese whaling fleet carries out whale hunts under the guise of "scientific research," though very few peer-reviewed papers have been published as a result of the program, and meat from the whales killed under the program is processed and sold at fish markets.

Norway and Iceland take whales commercially at present, either under objection to the moratorium decision or under reservation to it. These countries establish their own catch limits but must provide information on those catches and associated scientific data to the International Whaling Commission. The Russian Federation has also registered an objection to the moratorium decision but does not exercise it. The moratorium is binding on all other members of the International Whaling Commission. Norway takes minke whales in the North Atlantic Ocean within its Exclusive Economic Zone, and Iceland takes minke whales and fin whales in the North Atlantic Ocean, within its Exclusive Economic Zone (IWC 2012).

Under current International Whaling Commission regulations, aboriginal subsistence whaling is permitted for Denmark (Greenland, fin and minke whales, *Balaenoptera* spp.), the Russian Federation (Siberia, gray [*Eschrichtius robustus*], and bowhead [*Balaena mysticetus*] whales), St. Vincent and the Grendaines (Bequia, humpback whales [*Megaptera novaeangliae*]) and the U.S.

(Alaska, bowhead and gray whales). It is the responsibility of national governments to provide the International Whaling Commission with evidence of the cultural and subsistence needs of their people. The Scientific Committee provides scientific advice on safe catch limits for such stocks (IWC 2012). Based on the information on need and scientific advice, the International Whaling Commission then sets catch limits, recently in five-year blocks.

Scientific permit whaling has been conducted by Japan and Iceland. In Iceland, the stated overall objective of the research program was to increase understanding of the biology and feeding ecology of important cetacean species in Icelandic waters for improved management of living and marine resources based on an ecosystem approach. While Iceland states that its program was intended to strengthen the basis for conservation and sustainable use of cetaceans, it noted that it was equally intended to form a contribution to multi-species management of living resources in Icelandic waters. These whaling activities may or may not operate outside of the action area but the whales killed in these whaling expeditions are part of the populations of whales (e.g., fin, sei, and sperm) occurring within the action area for this consultation.

Most current whaling activities occur outside of the core study areas, but within the overall action area. Regardless, prior exploitation is likely to have altered population structure and social cohesion of all whale species within the action area, such that effects on abundance and recruitment continued for years after harvesting has ceased. ESA-listed whale mortalities since 1985 resulting from these activities can be seen below in Table 6 (IWC 2017, IWC 2017, IWC 2017).

Table 6. Endangered Species Act-listed whale mortalities as the result of whaling since 1985.

Species	Commercial Whaling	Scientific Research	Subsistence
Bryde's Whale	634	734	-- --
Bowhead Whale	-- --	-- --	1,592
Fin Whale	706	310	377
Gray Whale	-- --	-- --	3,787
Humpback Whale	-- --	-- --	120
Sei Whale	-- --	1,429	3
Sperm Whale	388	56	-- --

Many of the whaling numbers reported represent minimum catches, as illegal or underreported catches are not included. For example, recently uncovered Union of Soviet Socialists Republics catch records indicate extensive illegal whaling activity between 1948 and 1979 (Ivashchenko, Brownell Jr. et al. 2014). Additionally, despite the moratorium on large-scale commercial whaling, catch of some of these species still occurs in the Atlantic, Pacific, and Southern Oceans whether it be under objection of the International Whaling Commission, for aboriginal subsistence purposes, or under International Whaling Commission scientific permit 1985 through 2013. Some of the whales killed in these fisheries are likely part of the same population of whales occurring within the action area for this consultation.

Historically, commercial whaling caused all of the large whale species to decline to the point where they faced extinction risks high enough to list them as endangered species. Since the end of large-scale commercial whaling, the primary threat to the species has been eliminated. Many whale species have not yet fully recovered from those historic declines. Scientists cannot determine if those initial declines continue to influence current populations of most large whale species in the Artic, Atlantic, Indian, Pacific, and Southern Oceans. For example, the North Atlantic right whale has not recovered from the effects of commercial whaling and continue to face very high risks of extinction because of their small population sizes and low population growth rates. In contrast, populations of species such as the humpback whale have increased substantially from post-whaling population levels and appear to be recovering despite the impacts of vessel strikes, interactions with fishing gear, and increased levels of ambient sound.

10.4 Vessel Strikes

Vessels have the potential to affect animals through strikes, sound, and disturbance associated with their physical presence. Responses to vessel interactions include interruption of vital behaviors and social groups, separation of mothers and young, and abandonment of resting areas (Mann, Connor et al. 2000, Samuels, Bejder et al. 2000, Boren, Gemmell et al. 2001, Constantine 2001, Nowacek 2001). Whale watching, a profitable and rapidly growing business with more than nine million participants in 80 countries and territories, may increase these types of disturbance and negatively affected the species (Hoyt 2001).

Vessel strikes are considered a serious and widespread threat to ESA-listed marine mammals (especially large whales). This threat is increasing as commercial shipping lanes cross important breeding and feeding habitats and as whale populations recover and populate new areas or areas where they were previously extirpated (Swingle, Barco et al. 1993, Wiley, Asmutis et al. 1995). As vessels to become faster and more widespread, an increase in vessel interactions with cetaceans is to be expected. All sizes and types of vessels can hit whales, but most lethal and sever injuries are caused by vessels 80 meters (262.5 feet) or longer (Laist, Knowlton et al. 2001). For whales, studies show that the probability of fatal injuries from vessel strikes increases as vessels operate at speeds above 26 kilometers per hour (14 knots) (Laist, Knowlton et al. 2001). Evidence suggests that not all whales killed as a result of vessel strike are detected, particularly in offshore waters, and some detected carcasses are never recovered while those that are recovered may be in advanced stages of decomposition that preclude a definitive cause of death determination (Glass, Cole et al. 2010). The vast majority of commercial vessel strike mortalities of cetaceans are likely undetected and unreported, as most are likely never reported and most animals killed by vessel strike likely end up sinking rather than washing up on shore (Cassoff 2011). Kraus, Brown et al. (2005) estimated that 17 percent of vessel strikes are actually detected. Therefore, it is likely that the number of documented cetacean mortalities related to vessel strikes is much lower than the actual number of moralities associated with vessel strikes, especially for less buoyant species such as blue, humpback, and fin whales (Rockwood, Calambokidis et al. 2017). Rockwood, Calambokidis et al. (2017) modeled vessel strike mortalities of blue, humpback, and fin whales off California using carcass recovery rates of five and 17 percent and conservatively estimated that vessel strike mortality may be as high as 7.8, 2.0, and 2.7 times the recommended limit for blue, humpback, and fin whale stocks in this area, respectively.

Of 11 species of cetaceans known to be threatened by vessel strikes in the northern hemisphere, fin whales are the mostly commonly struck species, but North Atlantic right, gray, humpback, and sperm whales are also struck (Laist, Knowlton et al. 2001, Vanderlaan and Taggart 2007). In some areas, one-third of all fin whale and North Atlantic right whale strandings appear to involve vessel strikes (Laist, Knowlton et al. 2001). Vessel traffic within the action area can come from both private (e.g., commercial, recreational) and federal vessel (e.g., military, research), but traffic that is most likely to result in vessel strikes comes from commercial shipping.

The potential lethal effects of vessel strikes are particularly profound on species with low abundance. However, all whale species have the potential to be affected by vessel strikes. The latest five-year average mortalities and serious injuries related to vessel strikes for the ESA-listed cetacean stocks within U.S. waters likely to be found in the action area are given in Table 7 below (Hayes, Josephson et al. 2017, Henry, Cole et al. 2017). Data represent only known mortalities and serious injuries; more, undocumented mortalities and serious injuries for these and other stocks found within the action area have likely occurred.

Table 7. Five-year annual average mortalities and serious injuries related to vessel strikes for Endangered Species Act-listed marine mammals within the action area.

Species	Pacific Stock	Hawaii Stock	Alaska Stock	Gulf of Mexico	Western North Atlantic
Blue Whale	0.6	NA	NA	NA	0
Bryde’s Whale	NA	NA	NA	1	NA
Fin Whale	1.8	NA	0.4	NA	1.6
Gray Whale	0	NA	NA	NA	NA
Humpback Whale– Multiple ESA-listed DPSs	1	2.4	0.4	NA	NA
Killer Whale	0	NA	0	NA	NA
North Atlantic Right Whale	NA	NA	NA	NA	0.81

North Pacific Right Whale	0	NA	NA	NA	NA
Sei Whale	0	NA	NA	NA	NA
Sperm Whale	0	NA	0	0	0.2

DPS=Distinct Population Segment
NA=Not Applicable

10.5 Whale Watching

Whale watching is a rapidly-growing industry with more than 3,300 operators worldwide, serving 13 million participants in 119 countries and territories (O'connor, Campbell et al. 2009). As of 2010, commercial whale watching was a one billion dollar global industry per year (Lambert, Hunter et al. 2010). Private vessels may partake in this activity as well. NMFS has issued certain regulations and guidelines relevant to whale watching. As noted previously, many of the cetaceans considered in this opinion are highly migratory, so may also be exposed to whale watching activity occurring outside of the study areas.

Although considered by many to be a non-consumptive use of marine mammals with economic, recreational, educational and scientific benefits, whale watching is not without potential negative impacts (reviewed in Parsons 2012). Whale watching has the potential to harass whales by altering feeding, breeding, and social behavior or even injure them if the vessel gets too close or strikes the animal. Preferred habitats may be abandoned if disturbance levels are too high. Animals may also become more vulnerable to vessel strikes if they habituate to vessel traffic (Swingle, Barco et al. 1993, Wiley, Asmutis et al. 1995).

Several studies have examined the short-term effects of whale watch vessels on marine mammals. (Watkins 1986, Corkeron 1995, Au and Green 2000, Felix 2001, Erbe 2002, Magalhaes, Prieto et al. 2002, Williams, Trites et al. 2002, Richter, Dawson et al. 2003, Scheidat, Castro et al. 2004, Simmonds 2005). The whale's behavioral responses to whale watching vessels depended on the distance of the vessel from the whale, vessel speed, vessel direction, vessel sound, and the number of vessels. In some circumstances, whales do not appear to respond to vessels, but in other circumstances, whales change their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. Disturbance by whale watch vessels has also been noted to cause newborn calves to separate briefly from their mother's sides, which leads to greater energy expenditures by the calves (NMFS 2006).

Although numerous short-term behavioral responses to whale watching vessels were documented, little information is available on whether long-term negative effects result from whale watching (NMFS 2006). Christiansen, Rasmussen et al. (2014) estimated that cumulative time minke whales spent with whale watching boats in Iceland to assess the biological significance of whale watching disturbances and found that, through some whales were repeatedly exposed to whale watching boats throughout the feeding season, the estimated cumulative time they spent with boats was very low. Christiansen, Rasmussen et al. (2014) suggested that the whale watching industry, in its current state, is likely not having any long-term negative effects on vital rates.

It is difficult to precisely quantify or estimate the magnitude of the risks posed to marine mammals in general from vessel approaches associated with whale watching. Given the proposed seismic survey activities will not occur within 70 kilometers (37.8 nautical miles) of land, few (if any) whale watching vessels will be expected to co-occur with the proposed action's research vessel.

10.6 Fisheries

Fisheries constitute an important and widespread use of the ocean resources throughout the action area. Fisheries can adversely affect fish populations, other species, and habitats. Direct effects of fisheries interactions on marine mammals and sea turtles include entanglement and entrapment, which can lead to fitness consequences or mortality as a result of injury or drowning. Indirect effects include reduced prey availability, including overfishing of targeted species, and destruction of habitat. Use of mobile fishing gear, such as bottom trawls, disturbs the seafloor and reduces structural complexity. Indirect impacts of trawls include increased turbidity, alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (i.e., lost fishing gear continuing to ensnare fish and other marine animals), and generation of marine debris. Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats and have the potential to entangle or be ingested by marine mammals.

Fisheries can have a profound influence on fish populations. In a study of restrospective data, Jackson, Kirby et al. (2001) concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance of coastal ecosystems, including pollution and anthropogenic climatic change. Marine mammals are known to feed on several species of fish that are harvested by humans (Waring, Josephson et al. 2008). Thus, competition with humans for prey is a potential concern. Reductions in fish populations, whether natural or human-caused, may affect the survival and recovery of several populations.

10.7 Fisheries Interactions

Globally, 6.4 million tons of fishing gear is lost in the oceans every year (Wilcox, Heathcote et al. 2015). Entrapment and entanglement in fishing gear is a frequently documented source of human-caused mortality in cetaceans (see Dietrich, Cornish et al. 2007); in an extensive analysis of global risks to marine mammals, incidental catch was identified as the most common threat category (Avila et al. 2018). Materials entangled tightly around a body part may cut into tissues, enable infection, and severely compromise an individual's health (Derraik 2002). Entanglements also make animals more vulnerable to additional threats (e.g., predation and vessel strikes) by restricting agility and swimming speed. The majority of cetaceans that die from entanglement in fishing gear likely sink at sea rather than strand ashore, making it difficult to accurately determine the extent of such mortalities. Between 1970 and 2009, two-thirds of mortalities of large whales in the Northwest Atlantic Ocean were attributed to human causes, primarily vessel strike and entanglement (Van der Hoop, Moore et al. 2013). In excess of 97 percent of entanglement is caused by derelict fishing gear (Baulch and Perry 2014).

Cetaceans are also known to ingest fishing gear, likely mistaking it for prey, which can lead to fitness consequences and mortality. Necropsies of stranded whales have found that ingestion of net pieces, ropes, and other fishing debris has resulted in gastric impaction and ultimately death (Jacobsen, Massey et al. 2010). As with vessel strikes, entanglement or entrapment in fishing gear likely has the greatest impact on populations of ESA-listed species with the lowest abundance (e.g., Kraus, Kenney et al. 2016). Nevertheless, all species of cetaceans may face threats from derelict fishing gear.

The latest five-year average mortalities and serious injuries related to fisheries interactions for the ESA-listed cetacean stocks within U.S. waters likely to be found in the action area are given in Table 8 below (Hayes, Josephson et al. 2017, Henry, Cole et al. 2017). Data represent only known mortalities and serious injuries; more, undocumented moralities and serious injuries for these and other stocks found within the action area have likely occurred.

Table 8. Five-year annual average mortalities and serious injuries related to fisheries interactions for Endangered Species Act-listed marine mammals within the action area.

Species	Pacific Stock	Hawaii Stock	Alaska Stock	Gulf of Mexico	Western North Atlantic
Blue Whale	0	0	NA	NA	NA
Bowhead Whale	0	NA	0.2	NA	NA
Bryde’s Whale	NA	NA	NA	0	NA
False Killer Whale (Main Hawaiian Island insular DPS)	NA	0.1	NA	NA	NA
Fin Whale	0.2	0	0.2	NA	1.05
Gray Whale	0	NA	NA	NA	NA
Humpback Whale – Multiple ESA-listed DPSs	1.2	1.1	0.6	NA	NA
Killer Whale	0	NA	NA	NA	NA
North Atlantic Right Whale	NA	NA	NA	NA	4.55
North Pacific Right Whale	0	NA	NA	NA	NA

Sei Whale	0	0.2	NA	NA	NA
Sperm Whale	0.7	0.7	3.7	NA	0.6

DPS=Distinct Population Segment
NA=Not Applicable

In addition to these direct impacts, cetaceans may also be subject to indirect impacts from fisheries. Marine mammals probably consume at least as much fish as is harvested by humans (Kenney, Hyman et al. 1985). Many cetacean species (particularly fin and humpback whales) are known to feed on species of fish that are harvested by humans (Carretta, Oleson et al. 2016). Thus, competition with humans for prey is a potential concern. Reductions in fish populations, whether natural or human-caused, may affect the survival and recovery of ESA-listed cetacean populations. Even species that do not directly compete with human fisheries could be indirectly affected by fishing activities through changes in ecosystem dynamics. However, in general the effects of fisheries on whales through changes in prey abundance remain unknown.

10.8 Aquaculture

Aquaculture has the potential to impact protected species via entanglement and/or other interaction with aquaculture gear (i.e., buoys, nets, and lines), introduction or transfer of pathogens, increased vessel traffic and noise, impacts to habitat and benthic organisms, and water quality (Lloyd 2003, Clement 2013, Price and Morris 2013, Price, Keane et al. 2017). Current data suggest that interactions and entanglements of ESA-listed marine mammals and sea turtles with aquaculture gear are rare (Price, Keane et al. 2017). This may be because worldwide the number and density of aquaculture farms are low, and thus there is a low probability of interactions, or because they pose little risk of ESA-listed marine mammals and sea turtles. Nonetheless, given that in some aquaculture gear, such as that used in longline mussel farming, is similar to gear used in commercial fisheries, aquaculture may impact similar to fisheries and bycatch, as discussed above in Section 10.6 and 10.7, respectively. There are very few reports of marine mammal interactions with aquaculture gear in the U.S. Atlantic Ocean, although it is not always possible to determine if the gear animals become entangled in it from aquaculture or commercial fisheries (Price, Keane et al. 2017).

10.9 Pollution

Within the action area, pollution poses a threat to ESA-listed marine mammals and sea turtles. Pollution can come in the form of marine debris, pesticides, contaminants, and hydrocarbons.

10.9.1 Marine Debris

Marine debris is an ecological threat that is introduced into the marine environment through ocean dumping, littering, or hydrologic transport of these materials from land-based sources (Gallo, Fossi et al. 2018). Even natural phenomena, such as tsunamis and continental flooding, can cause large amounts of debris to enter the ocean environment (Watters, Yoklavich et al. 2010). Marine debris has been discovered to be accumulating in gyres throughout the oceans.

Marine mammals often become entangled in marine debris, including fishing gear (Baird, Mahaffy et al. 2015). Despite debris removal and outreach to heighten public awareness, marine debris in the environment has not been reduced (NRC 2008) and continues to accumulate in the ocean and along shorelines within the action area.

Marine debris affects marine habitats and marine life worldwide, primarily by entangling or choking individuals that encounter it (Gall and Thompson 2015). Entanglement in marine debris can lead to injury, infection, reduced mobility, increased susceptibility to predation, decreased feeding ability, fitness consequences, and morality for ESA-listed species in the action area. Entanglement can also result in drowning for air breathing marine species including sea turtles and cetaceans. The ingestion of marine debris has been documented to result in blockage or obstruction of the digestive tract, mouth, and stomach lining of various species and can lead to serious internal injury or mortality (Derraik 2002). In addition to interference with alimentary processes, plastics lodged in the alimentary tract could facilitate the transfer of pollutants into the bodies of whales and dolphins (Derraik 2002). Law, Moret-Ferguson et al. (2010) presented a time series of plastic content at the surface of the western North Atlantic Ocean and Caribbean Sea from 1986 through 2008. More than 60 percent of 6,136 surface plankton net tows collected small, buoyant plastic pieces. Data on marine debris in some locations of the action area is largely lacking; therefore, it is difficult to draw conclusions as to the extent of the problem and its impacts on populations of ESA-listed species.

Cetaceans are also impacted by marine debris, which includes: plastics, glass, metal, polystyrene foam, rubber, and derelict fishing gear (Baulch and Perry 2014, Li, Tse et al. 2016). Over half of cetacean species (including fin, sei, and sperm whales) are known to ingest marine debris (mostly plastic), with up to 31 percent of individuals in some populations containing marine debris in their guts and being the cause of death for up to 22 percent of individuals found stranded on shorelines (Baulch and Perry 2014).

Given the limited knowledge about the impacts of marine debris on marine mammals, it is difficult to determine the extent of the threats that marine debris poses to marine mammals. However, marine debris is consistently present and has been found in marine mammals in and near the action area. Fin whales in the Mediterranean Sea are exposed to high densities of microplastics on the feeding grounds, and in turn exposed to a higher oxidative stress because of the presence of plasticizers, an additive in plastics (Fossi, Marsili et al. 2016). In 2008, two sperm whales stranded along the California coast, with an assortment of fishing related debris (e.g., net scraps, rope) and other plastics inside their stomachs (Jacobsen, Massey et al. 2010). One whale was emaciated, and the other had a ruptured stomach. It was suspected that gastric impactions was the cause of both deaths. Jacobsen, Massey et al. (2010) speculated the debris likely accumulated over many years, possibly in the North Pacific gyre that will carry derelict Asian fishing gear into eastern Pacific Ocean waters. In January and February 2016, 30 sperm whales stranded along the coast of the North Sea (in Germany, the Netherlands, Denmark, France, and Great Britain); of the 22 dissected specimens, nine had marine debris in their gastrointestinal tracts. Most of it (78 percent) was fishing-related debris (e.g., nets, monofilament line) and the remainder (22 percent) was general debris (plastic bags, plastic buckets, agricultural foils) (Unger, Rebolledo et al. 2016).

Plastic debris is a major concern because it degrades slowly and many plastics float. The floating debris is transported by currents throughout the oceans and has been discovered accumulating in oceanic gyres (Law, Moret-Ferguson et al. 2010). Additionally, plastic waste in the ocean chemically attracts hydrocarbon pollutants such as polychlorinated biphenyl and dichlorodiphenyltrichloroethane. Marine mammals can mistakenly consume these wastes containing elevated levels of toxins instead of their prey. It is expected that marine mammals may be exposed to marine debris over the course of the action although the risk of ingestion or entanglement and the resulting impacts are uncertain at the time of this consultation.

10.9.2 **Pesticides and Contaminants**

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

The accumulation of persistent organic pollutants, including polychlorinated-biphenyls, dibenzo-p-dioxins, dibenzofurans and related compounds, through trophic transfer may cause mortality and sub-lethal effects in long-lived higher trophic level animals (Waring, Josephson et al. 2016), including immune system abnormalities, endocrine disruption, and reproductive effects (Krahn, Hanson et al. 2007). Persistent organic pollutants may also facilitate disease emergence and lead to the creation of susceptible “reservoirs” for new pathogens in contaminated marine mammal populations (Ross 2002). Recent efforts have led to improvements in regional water quality and monitored pesticide levels have declined, although the more persistent chemicals are still detected and are expected to endure for years (Mearns 2001, Grant and Ross 2002).

Numerous factors can affect concentrations of persistent pollutants in marine mammals, such as age, sex and birth order, diet, and habitat use (Mongillo, Holmes et al. 2012). In marine mammals, pollutant contaminant load for males increases with age, whereas females pass on contaminants to offspring during pregnancy and lactation (Addison and Brodie 1987, Borrell, Bloch et al. 1995). Pollutants can be transferred from mothers to juveniles at a time when their bodies are undergoing rapid development, putting juveniles at risk of immune and endocrine system dysfunction later in life (Krahn, Hanson et al. 2009).

10.9.3 Hydrocarbons

A nationwide study examining vessel oil spills from 2002 through 2006 found that over 1.8 million gallons of oil were spilled from vessels in all U.S. waters (Dalton and Jin 2010). In this study, "vessel" included numerous types of vessels, including barges, tankers, tugboats, and recreational and commercial vessels, demonstrating that the threat of an oil spill can come from a variety of boat types. Below we review the effects of oil spills on marine mammals more generally. Much of what is known comes from studies of large oil spills such as the *Deepwater Horizon* oil spill since no information exists on the effects of small-scale oil spills within the action area.

Exposure to hydrocarbons released into the environment via oil spills and other discharges pose risks to marine species. Marine mammals are generally able to metabolize and excrete limited amounts of hydrocarbons, but exposure to large amounts of hydrocarbons and chronic exposure over time pose greater risks (Grant and Ross 2002). Acute exposure of marine mammals to petroleum products causes changes in behavior and may directly injure animals (Geraci 1990). The *Deepwater Horizon* oil spill in the Gulf of Mexico in 2010 led to the exposure of tens of thousands of marine mammals to oil, causing reproductive failure, adrenal disease, lung disease, and poor body condition. Sea turtles were also impacted, being mired and killed by oil at the water's surface. Exposure also occurred via ingestion, inhalation, and maternal transfer of oil compounds to embryos; these effects are more difficult to assess, but likely resulted in sub-lethal effects and injury (Deepwater Horizon Trustees 2016).

Cetaceans have a thickened epidermis that greatly reduces the likelihood of petroleum toxicity from skin contact with oils (Geraci 1990), but they may inhale these compounds at the water's surface and ingest them while feeding (Matkin and Saulitis 1997). For example, as a result of the *Deepwater Horizon* oil spill, sperm whales could have been exposed to toxic oil components through inhalation, aspiration, ingestion, and dermal exposure. There were 19 observations of 33 sperm whales swimming in *Deepwater Horizon* surface oil or that had oil on their bodies (Diaz 2015 as cited in Deepwater Horizon NRDA Trustees 2016). The effects of oil exposure likely included physical and toxicological damage to organ systems and tissues, reproductive failure, and death. Whales may have experienced multiple routes of exposure at the same time, over intermittent timeframes and at varying rates, doses, and chemical compositions of oil based on observed impacts to bottlenose dolphins. Hydrocarbons also have the potential to impact prey populations, and therefore may affect ESA-listed species indirectly by reducing food availability.

As noted above, to our knowledge the past and present impacts of oil spills on ESA-listed species within the action area are limited to those associated with small-scale vessel spills. Nevertheless, we consider the documented effects of oil spills outside the action area, such as the *Deepwater Horizon* oil spill, examples of the possible impacts that oil spill can have on ESA-listed species.

10.10 Aquatic Nuisance Species

Aquatic nuisance species are aquatic and terrestrial organisms introduced into new habitats throughout the U.S. and other areas of the world that produce harmful impacts on aquatic ecosystems and native species (http://www.anstaskforce.gov). They are also referred to as invasive, alien, or non-indigenous species. Invasive species have been referred to as one of the top four threats to the world's oceans (Raaymakers and Hilliard 2002, Raaymakers 2003, Terdalkar, Kulkarni et al. 2005, Pughiuc 2010). Introduction of these species is cited as a major threat to biodiversity, second only to habitat loss (Wilcove, Rothstein et al. 1998). A variety of vectors are thought to have introduced non-native species including, but not limited to aquarium and pet trades, recreation, and ballast water discharges from ocean-going vessels. Common impacts of invasive species are alteration of habitat and nutrient availability, as well as altering species composition and diversity within an ecosystem (Strayer 2010). Shifts in the base of food webs, a common result of the introduction of invasive species, can fundamentally alter predator-prey dynamics up and across food chains (Moncheva and Kamburska 2002), potentially affecting prey availability and habitat suitability for ESA-listed species. They have been implicated in the endangerment of 48 percent of ESA-listed species (Czech and Krausman 1997).

10.11 Sound

The ESA-listed species that occur in the action area are regularly exposed to several sources of anthropogenic sounds. These include, but are not limited to maritime activities, aircraft, seismic surveys (exploration and research), and marine construction (dredging).Cetaceans generate and rely on sound to navigate, hunt, and communicate with other individuals and anthropogenic sound can interfere with these important activities (Nowacek, Thorne et al. 2007). Noise generated by human activity has the potential to affect sea turtles as well, although effects to sea turtles are not well understood. The ESA-listed species have the potential to be impacted by either increased levels of anthropogenic-induced background sound or high intensity, short-term anthropogenic sounds.

Anthropogenic sound in the action areas may be generated by commercial and recreational vessels, sonar, aircraft, seismic surveys, in-water construction activities, wind farms, military activities, and other human activities. These activities occur to varying degrees throughout the year. The scientific community recognizes the addition of anthropogenic sound to the marine environment as a stressor that can possibly harm marine animals or significantly interfere with their normal activities (NRC 2005). The species considered in this opinion may be impacted by anthropogenic sound in various ways. Once detected, some sounds may produce a behavioral response, including but not limited to, changes in habitat to avoid areas of higher sound levels, changes in diving behavior, or (for cetaceans) changes in vocalization (MMC 2007).

Many researchers have described behavioral responses of marine mammals to sounds produced by boats and vessels, as well as other sound sources such as helicopters and fixed-wing aircraft, and dredging and construction (and Nowacek, Thorne et al. 2007, reviewed in Gomez, Lawson et al. 2016). Most observations have been limited to short-term behavioral responses, which included avoidance behavior and temporary cessation of feeding, resting, or social interactions; however, in terrestrial species habitat abandonment can lead to more long-term effects, which may have implications at the population level (Barber, Crooks et al. 2010). Masking may also occur, in which an animal may not be able to detect, interpret, and/or respond to biologically relevant sounds. Masking can reduce the range of communication, particularly long-range communication, such as that for blue and fin whales. This can have a variety of implications for an animal's fitness including, but not limited to, predator avoidance and the ability to reproduce successfully (MMC 2007). Recent scientific evidence suggests that marine mammals, including several baleen whales, compensate for masking by changing the frequency, source level, redundancy, or timing of their signals, but the long-term implications of these adjustments are currently unknown (Parks 2003, Mcdonald, Hildebrand et al. 2006, Parks 2009).

Despite the potential for these impacts to affect individual ESA-listed marine mammals and sea turtles, information is not currently available to determine the potential population level effects of anthropogenic sound levels in the marine environment (MMC 2007). For example, we currently lack empirical data on how sound impacts growth, survival, reproduction, and vital rates, nor do we understand the relative influence of such effects on the population being considered. As a result, the consequences of anthropogenic sound on ESA-listed marine mammals and sea turtles at the population or species scale remain uncertain, although recent efforts have made progress establishing frameworks to consider such effects (NAS 2017).

10.11.1 **Vessel Sound and Commercial Shipping**

Much of the increase in sound in the ocean environment is due to increased shipping, as vessels become more numerous and of larger tonnage (NRC 2003, Hildebrand 2009, Mckenna, Ross et al. 2012). Commercial shipping continues a major source of low-frequency sound in the ocean, particularly in the Northern Hemisphere where the majority of vessel traffic occurs. Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels above 2 kiloHertz. The low frequency sounds from large vessels overlap with many mysticetes predicted hearing ranges (7 Hertz to 35 kiloHertz) (NOAA 2018) and may mask their vocalizations and cause stress (Rolland, Parks et al. 2012). The broadband sounds from large vessels may interfere with important biological functions of odontocetes, including foraging (Holt 2008, Blair, Merchant et al. 2016). At frequencies below 300 Hertz, ambient sound levels are elevated by 15 to 20 dB when exposed to sounds from vessels at a distance (McKenna, Ross et al. 2013). Analysis of sound from vessels revealed that their propulsion systems are a dominant source of radiated underwater sound at frequencies less than 200 Hertz (Ross 1976). Additional sources of vessel sound include rotational and reciprocating machinery that produces tones and pulses at a constant rate. Other commercial and recreational vessels also operate within the action area and may produce similar sounds, although to a lesser extent given their much smaller size.

Individuals produce unique acoustic signatures, although these signatures may change with vessel speed, vessel load, and activities that may be taking place on the vessel. Peak spectral levels for individual commercial vessels are in the frequency band of 10 to 50 Hertz and range from 195 dB re: µPa^2-s at 1 meter for fast-moving (greater than 37 kilometers per hour [20 knots]) supertankers to 140 dB re: µPa^2-s at 1 meter for small fishing vessels (NRC 2003). Small boats with outboard or inboard engines produce sound that is generally highest in the mid-frequency (1 to 5 kiloHertz) range and at moderate (150 to 180 dB re: 1 µPa at 1 meter) source levels (Erbe 2002, Gabriele, Kipple et al. 2003, Kipple and Gabriele 2004). On average, sound levels are higher for the larger vessels, and increased vessel speeds result in higher sound levels. Measurements made over the period 1950 through 1970 indicated low frequency (50 Hertz) vessel traffic sound in the eastern North Pacific Ocean and western North Atlantic Ocean was increasing by 0.55 dB per year (Ross 1976, Ross 1993, Ross 2005). Whether or not such trends continue today is unclear. Most data indicate vessel sound is likely still increasing (Hildebrand 2009). However, the rate of increase appears to have slowed in some areas (Chapman and Price 2011), and in some places, ambient sound including that produced by vessels appears to be decreasing (Miksis-Olds and Nichols 2016). Efforts are underway to better document changes in ambient sound (Haver, Gedamke et al. 2018), which will help provide a better understanding of current and future impacts of vessel sound on ESA-listed species.

Sonar systems are used on commercial, recreational, and military vessels and may also affect cetaceans (NRC 2003). Although little information is available on potential effects of multiple commercial and recreational sonars to cetaceans, the distribution of these sounds would be small because of their short durations and the fact that the high frequencies of the signals attenuate quickly in seawater (Nowacek, Thorne et al. 2007). However, military sonar, particularly low frequency active sonar, often produces intense sounds at high source levels, and these may impact cetacean behavior (Southall, Nowacek et al. 2016). For further discussion of military sound on the ESA-listed species considered in this opinion, see Section 10.12.

10.11.2 **Aircraft**

Aircraft within the action area may consist of small commercial or recreational airplanes, helicopters, to large commercial airliners. These aircraft produce a variety of sounds that could potentially enter the water and impact marine mammals. While it is difficult to assess these impacts, several studies have documented what appear to be minor behavioral disturbances in response to aircraft presence (Nowacek, Thorne et al. 2007).

10.11.3 **Seismic Surveys**

There are seismic survey activities involving towed airgun arrays that may occur within the action area. They are the primary exploration technique to locate oil and gas deposits, fault structure, and other geological hazards. These activities may produce noise that could impact ESA-listed cetaceans and sea turtles within the action area. These airgun arrays generate intense low-frequency sound pressure waves capable of penetrating the seafloor and are fired repetitively at intervals of ten to 20 seconds for extended periods (NRC 2003). Most of the energy from the airguns is directed vertically downward, but significant sound emission also extends horizontally. Peak sound pressure levels from airguns usually reach 235 to 240 dB at dominant frequencies of five to 300 Hertz (NRC 2003). Most of the sound energy is at frequencies below 500 Hertz, which is within the hearing range of baleen whales (Nowacek, Thorne et al. 2007). In the U.S., all seismic surveys involving the use of airguns with the potential to take marine mammals are covered by incidental take authorizations under the MMPA, and if they involve ESA-listed species, undergo formal ESA section 7 consultation. In addition, the Bureau of Ocean Energy Management authorizes oil and gas activities in domestic waters as well as the National Science Foundation and U.S. Geological Survey funds and/or conducts these activities in domestic and foreign waters, and in doing so, consults with NMFS to ensure their actions do not jeopardize the continued existence of ESA-listed species or adversely modify or destroy designated critical habitat. More information on the effects of these activities on ESA-listed species, including authorized takes, can be found in recent biological opinions.

There were two known low-energy seismic surveys that occurred near the Mid-Atlantic Ridge in the North Atlantic Ocean from June to August 2018. These included a National Science Foundation and United States Geological Survey funded seismic survey. Each of these surveys were conducted for research purposes and contained a MMPA incidental take authorization that were both subject to a separate ESA section 7 consultation. Each of these consultations resulted in a “no jeopardy” opinion.

10.11.4 Marine Construction

Marine construction in the action area that produces sound includes drilling, dredging, pile-driving, cable-laying, and explosions. These activities are known to cause behavioral disturbance and physical damage (NRC 2003). While most of these activities are coastal, offshore construction does occur.

10.12 Military Activities

The U.S. Navy conducts training, testing, and other military readiness activities on range complexes throughout coastal and offshore areas in the United States and on the high seas. The U.S. Navy’s activities are conducted off the coast of the Atlantic and Pacific Oceans and elsewhere throughout the world. The U.S. Navy’s Atlantic Fleet Training and Testing range complex overlaps with the action area for Permit No. 21585. During training, existing and established weapon systems and tactics are used in realistic situations to simulate and prepare for combat. Activities include: routine gunnery, missile, surface fire support, amphibious assault and landing, bombing, sinking, torpedo, tracking, and mine exercises. Testing activities are conducted for different purposes and include at-sea research, development, evaluation, and experimentation. The U.S. Navy performs testing activities to ensure that its military forces have the latest technologies and techniques available to them. The majority of the training and testing activities the U.S. Navy conducts in the action area are similar, if not identical to activities that have been occurring in the same locations for decades.

The U.S. Navy's activities produce sound and visual disturbance to marine mammals and sea turtles throughout the action area (NMFS 2015, NMFS 2015, NMFS 2017). Anticipated impacts from harassment due to the U.S. Navy's activities include changes from foraging, resting, milling, and other behavioral states that require low energy expenditures to traveling, avoidance, and behavioral states that require higher energy expenditures. Based on the currently available scientific information, behavioral responses that result from stressors associated with these training and testing activities are expected to be temporary and will not affect the reproduction, survival, or recovery of these species. Sound produced during U.S. Navy activities is also expected to result in instances of temporary threshold shift and permanent threshold shift to marine mammals and sea turtles. The U.S. Navy's activities constitute a federal action and take of ESA-listed marine mammals and sea turtles considered for these activities have previously undergone separate ESA section 7 consultation. Through these consultations with NMFS, the U.S. Navy has implemented monitoring and conservation measures to reduce the potential effects of underwater sound from activities on ESA-listed resources in the Atlantic Ocean. Conservation measures include employing visual observers and implementing mitigation zones during activities using active sonar and explosives.

In addition to these testing and training activities, the U.S. Navy operates Surveillance Towed Array Sensor System Low Frequency Active sonar (SURTASS LFA) within the action area, which utilizes low frequency sounds to detect and monitor submarines. SURTASS LFA activities have a coherent low-frequency signal with a duty cycle of less than 20 percent, operating for a maximum of only 255 hours per year for each system (or 432 hours per year in the past) or a total of 10.6 days per year. This compares to an approximate 21.9 million days per year for the world's shipping industry. Thus, SURTASS LFA sonar transmissions will make up a very small part of the human-caused sound pollution in the ocean.

Prior to 2017, the U.S. Navy used SURTASS LFA sonar in the western and central North Pacific Ocean. However, in 2017 the U.S. Navy requested programmatic section 7 consultation for the operation of SURTASS LFA sonar from August 2017 through 2022 in the non-polar region of the world's oceans (including within the action area). The consultation was concluded in August 2017 (NMFS 2017) and considered the U.S. Navy's SURTASS LFA program as well as specific SURTASS LFA operations.

10.13 Scientific Research

Regulations for section 10(a)(1)(A) of the ESA allow issuance of permits authorizing take of certain ESA-listed species for the purposes of scientific research. Prior to the issuance of such a permit, the proposal must be reviewed for compliance with section 7 of the ESA. Marine mammals have been the subject of field studies for decades. The primary objective of most of these field studies has generally been monitoring populations or gathering data for behavioral and ecological studies. Over time, NMFS has issued dozens of permits on an annual basis for various forms of “take” of marine mammals in the action area from a variety of research activities.

Authorized research on ESA-listed marine mammals includes aerial and vessel surveys, close approaches, photography, videography, behavioral observations, active acoustics, remote ultrasound, passive acoustic monitoring, biological sampling (i.e., biopsy, breath, fecal, sloughed skin), and tagging. Research activities involve non-lethal “takes” of these marine mammals.

There have been numerous research permits issued since 2009 under the provisions of both the MMPA and ESA authorizing scientific research on marine mammals and sea turtles all over the world, including for research in the action area. The consultations which took place on the issuance of these ESA scientific research permits each found that the authorized research activities will have no more than short-term effects and will not result in jeopardy to the species or adverse modification of designated critical habitat.

Currently 29 permits, including one, Permit No. 14856 that would be replaced by the proposed action, allow research on a combination of the target species in areas that could overlap with the proposed action area. Of these permits, six currently authorize fully-implantable tags. Most permits authorize a smaller study area or region within an ocean basin, reducing the chance of repeated harassment of individual animals by multiple researchers. Therefore, most of this research does not overlap in area or timing. Some spatial overlap exists for research on species with known feeding or breeding grounds, such as humpback whales.

Additional “take” is likely to be authorized in the future as additional permits are issued. It is noteworthy that although the numbers tabulated below represent the maximum number of “takes” authorized in a given year, monitoring and reporting indicate that the actual number of “takes” rarely approach the number authorized. Therefore, it is unlikely that the level of exposure indicated below has or will occur in the near term. However, our analysis assumes that these “takes” will occur since they have been authorized. It is also noteworthy that these “takes” are distributed across the Atlantic Ocean. Although marine mammals and sea turtles are generally wide-ranging, we do not expect many of the authorized “takes” to involve individuals that will also be “taken” under the proposed research activities.

10.14 Impact of the Baseline on Endangered Species Act-Listed Species

Collectively, the stressors described above have had, and likely continue to have, lasting impacts on the ESA-listed species considered in this consultation. Some of these stressors result in mortality or serious injury to individual animals (e.g., vessel strikes and whaling), whereas others result in more indirect (e.g., fishing that impacts prey availability) or non-lethal (e.g., whale watching) impacts. Assessing the aggregate impacts of these stressors on the species considered in this opinion is difficult and, to our knowledge, no such analysis exists. This becomes even more difficult considering that many of the species in this opinion are wide ranging and subject to stressors in locations throughout and outside the action area.

We consider the best indicator of the aggregate impact of the *Environmental Baseline* on ESA-listed resources to be the status and trends of those species. As noted in Section 9, some of the species considered in this consultation are experiencing increases in population abundance, some are declining, and for others, their status remains unknown. Taken together, this indicates that the *Environmental Baseline* is impacting species in different ways. The species experiencing increasing population abundances are doing so despite the potential negative impacts of the *Environmental Baseline*. Therefore, while the *Environmental Baseline* may slow their recovery, recovery is not being prevented. For the species that may be declining in abundance, it is possible that the suite of conditions described in the *Environmental Baseline* is preventing their recovery. However, is also possible that their populations are at such low levels (e.g., due to historical commercial whaling) that even when the species' primary threats are removed, the species may not be able to achieve recovery. At small population sizes, species may experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their limited population size to become a threat in and of itself. A thorough review of the status and trends of each species is discussed in the *Species and Critical Habitat Likely to be Adversely Affected* (Section 8) and *Status of Species and Critical Habitat Likely to be Adversely Affected* (Section 9) sections of this opinion.

11 Effects of the Action

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

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

In this section, we describe the potential stressors associated with the proposed action, the probability of individuals of ESA-listed species being exposed to these stressors based on the best scientific and commercial evidence available, and the probable responses to those individuals (given probable exposures) based on the available evidence. As described in Section 2, for any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, or lifetime reproductive success), the assessment would consider the risk posed to the viability of the population(s) those individuals comprise and to the ESA-listed species those populations represent. For this consultation, we are particularly concerned about behavioral and stress-based physiological disruptions and potential unintentional mortality that may result in animals that fail to feed, reproduce, or survive because these responses are likely to have population-level consequences. The purpose of this assessment and, ultimately, of this consultation is to determine if it is reasonable to expect the proposed action to have effects on ESA-listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

11.1 Stressors Associated with the Proposed Action

Stressors are any physical, chemical, or biological entity that may induce an adverse response either in an ESA-listed species or their designated critical habitat. The issuance of Permit No. 21585 will authorize several methods for research activities that may expose ESA-listed marine mammals within the action areas to a variety of stressors. Each research activity presents a unique set of stressors, as further detailed below. Given the directed nature of the proposed research, all research activities directed only at non-ESA-listed cetaceans (except active acoustics) are not expected to present any stressors to the ESA-listed cetaceans found in the action areas, and so these activities are not considered further (see Section 3).

We have determined that the Oregon State University's import and export of materials from ESA-listed cetacean species will have no effect on populations in the wild and will not discuss these research activities further in this opinion.

The potential stressors we expect to result from the proposed action are pollution, vessel strike, vessel noise, gear entanglement, aerial surveys, vessel surveys, active acoustics (prey mapping), close approaches, biological sampling (i.e., biopsy sampling, prey sampling, and sloughed skin sampling), and tagging.

Manned aerial surveys will expose cetaceans to aircraft noise and visual disturbance depending on the aircraft altitude. Vessel surveys and close approaches will present a range of stressors including vessel traffic, discharge, and visual and auditory disturbances.

Photography will follow close approaches, but will not present any additional stressors other than those associated with vessel surveys and close approaches by vessels and aircraft. Prey mapping will present the additional stressors as described for vessel surveys and close approaches, but for a longer duration than a typical vessel survey or close approach. Passive acoustic monitoring will present the additional stressors as described for vessel surveys, but also include gear entanglement. Given their non-invasive nature, most documentation activities (photo and video) are not expected to produce any stressors aside from those associated with vessel surveys and close approaches by vessels.

Biological sampling (i.e., biopsy sampling, prey sampling, sloughed skin sampling) can present the additional stressor of interaction with scientific equipment, if cetaceans happen to approach researchers during biological sampling. Biopsy sampling can carry the stressor of a closer vessel approach than is typical for other vessel survey activities (except tagging), direct physical contact with the animal, a minor puncture wound, and tissue collection. Partially- and fully-implantable tagging will present the additional stressors of a very close approach and puncture wounds.

11.2 Exposure and Response Analysis

The *Exposure Analysis* identifies, as possible, the number, age (or life stage), and gender of the ESA-listed individuals that are likely to be exposed to the stressors and the population(s) of sub-population(s) those individuals belong. The *Response Analysis* evaluates the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure.

11.2.1 Exposure Analysis

In this section, we quantify the likely exposure of ESA-listed species to the activities and associated stressors that may result from the proposed action (Section 3). Table 2 specifies the applicants' and the Permits and Conservation Division's proposed exposure to ESA-listed species associated with pollution, vessel strike, vessel noise, gear entanglement, aerial surveys, vessel surveys, active acoustics (prey mapping), close approaches, biological sampling, and tagging. In accordance with our regulations (50 C.F.R §402), here we evaluate whether or not this proposed level of exposure is reasonably certain to occur.

Dr. Bruce Mate (Oregon State University) has explained his MMPA take number estimates in the permit application for Permit No. 21585. With these explanations of MMPA take number estimates, our own evaluation of these numbers in comparison to Dr. Bruce Mate's and other researchers' annual reports for similar species and research activities, and the conservative assumption that all MMPA take that the Permits and Conservation Division authorize *could* occur, we adopt the exposure of ESA-listed species that are reasonably certain to occur as the number of animals specified in Table 2 for specific research activities.

Under Permit No. 21585, Dr. Bruce Mate plans to target cetacean species and opportunistically study pinnipeds and other cetaceans that are encountered in the Arctic, Atlantic, Indian, Pacific, and Southern Oceans, but most work will be conducted in the western North Atlantic, Gulf of Mexico, Pacific waters off the U.S. west coast, and waters around Hawaii.

For vessel surveys, Dr. Bruce Mate has requested takes on an annual basis that are high enough to conduct research activities each year. Researchers cannot be certain which species and the number of animals that will be encountered in the action area, and all species are of interest; therefore, they have requested more takes than will be needed for flexibility purposes.

For tagging and biopsy sampling, Dr. Bruce Mate plans to take up to 50 each of humpback, blue, fin, southern right, Eastern North Pacific stock gray, and sperm whales, 25 non-Gulf of Mexico Bryde's whales, five North Pacific right whales, and six Western North Pacific stock gray whales, in U.S. and international waters, annually. Dr. Bruce Mate is also requesting to collect biopsy samples of up to 20 additional non-tagged conspecifics during tagging operations. Researchers will avoid resampling known individuals by utilizing identification techniques on the research vessel. These requested takes reflect numbers that the researchers feel are necessary to provide a representative sample given the high degree of individual variation seen in whale distribution and behavior as well as variation in tag duration and potential tag failure. As North Pacific right whales and Western North Pacific gray whales have smaller population sizes, smaller take numbers have been proposed for these species.

For research activities on humpback whales that will be authorized under Permit No. 21585, estimates of the number of individuals to be sampled are based on the location in which research activities will occur off the coast of British Columbia, Washington, Oregon, and California, but within these locations multiple DPSs of ESA-listed humpback whales can be found. To determine the exposure of individual humpback whale DPSs, we rely on NMFS internal guidance as derived from Wade, Quinn et al. (2016) (NMFS 2016, NMFS 2016). For British Columbia, Washington, Oregon, and California, which in Wade, Quinn et al. (2016) is composed of several smaller sub-locations, we use the percentage estimates from Wade, Quinn et al. (2016) for the greater North Pacific Ocean (including Washington, Oregon, California) area in which Dr. Bruce Mate, Oregon State University, will work (Table 9). For Permit No. 21585, the proportion of research activities in the Alaska, Washington, Oregon, and California action area is unknown. We use each location specified in Wade, Quinn et al. (2016) (Aleutian Islands/Bering Sea/Chukchi Sea/Beaufort Sea, Gulf of Alaska, and Southeast Alaska/Northern British Columbia) and the probability of encountering the DPS breakdown percentages across the larger Alaskan area. We recognize that these percentages sum to greater than 100 percent in some cases, but this overestimation is necessary in order to conservatively address uncertainty in the percentage estimates likely to be taken for each DPS and to protect the small endangered Central America DPS, threatened Mexico DPS, and endangered Western North Pacific DPS of humpback whales. Furthermore, percentages are rounded up, as partial numbers of individuals were not acceptable in our calculations. The percentages are directly multiplied by the MMPA takes specified in Table 2 to estimate the number of individual humpback whales from each DPS that will be exposed to research activities under Permit No. 21585. At this time, this method of estimating humpback whale DPS exposure represents the best available data and method given the granularity Dr. Bruce Mate, Oregon State University, is able to project in the proposed research activities.

Table 9. Probability of encountering humpback whales from each distinct population segment of humpback whales in the North Pacific Ocean in various feeding areas. Adapted from Wade et al. (2016).

Summer Feeding Areas	Western North Pacific Distinct Population Segment	Hawaii Distinct Population Segment	Mexico Distinct Population Segment	Central America Distinct Population Segment
Aleutian Islands, Bering Sea, Chukchi Sea, Beaufort Sea	4.4%	86.5%	11.3%	0%
Gulf of Alaska	0.5%	89.0%	10.5%	0%
Southeast Alaska, Northern British Columbia	0%	93.9%	6.1%	0%
Southern British Columbia, Washington	0%	52.9%	41.9%	14.7%
Oregon, California	0%	0%	89.6%	19.7%

Given the Permits and Conservation Division's issuance and counting of takes as well as the researchers' inability to identify each individual animal in the field in real time, the *Annual Number of Authorized Takes* presented in Table 2 represents the maximum number of individuals that may be exposed to the proposed research activities annually, although it is possible that individuals can be exposed more than the number of takes specified in *Takes Per Individual* in a given year for research activities under Permit No. 21585. The Permits and Conservation Division directs researchers to count and report one take per cetacean per day including all approaches and procedure attempts, regardless of whether a behavioral response to the permitted activity is observed. For example, if researchers sample an animal one day it will count as one individual taken under the MMPA permit. If the same individual were sampled on another day that same year without realizing it, it will be counted as a different individual taken under the MMPA permit. This will result in the total annual number of individuals exposed to the proposed research activities being less than in Table 2. This scenario also illustrates that researchers may unintentionally sample the same individual more than once in a single year, and thus may not be able to adhere to the number specified in the *Takes Per Individual* column. However, given the nature of fieldwork (unpredictability, reliance on equipment and personnel availability, and good weather for operations, etc.), the vast action area of Permit No. 21585, and the range of most ESA-listed cetaceans and pinnipeds, it is likely that many, if not all animals will only be sampled once or at most two or three times. For fairly small residential populations such as that of the Main Hawaiian Islands insular DPS of false killer whales, there is an increased possibility that the same animal may be intentionally or unintentionally sampled more than once or multiple times in a given year. However, in these circumstances, researchers typically have well-established photo-identification catalogs and are able to readily identify the animals in the field and avoid repeat sampling, if necessary.

11.2.2 Response Analysis

Given the exposure detailed above, in this section we describe the range of responses among ESA-listed cetaceans that may result from the stressors associated with the research activities that will be authorized under Permit No. 21585. These include stressors associated with the following activities: manned aerial surveys, vessel surveys, close approaches, behavioral observations, focal follows, photography, videography, passive acoustic (tag dosimeters, towed arrays, hand-held hydrophones, prey sampling, active acoustics (prey mapping), biopsy sampling, and tagging (partially- and fully-implantable). Based on a review of available information, this opinion determined which of these possible stressors will be discountable or insignificant and which may lead to lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals. As discussed in Section 3, prey sampling, sloughed skin sampling, and most documentation activities are not expected to produce any stressors themselves. Thus, no response to these research activities is expected beyond the response to the vessel surveys and close approaches needed to perform these research activities. Our response analysis considers and weighs evidence of adverse consequences, as well as evidence suggesting the absence of such consequences. In cases where data specific to a species are unavailable, we rely on data from other species, including cetaceans, particularly large whales (i.e., mysticetes and sperm whales). We recognize that there can be species' specific responses, and even within species all individual animals do not respond to each stressor in the same way (e.g., Noren and Mocklin 2012). Examining the range of responses large whales exhibit to research activities allows us to incorporate the uncertainty that stems from intra- and inter-species response heterogeneity, and makes use of the best available science.

In general, all the research activities described in Section 3 have the potential to cause some sort of disturbance. Responses by animals to human disturbance are similar to their responses to potential predators (Harrington and Veitch 1992, Lima 1998, Gill, Norris et al. 2001, Frid and Dill 2002, Frid 2003, Beale and Monaghan 2004, Romero 2004). These responses manifest themselves as stress responses in which an animal perceives human activity as a potential threat and undergoes physiological changes to prepare a flight or fight response to more serious physiological changes resulting from chronic exposure to stressors. Stress responses can also lead to interruptions of essential behavioral or physiological events, alteration of an animal’s time budget, or some combination of these responses (Sapolsky, Romero et al. 2000, Frid and Dill 2002, Romero 2004, Walker, Dee Boersma et al. 2005). Further, these responses have been associated with abandonment of sites (Sutherland and Crockford 1993), reduced reproductive success (Giese 1996, Mullner, Linsenmair et al. 2004), and the death of individual animals (Feare 1976, Daan 1996, Bearzi 2000).

The mammalian stress response involves the hypothalamic-pituitary-adrenal axis being stimulated by a stressor, causing a cascade of physiological responses, such as the release of the stress hormones adrenaline (epinephrine), glucocorticosteroids, and others (Thomson and Geraci 1986, St. Aubin and Geraci 1988, St. Aubin, Ridgway et al. 1996, Gulland, Haulena et al. 1999, Busch and Hayward 2009). These hormones can subsequently cause short-term weight loss, the liberation of glucose into the blood stream, impairment of the immune and nervous systems, elevated heart rate, body temperature, blood pressure, and alertness, and other responses (Thomson and Geraci 1986, Kaufman and Kaufman 1994, Dierauf and Gulland 2001, Dierauf and Gulland 2001, Cattet, Christison et al. 2003, Elftman, Norbury et al. 2007, Fonfara, Siebert et al. 2007, Noda, Akiyoshi et al. 2007, Mancia, Warr et al. 2008, Busch and Hayward 2009, Dickens, Delehanty et al. 2010). In some species, stress can also increase an individual's susceptibility to gastrointestinal parasitism (Greer 2008). In highly stressful circumstances, or in species prone to strong "fight-or-flight" responses, more extreme consequences can result, including muscle damage and death (Cowan and Curry 1998, Cowan and Curry 2002, Herraez, Sierra et al. 2007, Cowan and Curry 2008). The most widely recognized hormonal indicator of vertebrate stress, cortisol, normally takes hours to days to return to baseline levels following a significantly stressful event, but other hormones of the hypothalamic-pituitary-adrenal axis may persist for weeks (Dierauf and Gulland 2001). Mammalian stress levels can vary by age, sex, season, and health status (Peters 1983, Hunt, Rolland et al. 2006, Keay, Singh et al. 2006). In addition, smaller mammals tend to react more strongly to stress than larger mammals (Peters 1983, Hunt, Rolland et al. 2006, Keay, Singh et al. 2006).

In sum, the common underlying stressor of a human disturbance caused by the research activities that will occur under Permit No. 21585 may lead to a variety of different stress-related responses. However, given the relatively short duration of the research activities (a few seconds to several hours) relative to marine mammal life histories (e.g., life expectancies of 15 to over 100 years), we do not anticipate these responses to result in negative fitness consequences. In addition to possibly causing a stress-related response, each research activity is likely to produce unique responses as detailed further below. For unintentional disturbance that may result when animals are associated with individuals targeted for directed research, we expect responses to be similar to, or in most cases less than, those described below for each research activity, and above for general human disturbances.

11.2.2.1 Manned Aerial Surveys

Responses to aerial surveys consist only of behavioral responses, which vary by species and aircraft type. As outlined below, behavioral responses to manned aerial surveys are likely more pronounced than to unmanned aerial surveys.

Manned aerial surveys that will be authorized under Permit No. 21585 may cause visual disturbance or auditory disturbance (i.e., noise) that may affect ESA-listed cetaceans within the action areas. Cetacean responses to aircraft depend on the animals' behavioral state at the time of exposure (e.g., resting, socializing, foraging, or traveling) as well as the altitude and lateral distance of the aircraft to the animals (Luksenburg and Parsons 2009). The underwater and sound intensity from aircraft is less than produced by boats and visually, aircraft are more difficult for cetaceans to locate since they are not in the water and move rapidly (Richter, Dawson et al. 2006). However, when aircraft fly below certain altitudes (about 500 meters [1,640.4 feet]), they have caused cetaceans to exhibit behavioral responses that might constitute a significant disruption of their normal behavioral patterns (Patenaude, Richardson et al. 2002). Thus, aircraft flying at low altitude, at close lateral distances and above shallow water elicit stronger responses than aircraft flying higher, at greater lateral distances and over deep water (Patenaude, Richardson et al. 2002, Smultea, Mobley et al. 2008). The sensitivity to disturbance by aircraft may also differ among species (Wursig, Lynn et al. 1998). Sperm whales have been observed to respond to a fixed-wing aircraft circling at altitudes of 245 to 335 meters (803.8 to 1,099.1 feet) by ceasing forward movement and moving closer together in a parallel flank-to-flank formation, a behavioral response interpreted as an agitation, distress, and/or defense reaction to the circling aircraft (Smultea, Mobley et al. 2008). About 14 percent of bowhead whales approached during aerial surveys exhibited short-term behavioral reactions (Patenaude, Richardson et al. 2002). While all ESA-listed whale species exposed to aerial surveys may exhibit short-term behavioral reactions, data from the Oregon State University from past permits indicated no behavioral responses. Therefore, it is expected the aerial surveys using manned aircraft conducted during the proposed research activities will result in no reaction or only mild short-term behavioral reactions and not any long-term behavioral changes or reduction in fitness. Therefore, we conclude that the effects of disturbance on ESA-listed cetaceans (i.e., blue, fin, Western North Pacific gray, humpback [Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS], North Pacific right, southern right, and sperm whales) that may result from this stressor (manned aerial surveys) are insignificant, and we will not discuss it further in this opinion.

11.2.2.2 Vessel Surveys, Close Approaches, and Documentation

Vessel surveys and close approaches conducted under both permits will expose ESA-listed marine mammals within the action areas to vessel traffic, discharge, and visual and auditory disturbances. As noted previously, most documentation does not present any stressors outside of those associated with vessel surveys and close approaches. The purpose of vessel surveys and close approaches is to allow researchers to conduct other research activities, responses to which are described below in individual sections.

Vessel surveys necessarily involve transit within the marine environment, and the transit of any research vessel in waters inhabited by cetaceans carries the risk of striking an animal. Responses to a vessel strike can involve death, serious injury, or minor, non-lethal injuries. The probability of a vessel collision and the associated response depends, in part, on the size and speed of the vessel. The majority of vessel strikes of large whales occur when vessels are traveling at speeds greater than approximately 18.5 kilometers per hour (10 knots), with vessels traveling faster, especially large vessels (80 meters [262.5 feet] or greater), being more likely to cause serious injury or death (Laist, Knowlton et al. 2001, Jensen and Silber 2004, Vanderlaan and Taggart 2007, Conn and Silber 2013).

The research vessels will be traveling at generally slow speeds, reducing the amount of noise produced by the propulsion system and the probability of vessel strikes (Kite-Powell, Knowlton et al. 2007, Vanderlaan and Taggart 2007). While ship strikes during research activities are possible, we are aware of only two instances of a research vessel striking a whale in thousands of hours at sea (Wiley, Mayo et al. 2016). One of these strikes involved the NOAA research vessel (R/V) *Auk*. While transiting to port on April 9, 2009 in Massachusetts Bay, the R/V *Auk* struck a North Atlantic right whale (Wiley, Mayo et al. 2016). A captain and mate each of whom had logged many hours of ship time during marine mammal research activities operated the vessel. The vessel was traveling at 10.6 kilometers per hour (19.7 knots), which, while not required for a vessel of its size (15 meters [49.2 feet]), is well above the 18.5 kilometers per hour (10 knots) restrictions that were active at the time within the area for larger vessels (greater than 19.8 meters [65 feet]). Winds were 37 to 42.6 kilometers per hour (20 to 23 knots) out of the northeast, and wave heights were approximately 1.3 meters (4.3 feet), not ideal conditions for spotting marine mammals. Six marine mammal observers were on the lookout when the mate spotted a whale approximately 9 meters (29.5 feet) in front of the vessel, which was subsequently seen by a marine mammal observer when the whale's fluke was directly in front of the vessel. There was not time to notify the captain, nor adjust course and speed; the North Atlantic right whale was struck. The North Atlantic right whale exhibited minor bleeding from seven to eight lacerations on the tip of its left tail fluke, which follow up photographs show eventually healed with the tip of the fluke falling off. After assessing the animal's condition, the R/V *Auk* departed approximately one hour following the initial strike, since at this point the animal appeared to be behaving normally. Since the event, the North Atlantic right whale has been seen at least 46 times, with the injury being fully healed by day 719 after the vessel strike and the animal appearing to be healthy (Wiley, Mayo et al. 2016).

The R/V *Auk* ship strike incident is an important reminder that even with well-trained marine mammal observers and vessel operators, all vessels, even research vessels, have the potential to strike cetaceans. In this particular instance, there were six dedicated marine mammal observers, but no indication of the animal's presence prior to the initial sighting within 9 meters (29.5 feet) of the vessel by the mate. We consider this event extremely rare given that only two instances of research vessel ship strikes have ever been reported over the years of cetacean research similar to the proposed actions under MMPA permits, neither of which appear to have been lethal (Wiley, Mayo et al. 2016).

We generally expect the movement of marine mammals away from or parallel to the research vessels, as well as the generally slow movement of the research vessels during most of its travels. Also, the researchers have not documented any vessel strikes on ESA-listed marine mammals during research activities. Given the rarity of ship strikes of large whales during research activities from historical data, the extensive experience of researchers at the Oregon State University have in spotting cetaceans at sea, and the slow speeds (generally 18 kilometers per hour [10 knots]) at which they will operate when near animals, we believe the likelihood of a vessel strike from research vessel transits is extremely unlikely. As such, the potential for vessel strike from the research vessels is highly improbable. Therefore, we conclude that the effects on ESA-listed cetaceans [i.e., blue, fin, Western North Pacific gray, humpback (Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS), North Pacific right, southern right, and sperm whales] that may result from this stressor (vessel strike) are discountable, and thus vessel transit associated with the proposed action may affect, but is not likely to adversely affect these species, and we will not discuss it further in this opinion.

Discharge from research vessels in the form of leakages of fuel or oil is possible, though effects of any spills will have minimal, if any, effects on ESA-listed cetaceans (i.e., blue, fin, Western North Pacific gray, humpback [Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS], North Pacific right, southern right, and sperm whales). The potential for fuel or oil leakages is extremely unlikely. An oil or fuel leak will likely pose a significant risk to the vessel and its crew and actions to correct a leak should occur immediately to the extent possible. In the event that a leak should occur, the amount of fuel and oil onboard the research vessels is unlikely to cause widespread, high dose contamination (excluding the remote possibility of severe damage to the research vessel) that will impact ESA-listed species directly or pose hazards to their food sources. Given the experience of the researchers and boat operators in conducting research activities and maintaining research vessels in the action areas, it is unlikely that spills or discharges will occur. If discharge does occur, the amounts of leakage will be small, disperse into the water, and not affect cetaceans directly. Therefore, we conclude that the effects on ESA-listed cetaceans that may result from this stressor (discharge) are discountable. Thus, discharge from research vessels associated with the proposed action may affect, but is not likely to adversely affect these species, and we will not discuss it further in this opinion.

Close approaches by research vessels may cause visual or auditory disturbances to cetaceans and more generally disrupt their behavior, which may negatively influence essential functions such as breeding, feeding, and sheltering. Cetaceans react in a variety of ways to close vessel approaches. Responses range from little to no observable change in behavior to momentary changes in swimming speed and orientation, diving, surface, and foraging behavior, and respiratory patterns (Watkins, Moore et al. 1981, Hall 1982, Baker, Herman et al. 1983, Malme, Miles et al. 1983, Richardson, Greene et al. 1985, Au and Green. 2000, Baumgartner and Mate 2003, Jahoda, Lafortuna et al. 2003, Koehler 2006, Scheidat, Gilles et al. 2006, Isojunno and Miller 2015). Changes in cetacean behavior can correspond to vessel speed, size, and distance from the whale, as well as the number and frequency of vessel approaches (Baker, Perry et al. 1988, Beale and Monaghan 2004). Characteristics of the individual and/or the context of the approach, including age, sex, the presence of offspring, whether or not habituation to vessels has occurred, individual differences in reactions to stressors, and the behavioral state of the whales can also influence the responses to close vessel approaches (Baker, Perry et al. 1988, Wursig, Lynn et al. 1998, Gauthier and Sears 1999, Hooker, Baird et al. 2001, Lusseau 2004, Koehler 2006, Richter, Dawson et al. 2006, Weilgart 2007). Observations of large whales indicate that cow-calf pairs, smaller groups, and groups with calves appear to be more responsive to close vessel approaches (Hall 1982, Bauer 1986, Bauer and Herman 1986, Clapham and Mattila 1993, Williamson, Kavanagh et al. 2016). Cetaceans may become sensitized or habituated to vessels as the result of multiple approaches (Constantine 2001), which could increase or decrease stress levels associated with additional approaches and or research activities following an approach. Reactions to vessel noise by bowhead and gray whales (ESA-listed species or population of cetaceans) have been observed when engines are started at distances of 914.4 meters (3,000 feet) (Malme, Miles et al. 1983, Richardson, Greene et al. 1985) from the animals, suggesting that some level of disturbance may result even if the vessel does not closely approach. It should be noted that human observations of a whale's behavioral response may not reflect a whale's actual experience; thus, our use of behavioral observations as indicators of a whale's response to research may or may not be correct (Clapham and Mattila 1993).

We expect that the research vessels will not add significantly to the local noise environment in their operating area due to the propulsion and other noise characteristics of the vessel's machinery. Any contribution is likely small in the overall environment of regional ambient sound levels. A research vessel's transit past a marine mammal will be brief and not likely to be significant in impacting any individual's ability to feed, reproduce, or avoid predators. Brief interruptions in communication via masking are possible, but unlikely given the habits of marine mammals to move away from the research vessels, either as a result of engine noise, the physical presence of the research vessel, or both (Lusseau 2006). In addition, the research vessels will be traveling at relatively slow speeds, reducing the amount of noise produced by the propulsion system. The source levels of sounds that will be generated by research vessels (i.e., vessel noise) are below that which could cause physical injury or temporary hearing threshold shifts, and they are unlikely to mask cetaceans ability to hear mates and other conspecifics for any significant amount of time (Hildebrand 2009, NOAA 2016). Because the potential acoustic interference from engine noise will be undetectable or so minor that it could not be meaningfully be evaluated, we find that the effects to blue, fin, Western North Pacific gray, humpback (Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS), North Pacific right, southern right, and sperm whales from this potential stressor are insignificant. Thus, noise from research vessels associated with the proposed action may affect, but is not likely to adversely affect these species, and we will not discuss the effects further in this opinion.

Despite the varied observed responses to vessel approaches documented in the literature, and the multitude of factors that may affect an individual whale's response, we expect affects from close approaches by research vessels that will be authorized under Permit No. 21585, with the exception of close approaches for tagging and biopsies, to be minimal for several reasons. First, researchers at the Oregon State University have years of experience approaching cetaceans in a way that is designed to minimize disturbance and associated responses. Researchers will be on constant lookout for marine mammals, and thus, if non-target ESA-listed marine mammals are spotted, researchers will be able to avoid closely approaching them. Nonetheless, a close approach to these species can occur if researchers are unable to identify the marine mammal species or DPS from a distance. No long-term effects on behavior or fitness from disturbances caused by close approaches by research vessels have been documented by researchers at the Oregon State University and more generally in the literature. Based on accounts from past research activities, responses documented in the literature, and the proposed research method for closely approaching cetaceans using a research vessel, we expect the proposed close approaches may produce short- to mid-term behavioral and stress responses, but would not significantly disrupt the normal behavioral patterns of cetaceans to an extent that they would create the likelihood of injury or impact fitness. As a result, we do not expect close approaches to have fitness consequences for individual cetaceans. This conclusion is based on close approaches by research vessels made during most research activities. The anticipated response from the close approaches that will be required for tagging, which occur at much closer distances (within a few meters) are further discussed below. Therefore, we conclude that the effects on ESA-listed cetaceans that may result from this stressor (close approaches for research activities other than tagging and biopsies) are insignificant, and thus these approaches may affect but are not likely to adversely affect these species, and we will not discuss them further in this opinion.

11.2.2.3 Photography and Videography

As noted previously, photography and videography will occur following close approaches, and as such, photography and videography is expected to produce the same responses as previously described in Section 11.2.2.2. Simply taking an animal’s photograph or video is not expected to present any unique stressors that will cause additional responses. Therefore, no response is expected to photography and videography that has not already been described above. Photography and videography itself will not affect the fitness of individual cetaceans. Therefore, we conclude that the effects on ESA-listed cetaceans (i.e., blue, fin, Western North Pacific gray, humpback [Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS], North Pacific right, southern right, and sperm whales) that may result from this stressor (photography and videography) are insignificant, and thus photography and videography may affect, but is not likely to adversely affect these species, and we will not discuss it further in this opinion.

11.2.2.4 Behavioral Observation

Observation of cetaceans will occur during research activities to increase the understanding of cetacean ecology and behavior as well as provide insight on the effects of anthropogenic disturbance on cetaceans. Behavioral observations will occur concurrently with other research activities including aerial surveys, vessel surveys, focal follows, active acoustics, biological sampling, tagging, and biopsies. Given that observation itself does not present any unique stressors not already described in detail for aerial and vessel surveys and close approaches, we do not anticipate unique responses to observation. However, the duration of observations following biological sampling, tagging, or biopsies will generally be greater than a typical vessel survey. As detailed in Section 3.3.2, most of the time the research vessel will be at distances ranging from 10 to 200 meters (32.8 to 656.1 feet). If the individual were to exhibit an indication of disturbance, then we anticipate the researchers will move away and take all possible actions to minimize such disturbance since such disruption of natural behavior invalidates their dataset. Thus, given the possible responses to close approach during vessel surveys, the far distances at which most observation will occur, and the motivation of the researchers to minimize disturbing cetaceans during observations, we expect no effects on fitness as the result of observations. Therefore, we conclude that the effects on ESA-listed cetaceans (i.e., blue, fin, Western North Pacific gray, humpback [Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS], North Pacific right, southern right, and sperm whales) that may result from this stressor (observation) are insignificant, and thus observations may affect, but are not likely to adversely affect these species, and we will not discuss them further in this opinion.

11.2.2.5 Active Acoustics – Prey Mapping

Prey mapping will image prey fields, including while marine mammals utilize habitats for foraging. Most of the responses to prey mapping are associated with the vessel survey and observation described above. While prey mapping does present the unique stressors of sound used to map prey and close approaches to foraging cetaceans, we do not anticipate these will have significant impacts on cetaceans. Marine mammal hearing is not suspected to be above 160 kiloHertz, but 200 kiloHertz is often used as the cutoff for high-frequency cetaceans. Specifically for low-frequency cetaceans, such as mysticetes, the generalized hearing range is estimated to be from 7 Hertz to 35 kiloHertz. For mid-frequency cetaceans, such as false killer and killer whales, the generalized hearing range is 150 Hertz to 160 kiloHertz. The prey mapping equipment (echosounders) frequencies of 38, 70, and 120 kiloHertz for imaging and characterizing prey fields are generally outside the predicted hearing ranges (7 Hertz to 35 kiloHertz) (NOAA 2016) of low frequency cetaceans [i.e., blue, fin, Western North Pacific gray, humpback (Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS), North Pacific right, southern right, and sperm whales], and thus, we do not anticipate a response to these sounds. Active acoustics involving a multi-beam echosounder with signal frequencies of 200 kiloHertz were used to monitor the behavior of spinner dolphins (*Stenella longirostris*) in Hawaii while foraging and the researchers did not report behavioral responses by the animals to the sound source (Benoit-Bird and Au 2009). Spinner dolphins are considered mid-frequency cetaceans with predicted hearing ranges similar to sperm whales (NOAA 2018). Close approaches to actively feeding cetaceans can cause dense prey patches to break up or redistribute, but the amount of prey that will be disturbed will be insignificant compared to that which the animal consumes in any given mouthful and that is expected to be available in the action area.

Also, the ensonification of animals can be easily prevented given the sonar's relatively narrow beam production and directionality, which is often oriented downward thus making it likely that air-breathing, non-target vertebrates will go undetected. Relative to the speaker, sound frequency output is much higher and characterized by lower power, rapid signal attenuation, and a much more limited spatial theater over which the research activities are conducted. Sound propagation, even when conducted from narrow beam devices, often contain a strong spherical spreading component. The concentrated sound energy of narrow beam transducers are much higher in frequency and thus well above mysticete's hearing sensitivity, and attenuate rapidly further reducing their likelihood of affecting non-target ESA-listed cetacean species. Thus, we do not anticipate the unique stressors associated with prey mapping to affect the fitness of individual cetaceans. Therefore, we conclude that the effects on ESA-listed cetaceans (i.e., blue, fin, Western North Pacific gray, humpback [Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS], North Pacific right, southern right, and sperm whales) that may result from this stressor (active acoustics – prey mapping) are insignificant, and thus the use of active acoustics for prey mapping may affect, but is not likely to adversely affect these species, and we will not discuss them further in this opinion.

11.2.2.6 Passive Acoustic Monitoring

The towed hydrophone arrays and hydrophones suspended in the water column from a research vessel for passive acoustic monitoring can come in direct contact with ESA-listed cetaceans. Entanglement is unlikely due to the towed hydrophone array and hand-held hydrophone design, as well as the fact that researchers monitor the equipment during deployment. Observers on the research vessels will spot cetaceans prior to and during deployment of this equipment. Instances of ESA-listed cetcean entanglement events during research activities using these hydrophone systems have not been reported. The potential for entanglements is considered highly unlikely and therefore discountable. Therefore, we conclude that the effects on ESA-listed cetaceans (i.e., blue, fin, Western North Pacific gray, humpback [Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS], North Pacific right, southern right, and sperm whales) that may result from this stressor (entanglement from passive acoustic monitoring) may affect but are not likely to adversely affect these species, and we will not discuss them further in this opinion.

11.2.2.7 Biological Sampling

Under Permit No. 21585, the Oregon State University will be authorized to collect biological samples, including prey and sloughed skin. The only stressors associated with prey and sloughed skin sampling will be those associated with a potential close vessel approach as described above. As a result, we anticipate the very close approaches associated with vessel-based sampling may elicit a greater proportion of the more extreme responses noted above, such as momentary changes in swimming speed and orientation, diving, changes in surface and foraging behavior, and changes in respiratory patterns as described above and below.

11.2.2.8 Biopsy Sampling

Biopsy sampling will result in stressors from a minor puncture wound and tissue collection, and requires a very close approach. In general, it is difficult to distinguish between animals' reactions to these different stressors without explicit studies designed to isolate the response to individual stressors, which to our knowledge have not been conducted. As such, below we describe the range of responses, both physiological and behavioral, to the overall procedure of biopsy sampling, and where data are available, indicate possible responses to specific stressors.

Physiological responses of cetaceans to biopsy sampling may include the biopsy site wound and associated healing, a stress response, serious injury, or even death (reviewed in Noren and Mocklin 2012). Responses vary by species, biopsy tip dimensions, the draw weight of the sampling method, and the distance from which animals are sampled but most animals heal quickly, often within a month or less, and show no signs of infection (Noren and Mocklin 2012). In fact, for at least some large whale species (e.g., Southern right whale [*Eubalaena australis*]) immediately after sampling takes place, biopsy sites are hardly noticeable (Reeb and Best 2006). This is perhaps not surprising given that cetaceans have high rates of cell proliferation that enable them to heal from large shark inflicted wounds within months (Corkeron, Morris et al. 1987, Lockyer and Morris 1990, Dwyer and Visser 2011).

Beyond the wound itself, biopsy sampling could cause a physiological stress response similar to that described in the beginning of this section, even if the biopsy dart does not successfully penetrate the animal's tissue. Such a response may involve the release of stress hormones, short-term weight loss, susceptibility to gastrointestinal parasitism, the liberation of glucose into the blood stream, impairment of the immune and nervous system, an elevated heart rate, body temperature, blood pressure, and alertness, muscle damage, and death. However, given the small size of wounds created by biopsy sampling and the short duration over which the sampling occurs, stress responses to remote biopsy sampling are likely minimal.

Finally, biopsy sampling could result in serious injury or death. However, in over 40 years of researchers collecting biopsy samples from cetaceans, we are aware of only one example of such an event: a common dolphin death following biopsy sampling in 2000 (Bearzi 2000). Several possible explanations exist for why this particular animal died including a dart stopper malfunction, the location of the biopsy wound, the thinness of the animal's blubber, the handling of the animal, and possibly this animal having a predisposition to catatonia and death during stressful events (Bearzi 2000). It is important to note that due to this animal's unusually thin blubber layer, the biopsy tip penetrated the animal's muscle, which is not the intent of most researcher's biopsy sampling efforts.

While the above discussion indicates a range of physiological responses to biopsy sampling, only minor wounds and low-level stress responses are anticipated as the result of biopsy sampling that will be conducted under Permit No. 21585. This is because all biopsy dart tips used will be (1) thoroughly sterilized before sampling, thus minimizing any chance of infection, (2) only penetrate 2.6 to 4 centimeters (1 to 1.6 inch), less than the typical thickness of most large cetacean blubber (five to 10 centimeters, Lockyer, Mcconnell et al. 1985), and will be fitted with a cushioned stop encircling the biopsy dart tip to ensure recoil and prevent deeper penetration, and so will not penetrate any individual's muscle based on the anticipated thickness of the blubber layer of species to be sampled. Thus, biopsy dart tips are not expected to result in serious injury or death.

Cetaceans also exhibit a wide range of behavioral responses to biopsy sampling (reviewed in Noren and Mocklin 2012), and in some cases these are indistinguishable from those described below for penetrating tags (Reisinger, Oosthuizen et al. 2014). Most researchers report either no behavioral response or minor behavioral responses including changes in dive behavior, heading, or speed, and startle responses and tail flicks (Noren and Mocklin 2012). On occasion, researchers report similar low-level responses from animals nearby those being biopsied and to darts entering the water, suggesting that some observed responses are a general startle response and not necessarily due to being contacted by the biopsy dart (Gorgone, Haase et al. 2008, Noren and Mocklin 2012). From past research documented in annual reports, various researchers have observed responses to biopsy sampling ranging from no visible response to a 'startled' reaction sometimes followed by an animal swimming away or diving. On rare occasions (zero to six percent of animals biopsied), researchers have reported more severe behavioral responses such as flight response, breaching, multiple tail slaps, and/or numerous trumpet blows (Noren and Mocklin 2012). These more severe responses appear to coincide with instances where biopsy tips struck an unintended body part (e.g., dorsal fin) or when tips remain lodged in the animal (Weinrich, Lambertsen et al. 1991, Weinrich, Lambertson et al. 1992, Gauthier and Sears 1999, Berrow, Mchugh et al. 2002). This being said, when darts remain in animals it does not appear to result in mortality, infection, or lasting behavioral changes (Clapham and Mattila 1993, Barrett-Lennard, Smith et al. 1996, Parsons, Durban et al. 2003).

For all of these responses, it is important to keep in mind that in many cases it is hard to distinguish the behavioral response to biopsy sampling from the response to the close vessel approach (Pitman 2003). Regardless, in most instances animals return to pre-biopsying/close approach behavior quickly, usually within 30 seconds to three minutes (Noren and Mocklin 2012). In fact, biopsied individuals do not appear to avoid vessels during subsequent biopsy attempts (within one week to five months), and in many cases show the same or a lesser response to the second biopsying event (Best, Reeb et al. 2005, Noren and Mocklin 2012).

A variety of factors influence how cetaceans respond behaviorally to biopsy sampling, including the species, age and sex, behavioral context, location, methods and or equipment used, type and size of the boat, size of the biopsy dart, season, water depth, and sea state (Noren and Mocklin 2012). For example, a higher proportion of odontocetes respond to the biopsy sampling compared to mysticetes (Noren and Mocklin 2012). In some cases (Best, Reeb et al. 2005), but not others (Weinrich, Lambertsen et al. 1991), mothers and calves appear to be more sensitive to biopsy sampling than other age groups. Migrating humpback whales appear to be less responsive than those on the feeding grounds (Weinrich, Lambertsen et al. 1991, Clapham and Mattila 1993). However, on the feeding grounds, foraging humpback whales are less likely to respond than resting humpback whales (Weinrich, Lambertson et al. 1992).

The biopsy sampling may cause temporary stress, pain, wounding, and injury, with the potential for behavioral responses. The potential for serious injury and/or long-term effects on individuals from biopsy sampling is minimal, given that the biopsy darts will not contain any hazardous materials, the penetration depth of the dart is superficial to the blubber/muscle interface, and minimization measures (see *Description of the Proposed Action* [Section 3] and *Conservation Measures* [Section 3.8]) are employed to prevent deeper penetration.

Given the above overview of possible behavioral responses of cetaceans to biopsy sampling, and the mitigation measures proposed by the Permits and Conservation Division and the applicants (Section 3.8), we expect ESA-listed cetaceans to behaviorally respond to biopsy sampling by exhibiting short-term, minor to moderate changes in behavior. However, we do not expect these behavioral responses will significantly disrupt their normal behavioral patterns to an extent that it will create the likelihood of injury or impact any individuals' fitness.

In summary, of the large number of cetaceans that have been biopsy sampled in recent decades (probably in the tens of thousands), there has been only one documented case of an immediate fitness consequence associated with biopsy sampling (Bearzi 2000) and it was a dolphin, while whales will be targeted in the proposed actions that are the subject of this consultation. While studies on the delayed, long-term impacts of biopsy sampling are lacking, the available data suggests no effects to fitness (Best, Reeb et al. 2005, Noren and Mocklin 2012). Also, the Oregon State University have not observed any known injuries or other significant effects from biopsy sampling. As such, we expect biopsy sampling to result in minor wounds, low-level stress responses, and temporary behavior changes, but we do not expect any individuals to experience reductions in fitness. Note that there is further discussion of effects from biopsy sampling and tagging below.

11.2.2.9 Prey Sampling

Prey sampling will occur during vessel surveys and may affect ESA-listed cetaceans within the action areas. Prey sampling is expected to occur within 50-100 meters of a feeding whale and researchers would use a small otter trawl or bongo net. If a cetacean were to approach researchers collecting a prey sample, the sampling net may present a stressor if the cetacean were to interact with (i.e., contact) it. However, the otter trawl/bongo net would be small enough to ensure that researchers could quickly retrieve it if a cetacean were to come near the net. Thus, we do not anticipate any response from cetaceans to prey sampling, and as a result, no effects on the fitness of individual cetaceans. Therefore, we conclude that the effects on ESA-listed cetaceans (i.e., blue, fin, Western North Pacific gray, humpback [Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS], North Pacific right, southern right, and sperm whales) that may result from this stressor (prey sampling) are insignificant. Thus, prey sampling efforts associated with the proposed action may affect, but are not likely to adversely affect these species, and we will not discuss them further in this opinion.

11.2.2.10 Sloughed Skin Sampling

Sloughed skin sampling will occur during vessel surveys and may affect ESA-listed cetaceans within the action areas. Sloughed skin sampling is not expected to occur where cetaceans are, but rather in the path previously traveled by cetaceans. No approach to cetaceans will be made and the possibility that a cetacean surfaces at the same time and place as the sloughed skin sample collection is remote. Nevertheless, if a cetacean were to approach researchers collecting a sloughed skin sample, the sampling net may present a stressor if the cetacean were to interact with (i.e., contact). However, if a cetacean were to come near the net, given its small size and form, it is very unlikely to injure the cetacean. Thus, we do not anticipate any response from cetaceans to sloughed skin sampling, and as a result, no effects on the fitness of individual cetaceans. Therefore, we conclude that the effects on ESA-listed marine mammals that may result from this stressor (sloughed skin sampling) are insignificant. Thus, sloughed skin sampling associated with the proposed action may affect but is not likely to adversely affect these species, and we will not discuss it further in this opinion.

11.2.2.11 Tagging

The Oregon State University will be authorized to tag several ESA-listed cetacean species (i.e., blue, fin, Western North Pacific gray, humpback [Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS], North Pacific right, southern right, and sperm whales) with either partially- or fully-implantable tags. Tagging carries the stressors and responses associated with very close approach (as close as 1 meter [3.3 feet]), the initial attachment of the tag, and the continued attachment of tags, all of which have the potential to adversely affect cetaceans. Attachment of the tag will involve puncture wounds if dart/barb tags are used. Responses to these stressors may be physiological and/or behavioral in nature. Below we detail the range of physiological and behavioral responses to tags based on the timing of the response, from the initial tag deployment until the tag detaches.

11.2.2.12 Initial Tag Attachment

Cetaceans are likely to respond behaviorally to very close approaches for tag attachment in a similar way as previously described for other close approaches. However, given the closer proximity of these approaches (as close as 1 meter [3.3 feet]) we anticipate greater responses like those noted for research activities including biopsy sampling such as momentary changes in swimming speed and orientation, diving, changes to surface and foraging behavior, and changes in respiratory patterns.

Concurrent with this response will be a response to the tag penetration and puncture wounds. However, current research examining how cetaceans respond to tag attachments, regardless of type, does not usually distinguish between an animal's response to a very close approach and the tag attachment. Possible reasons for this include: (1) such responses are indistinguishable to researchers, (2) no proper controls exist to make such a distinction given that researchers generally do not approach very close unless they are also tagging, and (3) such a distinction is not warranted as cetaceans themselves may not differentiate between the two stressors. As such, below we describe what is known about how cetaceans respond behaviorally to the initial tag deployment, which includes the response to both the very close approach and the physical attachment of the tag.

The behavioral responses cetaceans exhibit to the application of invasive tags, such as dart/barb and fully-implantable tags, are similar to those described for very close approaches (Walker, Trites et al. 2012). Furthermore, despite the difference in depth of penetration and size between partially- and fully-implantable tags, behavioral responses to partially- and fully-implantable tags, do not appear to drastically differ between the two tag types (Mate, Mesecar et al. 2007, Walker, Trites et al. 2012, Mate, Palacios et al. 2016, Robbins, Andrews-Goff et al. 2016, Szesciorka, Calambokidis et al. 2016). These responses include head lifts, fluke lifts, exaggerated fluke beats on diving, quick dives, or increased swimming speeds. Less frequent behavioral responses include fluke slaps, head lunges, fluke swishes, defecation, decreased surfacing rates, disaffiliation with a group of whales, evasive swimming behavior, cessation of singing, breaching, bubble blowing, or rapid acceleration (Mate, Mesecar et al. 2007, Walker, Trites et al. 2012, Mate, Palacios et al. 2016, Szesciorka, Calambokidis et al. 2016).

Given that partially- and fully-implantable tags penetrate the animal's tissue, a physiological response is expected. Anticipated reactions to these puncture wounds include minor pain, cell damage, and possible local inflammation, swelling, bleeding, blood clotting, hemorrhaging, and bruising (Weller 2008, Walker, Trites et al. 2012, Mate, Palacios et al. 2016, Robbins, Andrews-Goff et al. 2016, Szesciorka, Calambokidis et al. 2016, NMFS 2017). However, since partially-implantable tags will be designed to not penetrate beyond the blubber layer, and the size of the puncture wounds will be small, very little bleeding, and no hemorrhaging, blood clotting, or bruising is expected to occur from these types of tags. While fully-implantable tags create larger wounds and penetrate deeper (to the muscle-blubber interface), and so increase the risk of these more pronounced physiological responses (Moore, Andrews et al. 2013), current evidence suggests such responses are rare, even for deeper penetrating implantable tags (Weller 2008, Walker, Trites et al. 2012, Mate, Palacios et al. 2016, Robbins, Andrews-Goff et al. 2016, Szesciorka, Calambokidis et al. 2016, NMFS 2017, NMFS 2017). In addition, a stress response to the deployment of invasive tags is possible, but the available data indicates such a response will be short-term and minimal (Eskesen, Teilmann et al. 2009). If the penetrating tips of tags were contaminated, a viral, fungal, or bacterial infection is possible (Weller 2008, Haulena 2016, NMFS 2016). However, given that researchers at the Oregon State University will thoroughly sterilize all tags prior to deployment, infection is unlikely (see *Description of Proposed Action* and *Conservation Measures* sections for sterilization procedures). That said, tag sterilization does not preclude the possibility that a pathogen on the cetacean's skin could enter the body upon tag insertion (Weller 2008).

There is also a possibility that some partially- or fully-implantable tags may break upon impact or soon after, leaving parts of these tags (e.g., petals) in the animal with no tag attached. Future tag breakage is less likely given that recent tag modifications made by researchers have greatly reduced or eliminated tag breakage (Robbins, Andrews-Goff et al. 2016, Szesciorka, Calambokidis et al. 2016). Researchers have noted tag breakage and have consulted with tag manufacturers to modify future tags in an effort to reduce and hopefully eliminate such tag breakage. Even if such an event were to occur, we do not anticipate the response to this initial tag breakage to be any different from that described above. However, as discussed below, when tag breakage results in tag parts remaining in animals, there may have adverse impacts beyond the initial tagging event. In the permit application, the Oregon State University notes similar behavioral responses to initial tag deployments as those described above.

Based on this and the available information presented above, we expect behavioral responses to initial tag attachments (including unsuccessful attempts) to consist of brief, low-level to moderate behavioral responses. For partially- and fully-implantable tags, a range of physiological responses is possible, but the initial deployment of tags is not expected to result in serious injury. Based on all of these responses, we do not anticipate that the initial tag attachment will affect the fitness of individual cetaceans. The potential consequences of continued tag attachment is discussed further below.

11.2.2.13 Continued Tag Attachment

Once tagged, cetaceans may respond both behavioral and physiologically to the continued attachment of tags as well as hydrodynamic drag. For all types of tags, current studies suggest little to no measurable impact on cetacean behavior. This is not surprising given that the heaviest tags weigh only a fraction of a percent of the weight of a cetacean respectively, and they have hydrodynamic designs to minimize drag (Aguilar 2009, Horwood 2009). In terms of size and weight, the tags proposed for use under Permit No. 21585 are approximately equal to or less than the weight (300 to 620 grams [0.7 to 1.4 pounds]) of the tags previously authorized for use by the

Oregon State University, and will be expected to create the same or less hydrodynamic drag. In addition, the proportion of the tags to the animal's size and weight is such that the energetic demand on the animal will likely be small. For fully-implantable tags, which penetrate deep and stay on longer than the partially-implantable tags being proposed here, researchers also note that cetaceans appear to return to baseline behavior within minutes of the initial tagging event. For example blue and humpback whales tagged with implantable tags appear to resume feeding soon after being tagged (Mate, Mesecar et al. 2007, Robbins, Andrews-Goff et al. 2016). Robbins, Andrews-Goff et al. (2016) reported that the median time it took humpback whales in the Gulf of Maine to recover behaviorally from being tagged with implantable tags was nine minutes. However, recovery times for some individuals were longer, lasting at least 4.5 hours for one individual, which appeared to be related to tag design flaws and the placement of the tag lower on the animal's body than is desired (Robbins, Andrews-Goff et al. 2016).

This suggests that under some circumstances, at least some individuals (and/or species) exhibit more extended behavioral responses to tagging. However, all but one animal in the study observed on subsequent days appeared to resume species' typical behavior recovery times (Robbins, Andrews-Goff et al. 2016). Thus, for most species and circumstances, behavioral response to continued attachment of tags is expected to be mild and short-term. These behavioral responses, for most species and circumstances, are in line with those described by researchers at the Oregon State University (Dr. Bruce Mate) in their application and annual reports from previous research activities.

Partially- and fully-implantable tags maintain long-term (months) penetration within the animal, which may lead to a variety of short-term or chronic responses including pain, tissue damage, inflammation, swelling, and/or depression, change in skin pigmentation and/or skin loss, tissue extrusion, exudate, serious injury, infection, changes in reproduction, or even death. The available data on the physiological responses of cetaceans to the continued attachment of invasive tags are primarily limited to short-term effects, as few studies have attempted to follow up on tagged individuals weeks, months, or years after tagging. In general, wounds from invasive tags heal with only minor scarring and indentation (Hanson, Andrews et al. 2008, Best, Mate et al. 2015, Calambokidis 2015, NMFS 2016, Robbins, Andrews-Goff et al. 2016, Szesciorka, Calambokidis et al. 2016, Norman, Flynn et al. in review).

Long-term impacts remain difficult to gauge (Mate, Mesecar et al. 2007). Several studies have examined long-term impacts of invasive tags and have not found any. In a study on false killer and pilot whales researchers found no significant different in survival (Baird, Zerbini et al. 2013). One recent study investigating long-term impacts from partially-implantable tags on cetaceans in Hawaii found little evidence of any impacts on survival or reproduction (Andrews, Baird et al. 2015), although the power to detect significant differences was very low. In studying the effects of fully-implantable tags, which are more invasive than the partially-implantable tags proposed here, on Southern right whales, Best, Mate et al. (2015) found similar calving rates between tagged and un-tagged females. Thus, in most instances where researchers have attempted to document long-term impacts of invasive tagging on fitness, they have failed to detect any negative effects. However, we are aware of three recent studies that suggest older tag designs may result in negative long-term fitness consequences.

Gendron, Serrano et al. (2014) monitored the wound site of a broken subdermal attachment from an invasive satellite tag somewhat similar to the partially-implantable tags being proposed here, on an adult female blue whale over a period of 16 years (1995 through 2011). In 2005, ten years after tag deployment, the tag attachment remained embedded in the animal, with swelling less than 60 centimeters (23.6 inches) in diameter observed at the site of the attachment. In 2006, 11 years after tag deployment, the sub-dermal attachment had been expelled, leaving an open wound with blubber tissue apparently visible at the center of the swelling, which appeared to have decreased in size compared to two years before. The animal was last seen in 2011 with a scar (closed wound) present at the tag site. The animal's calving history showed three calves, two were observed prior to, and one after, the swelling period (1999 through 2007). Though there was not definitive evidence of the tag attachment's effect on reproduction, the authors suggested that it may have affected the female's reproductive success during this period (Gendron, Serrano et al. 2014).

In a study on the effects of implantable tags on humpback whales in the Gulf of Maine, Robbins, Andrews-Goff et al. (2016) examined the effects of implantable tags on vital rates of both males and females. For both sexes, there did not appear to be any effect on survival and many tagged females continued to successfully reproduce. However, tagging did appear to increase female's inter-birth intervals, with non-tagged females being nearly twice as likely to produce a calf compared to tagged females in the year following the initial tagging (or relevant year for non-tagged females). This suggests that implantable tagging may have an effect on pregnancy. Following this first year after tagging, tagged and non-tagged females appeared to be similarly likely to reproduce. Additional analyses investigating the effects of different tag models indicated that this impact on reproduction may have been due to a tag design flaw that lead to tag breakage and parts of the tag being left inside the animal after the tag detached. This flaw was recently addressed with fully integrated implantable tags, and more recent data using these tags does not currently show the same negative effect on reproduction (Robbins, Andrews-Goff et al. 2016, NMFS 2017).

In examining the health effects and long-term impacts of implantable tags on large whales in the Pacific Ocean, Calambokidis (2015) used photographs and sightings records to evaluate tag-site wound healing and tagging effects on survival. Data came from a variety of long-term studies on blue and gray whales, which were tagged with implantable tags between 1993 and 2008 for blue whales, and in 2011 and 2013 for gray whales. While no effect on re-sighting rate was found for blue whales, tagged gray whales appeared to be less likely to be seen in subsequent years as compared to a control group. When sighting data were used in Cormack-Jolly-Seber capture recapture models to examine the effects of tagging on survival, there was no unequivocal evidence to support a tagging effort on survival, but several of the top models included a negative effect of tagging. Given this and the small sample size, caution should be used when interpreting these results, and effects of tagging on gray whale survival appear to be possible.

Importantly, all of these studies utilized much older tag technologies than will be used by researchers at the Oregon State University under Permit No. 21585. In recent years, many advances in tag technology have been made both to improve data collection and to minimize and avoid adverse impacts to tagged animals. These include smaller tag designs, stronger materials, fully-integrated designs, improved sterilization techniques, and better tag application methods, all of which are incorporated in tags that will be used under Permit No. 21585. With these improvements, the chances of long-term adverse effects are greatly reduced (Mate, Mesecar et al. 2007, NMFS 2016, Robbins, Andrews-Goff et al. 2016, Szesciorka, Calambokidis et al. 2016). However, even with these advances impacts to fitness can still occur, as exemplified by the recent death of a Southern Resident DPS of killer whale.

In 2016, the death of an individual from the Southern Resident DPS of killer whale, L95, was reported following attachment of a partially-implantable tag under Permit No. 16163. An expert veterinary panel concluded that a fungal infection developed at the tag site, as determined by gross dissection, radiographs, magnetic resonance imaging and histopathology, although the killer whale was in moderate to advanced decomposition at the time of necropsy (Haulena 2016, NMFS 2016). This fungal infection contributed to illness in the animal and most likely contributed to its death. There were several factors in this case that may have predisposed this animal to a fungal infection at the tagging site including incomplete disinfection of the tag after seawater contamination, retention of the tag petals which may have allowed for formation of a biofilm or direct pathogen, placement of the tag lower on the body and near large bore vessels which increased the chance of fungal dissemination through the blood system, poor body condition, and possible immunosuppression.

The case of L95 is an important reminder that all invasive tags carry some risk of death, even if minimal. However, the circumstances that led to L95’s death are extremely unlikely to occur under Permit No. 21585 for several reasons. First, the Oregon State University will follow stringent sterilization methods as described in the application and the permit’s terms and conditions. Second, the Oregon State University will not attempt to tag any individual that appears to be obviously emaciated, in poor health, demonstrating behavioral reactions that suggest a compromised status, or showing unusual wounds. Third, the Oregon State University will use the latest tag technologies, such as those associated with the fully-implantable tags, to minimize chances of tag breakage. Given these mitigation measures, we do not expect the use of invasive tags to result in the death of any individual cetacean.

In summary, we expect cetaceans to show minor to no behavioral response to the continued attachment of tags. For partially- and fully-implantable tags, we anticipate most wounds will heal with little to no complication and minimal scarring, with only a few animals exhibiting prolonged healing and scarring. Given recent advances in tagging technologies and the mitigation measures proposed by the Permits and Conservation Division and the Oregon State University, we find it unlikely that mortality or a reduction in fitness will result from invasive tagging. However, as indicated by the above review, mortality and fitness impacts have been documented in the literature for older tag designs and under extenuating circumstances (e.g., L95). Thus, we do not expect reductions in fitness to ESA-listed cetaceans (i.e., blue, fin, Western North Pacific gray, humpback [Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS], North Pacific right, southern right, and sperm whales) from the invasive tags proposed here.

11.3 Risk Analysis

In this section, we assess the consequences of the responses of the individuals that have been exposed to the stressors we have identified as adversely impacting ESA-listed cetaceans, the populations those individuals represent, and the species those populations comprise. Whereas the *Response Analysis* (Section 11.2.2) identified the potential responses of ESA-listed species to the proposed action, this section summarized our analysis of the expected risk to individuals, populations, and species given the expected exposure to the stressors (as described in Section 11.2.1) and the expected responses to those stressors (as described in Section 11.2.2).

We measure risk to individuals of endangered or threatened species based upon effects on the individual's "fitness," which may be indicated by changes to the individual's growth, survival, annual reproductive fitness, and lifetime reproductive success. When we do not expect ESA-listed animals exposed to an action's effects to experience reductions in fitness, we will not expect the action to have adverse consequences on the viability of the populations those individual represent or the species those populations comprise. As a result, if we conclude that ESA-listed animals are not likely to experience reductions in their fitness, we will conclude our assessment. If, however, we conclude that individual animals are likely to experience reductions in fitness, we will assess the consequences of those fitness reductions on the population(s) those individuals belong to.

As noted in the *Response Analysis*, none of the research activities and associated mitigation measures to minimize exposure and associated responses as proposed, are expected to reduce the long-term fitness of any individual ESA-listed cetacean (i.e., blue, fin, Western North Pacific gray, humpback [Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS], North Pacific right, southern right, and sperm whales). As such, the issuance of Permit No. 21585 is not expected to impede the long-term survival of populations, DPSs, or species listed under the ESA.

12 Cumulative Effects

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

This section attempts to identify the likely future environmental changes and their impact on ESA-listed and their critical habitat in the action areas. This section is not meant to be a comprehensive socio-economic evaluation, but a brief outlook on future changes in the environment. Projections are based upon recognized organizations producing best-available information and reasonable rough-trend estimates of change stemming from these data. However, all changes are based upon projections that are subject to error and alteration by complex economic and social interactions.

During this consultation, we searched for information on future state, tribal, local, or private (non-Federal) actions reasonably certain to occur in the action area. We conducted electronic searches of Google and other electronic search engines for other potential future state or private activities that are likely to occur in the action area. We are not aware of any non-Federal actions that are likely to occur in the action areas during the foreseeable future that were not considered in the *Environmental Baseline* (Section 10) of this opinion. Anthropogenic effects include climate change, whaling and subsistence harvesting, vessel strikes, whale watching, sound producing activities (e.g., vessel sound and commercial shipping, aircraft, seismic surveys, and marine construction), military activities, fisheries (fisheries interactions and aquaculture), pollution (e.g., marine debris, pesticides and contaminants, and hydrocarbons), aquatic nuisance species, and scientific research, although some of these activities would involve a federal nexus and thus be subject to future ESA section 7 consultation. An increase in these activities could result in an increased effect on ESA-listed species; however, the magnitude and significance of any anticipated effects remain unknown at this time. The best scientific and commercial data available provide little specific information on any long-term effects of these potential sources of disturbance on ESA-listed cetacean populations. Therefore, NMFS expects that the levels of interactions between human activities and marine mammals described in the *Environmental Baseline* will continue at similar levels into the foreseeable future.

13 Integration and Synthesis

The *Integration and Synthesis* section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the *Effects of the Action* (Section 11) to the *Environmental Baseline* (Section 10) and the *Cumulative Effects* (Section 12) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the *Status of the Species Likely to be Adversely Affected* (Section 9). For this consultation, we determined that the effects were not likely to adversely affect designated critical habitat; therefore only the risk to

ESA-listed cetaceans (i.e., blue, fin, Western North Pacific gray, humpback [Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS], North Pacific right, southern right, and sperm whales) are analyzed in this section.

The following discussions separately summarize the probable risks the proposed action poses to threatened and endangered species that are likely to be exposed to the stressors associated with the research activities under Permit No. 21585. These summaries integrate the exposure profiles presented previously with the results of our response analyses for each of the proposed actions considered in this opinion.

13.1 Blue Whale

No reduction in the distribution of blue whales from the Arctic, Atlantic, Indian, Pacific, and Southern Oceans are expected because of the research activities proposed for authorization under Permit No. 21585.

The blue whale is endangered as a result of past commercial whaling. In the North Atlantic Ocean, at least 11,000 blue whales were taken from the late 19th to mid-20th centuries. In the North Pacific Ocean, at least 9,500 whales were killed between 1910 and 1965. Commercial whaling no longer occurs, but blue whales are affected by anthropogenic noise, threatened by ship strikes, entanglement in fishing gear, pollution, harassment due to whale watching, and reduced prey abundance and habitat degradation due to climate change. There are three stocks of blue whales designated in United States waters: the Eastern North Pacific Ocean (approximately 1,647 individuals [minimum number of individuals N_{min}=1,551]), the Central North Pacific Ocean (approximately 133 individuals [N_{min}=63]), and Western North Atlantic Ocean (N_{min}=440). Current estimates indicate a growth rate of just under three percent per year for the Eastern North Pacific stock. An overall population growth rate for the species or growth rates for the two other individual United States stocks are not available at this time. Because populations appear to be increasing in size, the species appears to be somewhat resilient to current threats; however, the species has not recovered to pre-exploitation levels.

The Final Recovery Plan for the blue whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Determine stock structure of blue whale populations occurring in United States waters and elsewhere.
- Estimate the size and monitor trends in abundance of blue whale populations.
- Identify and protected habitat essential to the survival and recovery of blue whale populations.
- Reduce or eliminate human-caused injury and mortality of blue whales.
- Minimize detrimental effects of directed vessel interactions with blue whales.

- Maximize efforts to acquire scientific information from dead stranded, and entangled blue whales.
- Coordinate state, federal, and international efforts to implement recovery actions for blue whales.

We do not expect any mortalities of blue whales from the proposed action. Although the effects analysis was done by separating the activities into distinct stressors, many of which alone are not likely to adversely affect individual blue whales, the stressors often occur together (e.g., a whale cannot be tagged without being approached by a vessel). Considering the totality of the research activities, individual whales may experience stress, minor injury from tagging or the taking of a biopsy, or alter its behavior in some way. Under Permit No. 21585, 370 blue whales (not necessarily individuals) would be subject to research each year. Effects to individual blue whales are expected to be short term (generally hours or days). Any injury from biopsy is expected to heal within weeks. Partially- and fully-implantable tags are not expected to cause a hindrance to swimming because of the small size and mass of the tag compared to those of a blue whale. Behavioral and physiological responses that may be exhibited by blue whales upon tagging are expected to return to baseline within minutes of tag attachment. None of the research activities are expected to result in any fitness consequence for individual blue whales. As such, we do not anticipate the proposed research activities will impede the recovery objectives for blue whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of blue whales in the wild.

13.2 Fin Whale

No reduction in the distribution of fin whales from the Arctic, Atlantic, Indian, Pacific, and Southern Oceans are expected because of the research activities authorized under Permit No. 21585.

Of the three to seven stocks in the North Atlantic Ocean (approximately 50,000 individuals), one occurs in U.S. waters, where the best estimate of abundance is 1,618 individuals (minimum number of individuals [N_{min}]=1,234); however, this may be an underrepresentation as the entire range of stock was not surveyed (Palka 2012). There are three stocks in U.S. Pacific Ocean waters: Northeast Pacific [minimum 1,368 individuals], Hawaii (approximately 58 individuals [N_{min}=27]) and California/Oregon/Washington (approximately 9,029 [N_{min}=8,127] individuals) (Nadeem, Moore et al. 2016). The International Whaling Commission also recognizes the China Sea stock of fin whales, found in the Northwest Pacific Ocean, which currently lacks an abundance estimate (Reilly, Bannister et al. 2013). Abundance data for the Southern Hemisphere stock are limited; however, there were assumed to be somewhat more than 15,000 in 1983 (Thomas, Reeves et al. 2016).

Current estimates indicate approximately 10,000 fin whales in U.S. Pacific Ocean waters, with an annual growth rate of 4.8 percent in the Northeast Pacific stock and a stable population abundance in the California/Oregon/Washington stock (Nadeem, Moore et al. 2016). Overall population growth rates and total abundance estimates for the Hawaii stock, China Sea stock, western North Atlantic stock, and Southern Hemisphere fin whales are not available at this time.

The 2010 Final Recovery Plan for the fin whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Achieve sufficient and viable population in all ocean basins.
- Ensure significant threats are addressed.

We do not expect any mortalities of fin whales from the proposed action. Although the effects analysis was done by separating the activities into distinct stressors, many of which alone are not likely to adversely affect individual fin whales, the stressors often occur together (e.g., a whale cannot be tagged without being approached by a vessel). Considering the totality of the research activities, individual whales may experience stress, minor injury from tagging or the taking of a biopsy, or alter its behavior in some way. Under Permit No. 21585, 370 fin whales (not necessarily individuals) would be subject to research each year. Effects to individual fin whales are expected to be short term (generally hours or days). Any injury from biopsy is expected to heal within weeks. Partially- and fully-implantable tags are not expected to cause a hindrance to swimming because of the small size and mass of the tag compared to those of a fin whale. Behavioral and physiological responses that may be exhibited by fin whales upon tagging are expected to return to baseline within minutes of tag attachment. None of the research activities are expected to result in any fitness consequence for individual fin whales. As such, we do not anticipate the proposed research activities will impede the recovery objectives for fin whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of fin whales in the wild.

13.3 Gray Whale – Western North Pacific Population

No reduction in the distribution of the Western North Pacific population of gray whales from the Pacific Ocean are expected because of the research activities authorized under Permit No. 21585.

The Western North Pacific population of gray whale is endangered as a result of past commercial whaling and may still be hunted under “aboriginal subsistence whaling” provisions of the International Whaling Commission. Current threats include ship strikes, fisheries interactions (including entanglement), habitat degradation, harassment from whale watching, illegal whaling or resumed legal whaling, and noise.

The Western North Pacific population of gray whales has increased over the last ten years at an estimated rate of 3.3 percent. The Western North Pacific population was thought to be geographically isolated from the Eastern North Pacific population, but recent documentation of some gray whales moving between geographic areas in the Pacific Ocean indicate otherwise. Also, in recent years, gray whales have been sighted in the Eastern Atlantic Ocean and Mediterranean Sea, but it is unknown to which population those animals belong.

Photo-identification data collected between 1994 and 2011 on the Western North Pacific gray whale summer feeding ground off Sakhalin Island were used to calculate an abundance estimate of 140 whales for the non-calf population size in 2012 (Cooke, Weller et al. 2013). The minimum population estimate for the Western North Pacific stock is 135 individual gray whales on the summer feeding ground off Sakhalin Island. The current best growth rate estimate for the Western North Pacific gray whale stock is 3.3 percent annually.

There is currently no recovery plan for the Western North Pacific population of gray whale.

We do not expect any mortalities of the Western North Pacific population of gray whales from the proposed action. Although the effects analysis was done by separating the activities into distinct stressors, many of which alone are not likely to adversely affect individual gray whales, the stressors often occur together (e.g., a whale cannot be tagged without being approached by a vessel). Considering the totality of the research activities, individual whales may experience stress, minor injury from tagging or the taking of a biopsy, or alter its behavior in some way. Under Permit No. 21585, 206 gray whales from the Western North Pacific population (not necessarily individuals) would be subject to research each year. Effects to individual gray whales are expected to be short term (generally hours or days). Any injury from biopsy is expected to heal within weeks. Partially- and fully-implantable tags are not expected to cause a hindrance to swimming because of the small size and mass of the tag compared to those of a gray whale. Behavioral and physiological responses that may be exhibited by gray whales upon tagging are expected to return to baseline within minutes of tag attachment. None of the research activities are expected to result in any fitness consequence for individual gray whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of the Western North Pacific population of gray whales in the wild.

13.4 Humpback Whale – Arabian Sea Distinct Population Segment

No reduction in the distribution of Arabian Sea DPS of humpback whales from the Indian Ocean are expected because of the research activities authorized under Permit No. 21585.

Humpback whales were originally listed as endangered as a result of past commercial whaling, and the five DPSs that remain listed (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, Arabian Sea, and Mexico) have likely not yet recovered from this. Prior to commercial whaling, hundreds of thousands of humpback whales existed. Global abundance declined to the low thousands by 1968, the last year of substantial catches (IUCN 2012). Humpback whales may be killed under “aboriginal subsistence whaling” and “scientific permit whaling” provisions of the International Whaling Commission. Additional threats include ship strikes, fisheries interactions (including entanglement), energy development, harassment from whale-watching noise, harmful algal blooms, disease, parasites, and climate change. The species’ large population size and increasing trends indicate that it is resilient to current threats, but the Arabian Sea DPS still faces a risk of extinction.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Arabian Sea DPS is 82. A population growth rate is currently unavailable for the Arabian Sea DPS humpback whale.

The 1991 Final Recovery Plan for the humpback whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Maintain and enhance habitats used by humpback whales currently or historically.
- Identify and reduce direct human-related injury and morality.
- Measure and monitor key population parameters.
- Improve administration and coordination of recovery program for humpback whales.

We do not expect any mortalities of the Arabian Sea DPS of humpback whales from the proposed action. Although the effects analysis was done by separating the activities into distinct stressors, many of which alone are not likely to adversely affect individual humpback whales, the stressors often occur together (e.g., a whale cannot be tagged without being approached by a vessel). Considering the totality of the research activities, individual whales may experience stress, minor injury from tagging or the taking of a biopsy, or alter its behavior in some way. Under Permit No. 21585, a total of 570 humpback whales from the Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS (not necessarily individuals) would be subject to research each year. Effects to individual humpback whales are expected to be short term (generally hours or days). Any injury from biopsy is expected to heal within weeks. Partially- and fully-implantable tags are not expected to cause a hindrance to swimming because of the small size and mass of the tag compared to those of a humpback whale. Behavioral and physiological responses that may be exhibited by humpback whales upon tagging are expected to return to baseline within minutes of tag attachment. None of the research activities are expected to result in any fitness consequence for individual humpback whales. As such, we do not anticipate the proposed research activities will impede the recovery objectives for the Arabian Sea DPS of humpback whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of the Arabian Sea DPS of humpback whales in the wild.

13.5 Humpback Whale – Cape Verde Islands/Northwest Africa Distinct Population Segment

No reduction in the distribution of Cape Verde Islands/Northwest Africa DPS of humpback whales from the Atlantic Ocean are expected because of the research activities authorized under Permit No. 21585.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Cape Verde Islands/Northwest Africa DPS is unknown (81

FR 62259). A population growth rate is currently unavailable for the Cape Verde Islands/Northwest Africa DPS of humpback whales.

The 1991 Final Recovery Plan for the humpback whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Maintain and enhance habitats used by humpback whales currently or historically.
- Identify and reduce direct human-related injury and morality.
- Measure and monitor key population parameters.
- Improve administration and coordination of recovery program for humpback whales.

We do not expect any mortalities of the Cape Verde Islands/Northwest Africa DPS of humpback whales from the proposed action. Although the effects analysis was done by separating the activities into distinct stressors, many of which alone are not likely to adversely affect individual humpback whales, the stressors often occur together (e.g., a whale cannot be tagged without being approached by a vessel). Considering the totality of the research activities, individual whales may experience stress, minor injury from tagging or the taking of a biopsy, or alter its behavior in some way. Under Permit No. 21585, a total of 570 humpback whales from the Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS (not necessarily individuals) would be subject to research each year. Effects to individual humpback whales are expected to be short term (generally hours or days). Any injury from biopsy is expected to heal within weeks. Partially- and fully-implantable tags are not expected to cause a hindrance to swimming because of the small size and mass of the tag compared to those of a humpback whale. Behavioral and physiological responses that may be exhibited by humpback whales upon tagging are expected to return to baseline within minutes of tag attachment. None of the research activities are expected to result in any fitness consequence for individual humpback whales. As such, we do not anticipate the proposed research activities will impede the recovery objectives for the Cape Verde Islands/Northwest Africa DPS of humpback whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of the Cape Verde Islands/Northwest Africa DPS of humpback whales in the wild.

13.6 Humpback Whale – Central America Distinct Population Segment

No reduction in the distribution of Central America DPS of humpback whales from the Pacific Ocean are expected because of the research activities authorized under Permit No. 21585.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Central America DPS is 411. A population growth rate is currently unavailable for the Central America DPS of humpback whales.

The 1991 Final Recovery Plan for the humpback whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Maintain and enhance habitats used by humpback whales currently or historically.
- Identify and reduce direct human-related injury and morality.
- Measure and monitor key population parameters.
- Improve administration and coordination of recovery program for humpback whales.

We do not expect any mortalities of the Central America DPS of humpback whales from the proposed action. Although the effects analysis was done by separating the activities into distinct stressors, many of which alone are not likely to adversely affect individual humpback whales, the stressors often occur together (e.g., a whale cannot be tagged without being approached by a vessel). Considering the totality of the research activities, individual whales may experience stress, minor injury from tagging or the taking of a biopsy, or alter its behavior in some way. Under Permit No. 21585, a total of 570 humpback whales from the Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS (not necessarily individuals) would be subject to research each year. Effects to individual humpback whales are expected to be short term (generally hours or days). Any injury from biopsy is expected to heal within weeks. Partially- and fully-implantable tags are not expected to cause a hindrance to swimming because of the small size and mass of the tag compared to those of a humpback whale. Behavioral and physiological responses that may be exhibited by humpback whales upon tagging are expected to return to baseline within minutes of tag attachment. None of the research activities are expected to result in any fitness consequence for individual humpback whales. As such, we do not anticipate the proposed research activities will impede the recovery objectives for the Central America DPS of humpback whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of the Central America DPS of humpback whales in the wild.

13.7 Humpback Whale – Mexico Distinct Population Segment

No reduction in the distribution of Mexico DPS of humpback whales from the Pacific Ocean are expected because of the research activities authorized under Permit No. 21585.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Mexico DPS is unavailable. A population growth rate is currently unavailable for the Mexico DPS of humpback whales.

The 1991 Final Recovery Plan for the humpback whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Maintain and enhance habitats used by humpback whales currently or historically.
- Identify and reduce direct human-related injury and morality.
- Measure and monitor key population parameters.
- Improve administration and coordination of recovery program for humpback whales.

We do not expect any mortalities of the Mexico DPS of humpback whales from the proposed action. Although the effects analysis was done by separating the activities into distinct stressors, many of which alone are not likely to adversely affect individual humpback whales, the stressors often occur together (e.g., a whale cannot be tagged without being approached by a vessel). Considering the totality of the research activities, individual whales may experience stress, minor injury from tagging or the taking of a biopsy, or alter its behavior in some way. Under Permit No. 21585, 570 humpback whales from the Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS (not necessarily individuals) would be subject to research each year. Effects to individual humpback whales are expected to be short term (generally hours or days). Any injury from biopsy is expected to heal within weeks. Partially- and fully-implantable tags are not expected to cause a hindrance to swimming because of the small size and mass of the tag compared to those of a humpback whale. Behavioral and physiological responses that may be exhibited by humpback whales upon tagging are expected to return to baseline within minutes of tag attachment. None of the research activities are expected to result in any fitness consequence for individual humpback whales. As such, we do not anticipate the proposed research activities will impede the recovery objectives for the Mexico DPS of humpback whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of the Mexico DPS of humpback whales in the wild.

13.8 Humpback Whale – Western North Pacific Distinct Population Segment

No reduction in the distribution of Western North Pacific DPS of humpback whales from the Pacific Ocean are expected because of the research activities authorized under Permit No. 21585.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Western North Pacific DPS is 1,059. A population growth rate is currently unavailable for the Western North Pacific DPS of humpback whales.

The 1991 Final Recovery Plan for the humpback whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Maintain and enhance habitats used by humpback whales currently or historically.
- Identify and reduce direct human-related injury and morality.
- Measure and monitor key population parameters.
- Improve administration and coordination of recovery program for humpback whales.

We do not expect any mortalities of the Western North Pacific DPS of humpback whales from the proposed action. Although the effects analysis was done by separating the activities into distinct stressors, many of which alone are not likely to adversely affect individual humpback whales, the stressors often occur together (e.g., a whale cannot be tagged without being approached by a vessel). Considering the totality of the research activities, individual whales may experience stress, minor injury from tagging or the taking of a biopsy, or alter its behavior in some way. Under Permit No. 21585, 570 humpback whales from the Arabian Sea DPS, Cape Verde Islands/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS (not necessarily individuals) would be subject to research each year. Effects to individual humpback whales are expected to be short term (generally hours or days). Any injury from biopsy is expected to heal within weeks. Partially- and fully-implantable tags are not expected to cause a hindrance to swimming because of the small size and mass of the tag compared to those of a humpback whale. Behavioral and physiological responses that may be exhibited by humpback whales upon tagging are expected to return to baseline within minutes of tag attachment. None of the research activities are expected to result in any fitness consequence for individual humpback whales. As such, we do not anticipate the proposed research activities will impede the recovery objectives for the Western North Pacific DPS of humpback whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of the Western North Pacific DPS of humpback whales in the wild.

13.9 North Pacific Right Whale

No reduction in the distribution of North Pacific right whales from the Pacific Ocean are expected because of the research activities authorized under Permit No. 21585.

The North Pacific right whale remains one of the most endangered whale species in the world. Their abundance likely numbers fewer than 1,000 individuals. There are two currently recognized stocks of North Pacific right whales, a Western North Pacific stock that feeds primarily in the Sea of Okhotsk, and an Eastern North Pacific stock that feeds in eastern North Pacific Ocean waters off Alaska, Canada, and Russia. Several lines of evidence indicate a total population size of less than 100 for the Eastern North Pacific stock. Based on photo-identification from 1998 to 2013 (Wade, Kennedy et al. 2011) estimated 31 individuals, with a minimum population estimate of 26 individuals (Muto, Helker et al. 2017). Genetic data have identified 23 individuals based on samples collected between 1997 and 2011 (Leduc, Taylor et al. 2012). The Western North Pacific stock is likely more abundant and was estimated to consist of 922 whales (95 percent confidence intervals 404 to 2,108) based on data collected in 1989, 1990, and 1992 (IWC 2001, Thomas, Reeves et al. 2016). The population estimate for the Western North Pacific stock is likely in the low hundreds (Brownell Jr., Clapham et al. 2001). While there have been several sightings of Western North Pacific right whales in recent years, with one sighting identifying at least 77 individuals, these data have yet to be compiled to provide a more recent abundance estimate (Thomas, Reeves et al. 2016). There is currently no information on the population trend of North Pacific right whales.

The 2013 Final Recovery Plan for the North Pacific right whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Achieve sufficient and viable populations in all ocean basins.
- Ensure significant threats are addressed.

We do not expect any mortalities of the Western North Pacific stock of right whales from the proposed action. Although the effects analysis was done by separating the activities into distinct stressors, many of which alone are not likely to adversely affect individual right whales, the stressors often occur together (e.g., a whale cannot be tagged without being approached by a vessel). Considering the totality of the research activities, individual whales may experience stress, minor injury from tagging or the taking of a biopsy, or alter its behavior in some way. Under Permit No. 21585, 105 right whales from the Western North Pacific stock (not necessarily individuals) would be subject to research each year. Effects to individual right whales are expected to be short term (generally hours or days). Any injury from biopsy is expected to heal within weeks. Partially- and fully-implantable tags are not expected to cause a hindrance to swimming because of the small size and mass of the tag compared to those of a right whale. Behavioral and physiological responses that may be exhibited by right whales upon tagging are expected to return to baseline within minutes of tag attachment. None of the research activities are expected to result in any fitness consequence for individual right whales. As such, we do not anticipate the proposed research activities will impede the recovery objectives for the Western North Pacific stock of right whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of the Western North Pacific stock of right whales in the wild.

13.10 Southern Right Whale

No reduction in the distribution of Southern right whales from the Atlantic, Pacific, and Southern Ocean are expected because of the research activities authorized under Permit No. 21585.

In 2010, there were an estimated 15,000 Southern right whales worldwide; this is over twice the species estimate of 7,000 in 1997. The population structure for Southern right whales is uncertain, but some separation to the population level exists. Breeding populations can be delineated based on geographic region: South Africa, Argentina, Brazil, Peru and Chile, Australia, and New Zealand. Population estimates for all of the breeding populations are not available. There are about 3,500 Southern right whales in the Australia breeding population, about 4,000 in Argentina, 4,100 in South Africa, and 2,169 in New Zealand. Other smaller Southern right whale populations occur off Tristan da Cunha, South Georgia, Namibia, Mozambique and Uruguay, but not much is known about the population abundance of these groups.

The Australia, South Africa and Argentina breeding stocks of Southern right whales are increasing at an estimated seven percent annually. The Brazil breeding population is increasing, while the status of the Peru and Chile breeding population is unknown (NMFS 2015). The New Zealand breeding population is showing signs of recovery; recent population modeling estimates the population growth rate at 5.6 percent (Davidson 2016). Juveniles in New Zealand show high apparent annual survival rates, between 0.87 and 0.95 percent (Carroll, Fewster et al. 2016).

There is currently no recovery plan for the Southern right whale.

We do not expect any mortalities of Southern right whales from the proposed action. Although the effects analysis was done by separating the activities into distinct stressors, many of which alone are not likely to adversely affect individual right whales, the stressors often occur together (e.g., a whale cannot be tagged without being approached by a vessel). Considering the totality of the research activities, individual whales may experience stress, minor injury from tagging or the taking of a biopsy, or alter its behavior in some way. Under Permit No. 21585, 370 Southern right whales (not necessarily individuals) would be subject to research each year. Effects to individual right whales are expected to be short term (generally hours or days). Any injury from biopsy is expected to heal within weeks. Partially- and fully-implantable tags are not expected to cause a hindrance to swimming because of the small size and mass of the tag compared to those of a right whale. Behavioral and physiological responses that may be exhibited by right whales upon tagging are expected to return to baseline within minutes of tag attachment. None of the research activities are expected to result in any fitness consequence for individual right whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of Southern right whales in the wild.

13.11 Sperm Whale

No reduction in the distribution of sperm whales from the Arctic, Atlantic, Indian, Ocean and Pacific, and Southern Oceans Ocean are expected because of the research activities authorized under Permit No. 21585.

The sperm whale is the most abundant of the large whale species, with total abundance estimates between 200,000 and 1,500,000. The most recent estimate indicated a global population of between 300,000 and 450,000 individuals (Whitehead 2009). The higher estimates may be approaching population sizes prior to commercial whaling. There are no reliable estimates for sperm whale abundance across the entire Atlantic Ocean. However, estimates are available for two to three United States stocks in the Atlantic Ocean, the Northern Gulf of Mexico stock, estimated to consists of 763 individuals (N_{min}=560) and the North Atlantic stock, underestimated to consist of 2,288 individuals (N_{min}=1,815). There are insufficient data to estimate abundance for the Puerto Rico and U.S. Virgin Islands stock. In the northeast Pacific Ocean, the abundance of sperm whales was estimated to be between 26,300 and 32,100 in 1997. In the northeast Pacific Ocean, the abundance of sperm whales was estimated to be between 26,300 and 32,100 in 1997. In the eastern tropical Pacific Ocean, the abundance of sperm whales was estimated to be 22,700 (95 percent confidence intervals 14,800 to 34,600) in 1993. Population estimates are also available for two to three United States stocks that occur in the Pacific, the California/Oregon/Washington stock, estimated to consist of 2,106 individuals (N_{min}=1,332), and the Hawaii stock, estimated to consist of 3,354 individuals (N_{min}=2,539). There are insufficient data to estimate the population abundance of the North Pacific stock. We are aware of no reliable abundance estimates specifically for sperm whales in the South Pacific Ocean, and there is insufficient data to evaluate trends in abundance and growth rates of sperm whale populations at this time. There is insufficient data to evaluate trends in abundance and growth rates of sperm whales at this time.

The 2010 Final Recovery Plan for the sperm whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Achieve sufficient and viable populations in all ocean basins.
- Ensure significant threats are addressed.

We do not expect any mortalities of sperm whales from the proposed action. Although the effects analysis was done by separating the activities into distinct stressors, many of which alone are not likely to adversely affect individual sperm whales, the stressors often occur together (e.g., a whale cannot be tagged without being approached by a vessel). Considering the totality of the research activities, individual whales may experience stress, minor injury from tagging or the taking of a biopsy, or alter its behavior in some way. Under Permit No. 21585, 370 sperm whales would be subject to research each year. Effects to individual sperm whales are expected to be short term (generally hours or days). Any injury from biopsy is expected to heal within weeks. Partially- and fully-implantable tags are not expected to cause a hindrance to swimming because of the small size and mass of the tag compared to those of a sperm whale. Behavioral and physiological responses that may be exhibited by sperm whales upon tagging are expected to return to baseline within minutes of tag attachment. None of the research activities are expected to result in any fitness consequence for individual sperm whales. As such, we do not anticipate the proposed research activities will impede the recovery objectives for sperm whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of sperm whales in the wild.

14 Conclusion

After reviewing the current status of the ESA-listed species, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS' biological and conference opinion that the proposed action is not likely to jeopardize the continued existence of blue whales, fin whales, Western North Pacific population of gray whales, Arabian Sea DPS of humpback whales, Cape Verde Islands/Northwest Africa DPS of humpback whales, Central America DPS of humpback whales, Mexico DPS of humpback whales, Western North Pacific DPS of humpback whales, North Pacific right whales, Southern right whales, and sperm whales.

15 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (16 U.S.C. §1532(19)). "Harm" is further defined by regulation to include significant habitat modification or degradation that results in death or injury to ESA-listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 C.F.R. §222.102). "Harass" is further defined as an act that "creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering" (NMFSPD 02-110-19). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

All research activities associated with the issuance of Permit No. 21585 involve directed take for the purposes of scientific research. Therefore, the NMFS does not expect the proposed action will incidentally take threatened or endangered species. However, we request that the Permits and Conservation Division report to us whether the MMPA-authorized take specified in Table 2 actually occurs and the actual numbers of take in comparison to the permitted MMPA take numbers at the expiration of the permit, as well as any available information on the response animals exhibited to those takes. Such information will be used to inform the *Environmental Baseline* and *Effects of the Action* for future consultations for Dr. Bruce Mate, Oregon State University, and other similar research activities permitted by the Permits and Conservation Division.

16 CONSERVATION RECOMMENDATIONS

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

We make the following conservation recommendations, which will provide information for future consultations involving the issuance of permits that may affect ESA-listed marine mammals.

1. **Effects of Invasive Tagging**

We recommend the Permits and Conservation Division require that all researchers conducting invasive tagging of cetaceans provide detailed information on the responses they have observed from their past research. The level of detail provided in the application and supporting materials from the Oregon State University should be considered a good example of the level and type of information that other applicants should provide when possible to help inform recommendations related to minimizing impacts of invasive tagging on ESA-listed cetaceans.

2. Aggregate Take Tracking

We recommend that the Permits and Conservation Division develop a system for tracking and evaluating the extent of take issued and that which is realized for any given population of ESA-listed species. The Permits and Conservation Division's current permit tracking allows tracking of individual permit takes but for the purpose of understanding the extent of research at broad scales (e.g., number of research permits in a particular region), it remains difficult to quantify the extent of take each individual population of ESA-listed species may be subject to across permits for any given period of time. Such aggregate take tracking would be better enable us to evaluate the impacts of multiple, simultaneous research efforts on ESA-listed species.

3. Reporting

We recommend the Permits and Conservation Division tailor the required reporting for research permits to include information that would aid managers in protecting and conserving ESA-listed species. In requiring researchers to provide annual reports, the Permits and Conservation Division is positioned to collect unprecedented, nationwide data on ESA-listed species. We recommend that the Permits and Conservation Division continue to request information on the effects of research activities on ESA-listed cetaceans, and where possible, require applicants to provide quantitative data regarding the impacts of their research on species. We also recommend that the Permits and Conservation Division require at least basic behavioral response reports from all relatively new procedures that would be permitted. For the purposes of this consultation, this would include exhaled breath sampling because little information is available about how cetaceans respond to this procedure and the use of unmanned aircraft systems.

4. Data Sharing

We recommend the Permits and Conservation Division work to establish protocols for data sharing among all permit holders. While many researchers in the community collaborate, having a national standard for data sharing among all researchers permitted by the NMFS will reduce impacts to trusted resources by minimizing duplicative research efforts. We recommend basic reporting information be required from each researcher including the species, location, number of individuals, and age, sex, and identity (if known) at the expiration of each permit. This information would further inform the tracking of impacts of multiple research activities on ESA-listed cetaceans.

5. Designated Critical Habitat

The Permits and Conservation Division should include conditions in the scientific research permits to avoid, to the maximum extent practicable, proposed or designated critical habitat for the Cook Inlet DPS of beluga whale, Southern Resident DPS of killer whale, Main Hawaiian Islands insular DPS of false killer whale, North Atlantic right whale, North Pacific right whale, Hawaiian monk seal, Arctic subspecies of ringed seal (proposed), Western DPS of Steller sea lion, North Atlantic DPS of green turtle, hawksbill turtle, leatherback turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle.

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

17 Reinitiation Notice

This concludes formal consultation for Permits and Conservation Division proposed action to issue Permit No. 21585. As 50 C.F.R. §402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if:

(1) The amount or extent of taking specified in the incidental take statement is exceeded.
(2) New information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner or to an extent not previously considered.
(3) The identified action is subsequently modified in a manner that causes an effect to ESA-listed species or designated critical habitat that was not considered in this opinion.
(4) A new species is listed or critical habitat designated under the ESA that may be affected by the action.

18 References

Aburto, A., et al. (1997). Behavioral responses of blue whales to active signals. San Diego, CA, Naval Command, Control and Ocean Surveillance Center, RDT&E Division**:** 95.

Addison, R. F. and P. F. Brodie (1987). "Transfer of organochlorine residues from blubber through the circulatory system to milk in the lactating grey seal Halichoerus grypus." Canadian Journal of Fisheries and Aquatic Sciences **44**: 782-786.

Aguilar, A. (2009). Fin Whale: *Balaenoptera physalus*. Encyclopedia of Marine Mammals. W. F. Perrin, B. Wursig and J. G. M. Thewissen. San Diego, Academic Press**:** 1091-1097.

Albert, D. J. (2011). "What's on the mind of a jellyfish? A review of behavioural observations on Aurelia sp. jellyfish." Neurosci Biobehav Rev **35(**3): 474-482.

Andersen, S. M., et al. (2012). "Behavioural responses of harbour seals to human-induced disturbances." Aquatic Conservation: Marine and Freshwater Ecosystems **22**(1): 113-121.

André, M., et al. (1997). "Sperm whale (*Physeter macrocephalus*) behavioural responses after the playback of artificial sounds." Report of the International Whaling Commission **47**: 499-504.

Andrews, R. C., et al. (2015). Improving attachments of remotely-deployed dorsal fin-mounted tags: tissue structure, hydrodynamics, in situ performance, and tagged-animal follow-up, Final Technical Report for the Office of Naval Research.

Archer, F. I., et al. (2013). "Mitogenomic phylogenetics of fin whales (Balaenoptera physalus spp.): genetic evidence for revision of subspecies." PLoS One **8**(5): e63396.

Attard, C. R. M., et al. (2010). "Genetic diversity and structure of blue whales (*Balaenoptera musculus*) in Australian feeding aggregations." Conservation Genetics **11**(6): 2437-2441.

Au, W., et al. (2001). "High-frequency harmonics and source level of humpback whale songs." Journal of the Acoustical Society of America **110**(5 Part 2): 2770.

Au, W. W. L. and M. Green (2000). "Acoustic interaction of humpback whales and whale-watching boats." Marine Environmental Research **49**(5): 469-481.

Au, W. W. L. and M. Green. (2000). "Acoustic interaction of humpback whales and whale-watching boats." Marine Environmental Research **49**(5): 469-481.

Au, W. W. L., et al. (2000). "Seasonal and diurnal trends of chorusing humpback whales wintering in waters off western Maui." Marine Mammal Science **16**(3): 15.

Au, W. W. L., et al. (2006). "Acoustic properties of humpback whale songs." Journal of the Acoustical Society of America **120**(2): 1103.

Au, W. W. L., et al. (2006). "Acoustic properties of humpback whale songs." Journal of Acoustical Society of America **120**(August 2006): 1103-1110.

Au, W. W. L., et al. (2000). Hearing by whales and dolphins. New York, Springer-Verlag.

Avila, I.C., K. Kaschner, C.F. Dormann (2018). "Current global risks to marine mammals: Taking stock of the threats." Biological Conservation 221:44-58.

Baird, R. W., et al. (2015). "False killer whales and fisheries interactions in Hawaiian waters: Evidence for sex bias and variation among populations and social groups." Marine Mammal Science **31**(2): 579-590.

Baird, R. W., et al. (2013). LIMPET tagging of Hawaiian odontocetes: assessing reproduction and estimating survival of tagged and non-tagged individuals. Presentation at Workshop on Impacts of Cetacean Tagging: a review of follow up studies and approaches, Dunedin, NZ, 8 Dec 2013.

Baker, C. S., et al. (1983). The impact of vessel traffic on the behavior of humpback whales in southeast Alaska: 1982 season, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, National Marine Mammal Laboratory**:** 86.

Baker, C. S., et al. (1988). "Humpback whales of Glacier Bay, Alaska." Whalewatcher **22**(3): 13-17.

Barber, J. R., et al. (2010). "The costs of chronic noise exposure for terrestrial organisms." Trends in Ecology and Evolution **25**(3): 180-189.

Barnosky, A. D., et al. (2012). "Approaching a state shift in Earth/'s biosphere." Nature **486**(7401): 52-58.

Barrett-Lennard, L. G., et al. (1996). "A cetacean biopsy system using lightweight pneumatic darts, and its effect on the behavior of killer whales." Marine Mammal Science **12**(1): 14-27.

Bauer, G. B. (1986). The behavior of humpback whales in Hawaii and modifications of behavior induced by human interventions, University of Hawaii. **Ph.D.:** 314.

Bauer, G. B. and L. M. Herman (1986). Effects of vessel traffic on the behavior of humpback whales in Hawaii. Honolulu, Hawaii, National Oceanic and Atmospheric Administration, National Marine Fisheries Service**:** 151.

Baulch, S. and C. Perry (2014). "Evaluating the impacts of marine debris on cetaceans." Marine Pollution Bulletin **80**(1-2): 210-221.

Baulch, S. and C. Perry (2014). "Evaluating the impacts of marine debris on cetaceans." Mar Pollut Bull **80**(1-2): 210-221.

Baumgartner, M. F. and B. R. Mate (2003). "Summertime foraging ecology of North Atlantic right whales." Marine Ecology Progress Series **264**: 123-135.

Beale, C. M. and P. Monaghan (2004). "Human disturbance: people as predation-free predators?" Journal of Applied Ecology **41**: 335-343.

Beamish, R. J. (1993). "Climate and exceptional fish production off the west coast of North American." Canadian Journal of Fisheries and Aquatic Sciences **50**(10): 2270-2291.

Bearzi, G. (2000). "First report of a common dolphin (*Delphinus delphis*) death following penetration of a biopsy dart." Journal of Cetacean Research and Management **2**(3): 217-222.

Bennet, D. H., et al. (1994). Effects of Underwater Sound Simulating the Intermediate Scale Measurement System on Fish and Zooplankton of Lake Pend Orielle, Idaho. Moscow, Idaho, Department of Fish and Wildlife Resources, College of Forestry, Wildlife and Range Sciences, University of Idaho.

Benoit-Bird, K. J. and W. W. L. Au (2009). "Cooperative prey herding by the pelagic dolphin, Stenella longirostris." Journal of the Acoustical Society of America **125**(1): 125-137.

Benson, A. and A. W. Trites (2002). "Ecological effects of regime shifts in the Bering Sea and eastern North Pacific Ocean." Fish and Fisheries **3**(2): 95-113.

Benson, S. R., et al. (2002). "Changes in the cetacean assemblage of a coastal upwelling ecosystem during El Niño 1997-98 and La Niña 1999." Progress in Oceanography **54**: 279-291.

Berchok, C. L., et al. (2006). "St. Lawrence blue whale vocalizations revisited: Characterization of calls detected from 1998 to 2001." Journal of the Acoustical Society of America **120**(4): 2340-2354.

Berrow, S. D., et al. (2002). "Organochlorine concentrations in resident bottlenose dolphins (Tursiops truncatus) in the Shannon estuary, Ireland." Marine Pollution Bulletin **44**(11): 1296-1303.

Best, P. B., et al. (2015). "Tag retention, wound healing, and subsequent reproductive history of southern right whales following satellite-tagging." Marine Mammal Science **31**(2): 520-539.

Best, P. B., et al. (2005). "Biopsying southern right whales: Their reactions and effects on reproduction." Journal of Wildlife Management **69**(3): 1171-1180.

Bettridge, S., et al. (2015). Status review of the humpback whale (Megaptera novaeangliae) under the Endangered Species Act, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center**:** 263.

Biedron, I. S., et al. (2005). Counter-calling in North Atlantic right whales (*Eubalaena glacialis*). Sixteenth Biennial Conference on the Biology of Marine Mammals. San Diego, California**:** 35.

Blair, H. B., et al. (2016). "Evidence for ship noise impacts on humpback whale foraging behaviour." Biol Lett **12**(8).

Boren, L. J., et al. (2001). Controlled approaches as an indicator of tourist disturbance on New Zealand fur seals (Arctocephalus forsteri). Fourteen Biennial Conference on the Biology of Marine Mammals. 28 November-3 December Vancouver Canada. p.30.

Borrell, A., et al. (1995). "Age trends and reproductive transfer of organochlorine compounds in long-finned pilot whales from the Faroe Islands." Environmental Pollution **88**(3): 283-292.

Bort, J. E., et al. (2011). North Atlantic right whale (*Eubalaena glacialis*) acoustic activity on a potential wintering ground in the Central Gulf of Maine. 19th Biennial Conference on the Biology of Marine Mammals. Tampa, Florida**:** 38.

Branch, T. A. (2007). "Abundance of Antarctic blue whales south of 60 S from three complete circumpolar sets of surveys."

Brownell Jr., R. L., et al. (2001). "Conservation status of North Pacific right whales." Journal of Cetacean Research and Management(Special Issue 2): 269-286.

Buck, J. R. and P. L. Tyack (2000). "Response of gray whales to low-frequency sounds." Journal of the Acoustical Society of America **107**(5): 2774.

Burdin, A. M., et al. (2013). Status of western gray whales off northeastern Sakhalin Island, Russia in 2012. Jeju, Korea, IWC Scientific Committee**:** 9.

Burtenshaw, J. C., et al. (2004). "Acoustic and satellite remote sensing of blue whale seasonality and habitat in the Northeast Pacific." Deep-Sea Research II **51**: 967-986.

Busch, D. S. and L. S. Hayward (2009). "Stress in a conservation context: A discussion of glucocorticoid actions and how levels change with conservation-relevant variables." Biological Conservation **142**(12): 2844-2853.

Calambokidis, J. (2015). Examination of health effects and long-term impacts of deployments of multiple tag types on blue, humpback, and gray whales in the eastern North Pacific. Annual Report, Office of Naval Research, Marine Mammal Program, Annual Report.

Calambokidis, J. F., E.; Douglas, A.; Schlender, L.; Jessie Huggins, J. (2009). Photographic identification of humpback and blue whales off the US West Coast: Results and updated abundance estimates from 2008 field season. Olympia, Washington, Cascadia Research**:** 18.

Carder, D. A. and S. Ridgway (1990). "Auditory brainstem response in a neonatal sperm whale." Journal of the Acoustic Society of America **88**(Supplement 1): S4.

Carretta, J. V., et al. (2017). U.S. Pacific marine mammal stock assessments: 2016.

Carretta, J. V., et al. (2016). "U.S. Pacific marine mammal stock assessments: 2015."

Carroll, E. L., et al. (2016). "First direct evidence for natal wintering ground fidelity and estimate of juvenile survival in the New Zealand southern right whale Eubalaena australis." PLoS One **11**(1): e0146590.

Carroll, G. M., et al. (1989). Ice entrapped gray whales near Point Barrow, Alaska: Behavior, respiration patterns, and sounds. Eighth Biennial Conference on the Biology of Marine Mammals. Asilomar Conference Center, Pacific Grove, California**:** 10.

Cassoff, R. M. K. M. M. W. A. M. S. G. B. D. S. R. M. J. M. (2011). "Lethal entanglement in baleen whales." Diseases of Aquatic Organisms **96**(3): 175-185.

Cattet, M. R. L., et al. (2003). "Physiologic responses of grizzly bears to different methods of capture." Journal of Wildlife Diseases **39**(3-Jan): 649-654.

Cerchio, S., et al. (2005). Reproduction of female humpback whales off the Revillagigedo Archipelago during a severe El Niño event. Sixteenth Biennial Conference on the Biology of Marine Mammals. San Diego, California**:** 55.

Chapman, N. R. and A. Price (2011). "Low frequency deep ocean ambient noise trend in the Northeast Pacific Ocean." Journal of the Acoustical Society of America **129**(5): EL161-EL165.

Charif, R. A., et al. (2002). "Estimated source levels of fin whale (Balaenoptera physalus) vocalizations: Adjustments for surface interference." Marine Mammal Science **18**(1): 81-98.

Childers, A. R., et al. (2005). "Seasonal and interannual variability in the distribution of nutrients and chlorophyll a across the Gulf of Alaska shelf: 1998-2000." Deep-Sea Research II **52**: 193-216.

Christiansen, F., et al. (2014). "Inferring energy expenditure from respiration rates in minke whales to measure the effects of whale watching boat interactions." Journal of Experimental Marine Biology and Ecology **459**: 96-104.

Clapham, P. J. and D. K. Mattila (1993). "Reactions of humpback whales to skin biopsy sampling on a West Indies breeding ground." Marine Mammal Science **9**(4): 382-391.

Clapham, P. J., et al. (1999). "Baleen whales: conservation issues and the status of the most endangered populations." Mammal Review **29**(1): 35-60.

Clark, C. W. (1982). "The acoustic repertoire of the southern right whale, a quantitative analysis." Animal Behaviour **30**(4): 1060-1071.

Clark, C. W., et al. (2002). "Vocal activity of fin whales, Balaenoptera physalus, in the Ligurian Sea." Marine Mammal Science **18**(1): 286-295.

Clark, C. W. and R. A. Charif (1998). "Acoustic monitoring of large whales to the west of Britain and Ireland using bottom mounted hydrophone arrays, October 1996-September 1997." JNCC Report No. 281.

Clark, C. W. and P. J. Clapham (2004). "Acoustic monitoring on a humpback whale (Megaptera novaeangliae) feeding ground shows continual singing into late spring." Proceedings of the Royal Society of London Series B Biological Sciences **271**(1543): 1051-1057.

Clark, C. W. and G. J. Gagnon (2004). "Low-frequency vocal behaviors of baleen whales in the North Atlantic: Insights from Integrated Undersea Surveillance System detections, locations, and tracking from 1992 to 1996." Journal of Underwater Acoustics (USN) **52**(3): 48.

Clement, D. (2013). Effects on Marine Mammals. Ministry for Primary Industries. Literature review of ecological effects of aquaculture. Report prepared by Cawthron Institute. Nelson, New Zealand.

Conn, P. B. and G. K. Silber (2013). "Vessel speed restrictions reduce risk of collision-related mortality for North Atlantic right whales." Ecosphere **4**(4): art43.

Constantine, R. (2001). "Increased avoidance of swimmers by wild bottlenose dolphins (Tursiops truncatus) due to long-term exposure to swim-with-dolphin tourism." Marine Mammal Science **17**(4): 689-702.

Conversi, A., et al. (2001). "Seasonal and interannual dynamics of Calanus finmarchicus in the Gulf of Maine (Northeastern US shelf) with reference to the North Atlantic Oscillation." Deep Sea Research Part Ii: Topical studies in Oceanography 48(41-43)519-530.

Cooke, J. G., et al. (2013). Population assessment of the Sakhalin gray whale aggregation. Jeju, Korea, IWC Scientific Committee**:** 12.

Corkeron, P. J. (1995). "Humpback whales (Megaptera novaeangliae) in Hervey Bay, Queensland: Behaviour and responses to whale-watching vessels." Canadian Journal of Zoology **73**(7): 1290-1299.

Corkeron, P. J., et al. (1987). "Interactions between bottlenose dolphins and sharks in Moreton Bay, Queensland [Australia]." Aquatic Mammals **13**(3): 109-113.

COSEWIC (2002). "COSEWIC assessment and update status report on the blue whale Balaenoptera musculus (Atlantic population, Pacific population) in Canada." vi + 32.

Cowan, D. E. and B. E. Curry (1998). Investigation of the potential influence of fishery-induced stress on dolphins in the eastern tropical pacific ocean: Research planning, National Marine Fisheries Service, Southwest Fisheries Science Center.

Cowan, D. E. and B. E. Curry (2002). Histopathological assessment of dolphins necropsied onboard vessels in the eastern tropical pacific tuna fishery, National Marine Fisheries Service, Southwest Fisheries Science Center.

Cowan, D. E. and B. E. Curry (2008). "Histopathology of the alarm reaction in small odontocetes." Journal of Comparative Pathology **139**(1): 24-33.

Crane, N. L. and K. Lashkari. (1996). "Sound production of gray whales, Eschrichtius robustus, along their migration route: A new approach to signal analysis." Journal of the Acoustical Society of America **100**(3): 1878-1886.

Cranford, T. W. and P. Krysl (2015). "Fin whale sound reception mechanisms: Skull vibration enables low-frequency hearing." PLoS One **10**(1): e116222.

Croll, D. A., et al. (2002). "Only male fin whales sing loud songs." Nature **417**: 809.

Croll, D. A., et al. (2001). "Effect of anthropogenic low-frequency noise on the foraging ecology of Balaenoptera whales." Animal Conservation **4**(1): 13-27.

Croll, D. A., et al. (1999). "Marine vertebrates and low frequency sound." Technical report for LFA EIS, 28 February 1999. Marine Mammal and Seabird Ecology Group, Institute of Marine Sciences, University of California Santa Cruz. 437p.

Cummings, W. C. and P. O. Thompson (1971). "Gray whales, Eschrichtius robustus, avoid the underwater sounds of killer whales, Orcinus orca." Fishery Bulletin **69**(3): 525-530.

Cummings, W. C. and P. O. Thompson (1971). "Underwater sounds from the blue whale, Balaenoptera musculus." Journal of the Acoustical Society of America **50**(4B): 1193-1198.

Cummings, W. C. and P. O. Thompson (1994). "Characteristics and seasons of blue and finback whale sounds along the U.S. west coast as recorded at SOSUS stations." Journal of the Acoustical Society of America **95**: 2853.

Cummings, W. C., et al. (1968). "Underwater sounds of migrating gray whales, Eschrichtius glaucus (Cope)." Journal of the Acoustical Society of America **44**(5): 1278-1281.

Curry, R. G. and M. S. McCartney (2001). "Ocean gyre circulation changes associated with the North Atlantic Oscillation." Journal of Physical Oceanography **31**(12): 3374-3400.

Czech, B. and P. R. Krausman (1997). "Distribution and causation of species endangerment in the United States." Science **277**(5329): 1116-1117.

D'Vincent, C. G., et al. (1985). "Vocalization and coordinated feeding behavior of the humpback whale in southeastern Alaska." Scientific Reports of the Whales Research Institute **36**: 41-47.

Daan, N. (1996). Multispecies assessment issues for the North Sea. American Fisheries Society Symposium 20. E.K.Pikitch, D.D.Huppert and M.P.Sissenwine. Seattle, Washignton**:** 126-133.

Dahlheim, M. E., et al. (1984). Sound production by the gray whale and ambient noise levels in Laguna San Ignacio, Baja California Sur, Mexico. The Gray Whale, Eschrichtius robustus. M. L. J. S. L. S. S. Leatherwood. New York, Academic Press**:** 511-542.

No abstract

Dahlheim, M. E. and D. K. Ljungblad (1990). Preliminary hearing study on gray whales (Eschrichtius robustus) in the field. Sensory Abilities of Cetaceans: Laboratory and Field Evidence. J. A. T. R. A. Kastelein. New York, Plenum Press**:** 335-346.

No abstract

Dalton, T. and D. Jin (2010). "Extent and frequency of vessel oil spills in US marine protected areas." Marine Pollution Bulletin **60**(11): 1939-1945.

Danil, K. and S. J. Chivers (2005). Habitat-based spatial and temporal variability of life history characteristics of female common dolphins (Delphinus delphis) in the eastern tropical Pacific. Sixteenth Biennial Conference on the Biology of Marine Mammals. San Diego, California**:** 67.

Davidson, A. (2016). Population dynamics of the New Zealand southern right whale (Eubalaena australis), University of Otago.

Deepwater Horizon NRDA Trustees (2016). Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan (PDARP) and Final Programmatic Environmental Impact Statement, NOAA**:** 1.659.

Deepwater Horizon Trustees (2016). *Deepwater Horizon* Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement, Deepwater Horizon Natural Resource Damage Assessment Trustees. **http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan**.

Derraik, J. G. B. (2002). "The pollution of the marine environment by plastic debris: a review." Marine Pollution Bulletin **44**(9): 842-852.

Dickens, M. J., et al. (2010). "Stress: An inevitable component of animal translocation." Biological Conservation **143**(6): 1329-1341.

Dierauf, L. and M. Gulland (2001). Marine mammal unusual mortality events. CRC Handbook of Marine Mammal Medicine, CRC Press**:** 69-81.

Dierauf, L. A. and F. M. D. Gulland (2001). CRC Handbook of Marine Mammal Medicine. Boca Raton, Florida, CRC Press.

Dietrich, K. S., et al. (2007). Best practices for the collection of longline data to facilitate research and analysis to reduce bycatch of protected species., NOAA Technical Memorandum NMFS-OPR-35. 101p. Report of a workshop held at the International Fisheries Observer Conference Sydney, Australia, November 8,.

Doney, S. C., et al. (2012). "Climate change impacts on marine ecosystems." Marine Science **4**.

Drinkwater, K. F., et al. (2003). "The response of marine ecosystems to climate variability associated with the North Atlantic oscillation." Geophysical Monograph **134**: 211-234.

Dunlop, R. A., et al. (2008). "Non-song acoustic communication in migrating humpback whales (*Megaptera novaeangliae*)." Marine Mammal Science **24**(3): 613-629.

Dwyer, S. L. and I. N. Visser (2011). "Cookie cutter shark (Isistius sp.) bites on cetaceans, with particular reference to killer whales (orca) (Orcinus orca)." Aquatic Mammals **37**(2): 111-138.

Edds-Walton, P. L. (1997). "Acoustic communication signals of mysticete whales." Bioacoustics-the International Journal of Animal Sound and Its Recording **8**: 47-60.

Edds, P. L. (1988). "Characteristics of finback *Balaenoptera physalus* vocalizations in the St. Lawrence estuary." Bioacoustics **1**: 131-149.

Elftman, M. D., et al. (2007). "Corticosterone impairs dendritic cell maturation and function." Immunology **122**(2): 279-290.

Engelhaupt, D., et al. (2009). "Female philopatry in coastal basins and male dispersion across the North Atlantic in a highly mobile marine species, the sperm whale (*Physeter macrocephalus*)." Mol Ecol **18**(20): 4193-4205.

Epperly, S., et al. (2002). Analysis of sea turtle bycatch in the commercial shrimp fisheries of southeast U.S. waters and the Gulf of Mexico. NOAA Technical Memorandum, U.S. Department of Commerce 88.

Erbe, C. (2002). Hearing abilities of baleen whales., Defence R&D Canada – Atlantic report CR 2002-065. Contract Number: W7707-01-0828. 40pp.

Erbe, C. (2002). "Underwater noise of whale-watching boats and potential effects on killer whales (Orcinus orca), based on an acoustic impact model." Marine Mammal Science **18**(2): 394-418.

Eskesen, G., et al. (2009). "Stress level in wild harbour porpoises (*Phocoena phocoena*) during satellite tagging measured by respiration, heart rate and cortisol." Journal of the Marine Biological Association of the United Kingdom **89**(5): 885-892.

Feare, C. J. (1976). "Desertion and abnormal development in a colony of Sooty Terns infested by virus-infected ticks." Ibis **118**: 112-115.

Feldkamp, S. D., et al. (1991). Effects of El Niño 1983 on the foraging patterns of California sea lions (Zalophus californianus) near San Miguel Island, California. Pinnipeds and El Niño: Responses to environmental stress. F. Trillmich and K. A. Ono. Berlin, Germany, Springer-Verlag**:** 146-155.

Felix, F. (2001). Observed changes of behavior in humphack whales during whalewatching encounters off Ecuador. 14th Biennial Conference on the Biology of Marine Mammals. Vancouver, Canada**:** 69.

Fonfara, S., et al. (2007). "The impact of stress on cytokine and haptoglobin mRNA expression in blood samples from harbour porpoises (Phocoena phocoena)." Journal of the Marine Biological Association of the United Kingdom **87**(1): 305-311.

Fossi, M. C., et al. (2016). "Fin whales and microplastics: The Mediterranean Sea and the Sea of Cortez scenarios." Environmental Pollution **209**: 68-78.

Frankham, R. (2005). "Genetics and extinction." Biological Conservation **126**(2): 131-140.

Frantzis, A. and P. Alexiadou (2008). "Male sperm whale (Physeter macrocephalus) coda production and coda-type usage depend on the presence of conspecifics and the behavioural context." Canadian Journal of Zoology **86**(1): 62-75.

Frazer, L. N. and E. Mercado Iii (2000). "A sonar model for humpback whale song." IEEE Journal of Oceanic Engineering **25**(1): 160-182.

Frid, A. (2003). "Dall's sheep responses to overflights by helicopter and fixed-wing aircraft." Biological Conservation **110**(3): 387-399.

Frid, A. and L. Dill (2002). "Human-caused disturbance stimuli as a form of predation risk." Conservation Ecology **6**(1).

Friedlaender, A. S., et al. (2009). "Diel changes in humpback whale Megaptera novaeangliae feeding behavior in response to sand lance Ammodytes spp. behavior and distribution." Marine Ecology Progress Series **395**: 91-100.

Fromentin, J.-M. and B. Planque (1996). "*Calanus* and environment in the eastern North Atlantic. II. Influence of the North Atlantic Oscillation on *C. finmarchicus* and *C. helgolandicus*." Marine Ecology Progress Series **134**: 111-118.

Gabriele, C., et al. (2003). Underwater acoustic monitoring and estimated effects of vessel noise on humpback whales in Glacier Bay, Alaska. Fifteenth Biennial Conference on the Biology of Marine Mammals. Greensboro, North Carolina**:** 56-57.

Gabriele, C. M. and A. S. Frankel. (2002). Surprising humpback whale songs in Glacier Bay National Park. Alaska Park Science: Connections to Natural and Cultural Resource Studies in Alaska's National Parks. p.17-21.

Gall, S. C. and R. C. Thompson (2015). "The impact of debris on marine life." Marine Pollution Bulletin **92**(1-2): 170-179.

Gallo, F., et al. (2018). "Marine litter plastics and microplastics and their toxic chemicals components: the need for urgent preventive measures." Environmental Sciences Europe **30**(1).

Gambell, R. (1999). The International Whaling Commission and the contemporary whaling debate. Conservation and Management of Marine Mammals. J. R. R. R. R. T. Jr. Washington, Smithsonian Institution Press**:** 179-198.

No abstract

Garrett, C. (2004). Priority Substances of Interest in the Georgia Basin - Profiles and background information on current toxics issues. Technical Supporting Document, Canadian Toxics Work Group Puget Sound/Georgia Basin International Task Force**:** 402.

Gauthier, J. and R. Sears (1999). "Behavioral response of four species of balaenopterid whales to biopsy sampling." Marine Mammal Science **15**(1): 85-101.

Gendron, D., et al. (2014). "Long-term individual sighting history database: an effective tool to monitor satellite tag effects on cetaceans." Endangered Species Research.

Geraci, J. R. (1990). "Physiological and toxic effects on cetaceans." Pp. 167-197 *In:* Geraci, J.R. and D.J. St. Aubin (eds), Sea Mammals and Oil: Confronting the Risks. Academic Press, Inc.

Giese, M. (1996). "Effects of human activity on Adelie penguin (Pygoscelis adeliae) breeding success." Biological Conservation **75**: 157-164.

Gill, J. A., et al. (2001). "Why behavioural responses may not reflect the population consequences of human disturbance." Biological Conservation **97**: 265-268.

Gillespie, D. and R. Leaper (2001). Report of the Workshop on Right Whale Acoustics: Practical Applications in Conservation, Woods Hole, 8-9 March 2001. London, International Whaling Commission Scientific Committee**:** 23.

Glass, A. H., et al. (2010). Mortality and serious injury determinations for baleen whale stocks along the United States and Canadian Eastern Seaboards, 2004-2008, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center**:** 27.

Gomez, C., et al. (2016). "A systematic review on the behavioural responses of wild marine mammals to noise: The disparity between science and policy." Canadian Journal of Zoology **94**(12): 801-819.

Goold, J. C. (1999). "Behavioural and acoustic observations of sperm whales in Scapa Flow, Orkney Islands." Journal of the Marine Biological Association of the United Kingdom **79**(3): 541-550.

Goold, J. C. and S. E. Jones (1995). "Time and frequency domain characteristics of sperm whale clicks." Journal of the Acoustical Society of America **98**(3): 1279-1291.

Gorgone, A., et al. (2008). "Modeling response of target and nontarget dolphins to biopsy darting." Journal of Wildlife Management **72**(4): 926-932.

Graham, N. A. J., et al. (2006). "Dynamic fragility of oceanic coral reef ecosystems." Proceedings of the National Academy of Sciences of the United States of America **103**(22): 8425-8429.

Grant, S. C. H. and P. S. Ross (2002). Southern Resident killer whales at risk: toxic chemicals in the British Columbia and Washington environment. Canadian Technical Report of Fisheries and Aquatic Sciences 2412. Sidney, B.C., Fisheries and Oceans Canada.**:** 124.

Greene, C., et al. (2003). "Impact of climate variability on the recovery of endangered North Atlantic right whales." Oceanography **16**(4): 98-103.

Greene, C. H. and A. J. Pershing (2003). "The flip-side of the North Atlantic Oscillation and modal shifts in slope-water circulation patterns." Limnology and Oceanography **48**(1): 319-322.

Greene, C. H., et al. (2003). "Trans-Atlantic responses of *Calanus finmarchicus* populations to basin-scale forcing associated with the North Atlantic Oscillation." Progress in Oceanography **58**(2-4): 301-312.

Greer, A. W. (2008). "Trade-offs and benefits: Implications of promoting a strong immunity to gastrointestinal parasites in sheep." Parasite Immunology **30**(2): 123–132.

Gulland, F. M. D., et al. (1999). "Adrenal function in wild and rehabilitated Pacific harbor seals (Phoca vitulina richardii) and in seals with phocine herpesvirus-associated adrenal necrosis." Marine Mammal Science **15**(3): 810-827.

Hall, J. D. (1982). Prince William Sound, Alaska: Humpback whale population and vessel traffic study. Juneau, Alaska, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Juneau Management Office**:** 14.

Hammond, P. S., et al. (1990). "Individual recognition of cetaceans: Use of photo-identification and other techniques to estimate population parameters." Report of the International Whaling Commission **Special Issue 12**.

Hanson, M. B., et al. (2008). Re-sightings, healing, and attachment performance of remotely-deployed dorsal fin-mounted tags on Hawaiian odontocetes. Kihei, Hawaii, Pacific Scientific Review Group.

Hare, S. R. and N. J. Mantua (2001). An historical narrative on the Pacific Decadal Oscillation, interdecadal climate variability and ecosystem impacts. CIG Publication No. 160 University of Washington**:** 18.

Hare, S. R., et al. (1999). "Inverse production regimes: Alaska and West Coast Pacific salmon." Fisheries **24**(1): 6-14.

Harrington, F. H. and A. M. Veitch (1992). "Calving success of woodland caribou exposed to low-level jet fighter overflights." Arctic **45**(3): 213-218.

Hartwell, S. I. (2004). "Distribution of DDT in sediments off the central California coast." Marine Pollution Bulletin **49**(4): 299-305.

Haulena, M. (2016). Final Report AHC Case: 16-1760. Abbotsford, British Columbia, Animal Health Care Centre, Ministry of Agriculture of British Columbia.

Haver, S. M., et al. (2018). "Monitoring long-term soundscape trends in U.S. Waters: The NOAA/NPS Ocean Noise Reference Station Network." Marine Policy **90**: 6-13.

Hayes, S. A., et al. (2017). US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2016. Woods Hole, Massachusetts, National Marine Fisheries Service Northeast Fisheries Science Center.

Hayhoe, K., et al. (2018). In *Impacts, Risks, and Adaptation in the United States: Fourth National Cllimate Assessment, Volume II* [Reidmiller, D.R., et al. (eds.)]. U.S. Global Change Research Program, Washington, DC, USA. doi: 10.7930/NC4.2018.CH2.

Hayward, T. L. (2000). "El Niño 1997-98 in the coastal waters of southern California: A timeline of events." CalCOFl Reports **41**: 98-116.

Hazel, J., et al. (2007). "Vessel speed increases collision risk for the green turtle Chelonia mydas." Endangered Species Research **3**: 105-113.

Hazen, E. L., et al. (2009). "Fine-scale prey aggregations and foraging ecology of humpback whales Megaptera novaeangliae." Marine Ecology Progress Series **395**: 75-89.

Hazen, E. L., et al. (2012). "Predicted habitat shifts of Pacific top predators in a changing climate." Nature Climate Change Letters.

Heide- Jørgensen, M.P., L. Kleivane, N. Oeien, K.L. Laidre and M.V. Jensen. 2001. A new technique for deploying satellite transmitters on baleen whales: Tracking a blue whale (Balaenoptera musculus) in the North Atlantic. Marine Mammal Science 17:949-954.

Helweg, D. A., et al. (1992). Humpback whale song: Our current understanding. Marine Mammal Sensory Systems. J. A. Thomas, R. A. Kastelein and A. Y. Supin. New York, Plenum Press**:** 459-483.

Henry, A. G., et al. (2017). Serious Injury and Mortality Determinations for Baleen Whale Stocks along the Gulf of Mexico, United States East Coast, and Atlantic Canadian Provinces, 2011-2015. Woods Hole, Massachusetts, Northeast Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

Herraez, P., et al. (2007). "Rhabdomyolysis and myoglobinuric nephrosis (capture myopathy) in a striped dolphin." Journal of Wildlife Diseases **43**(4): 770-774.

Hildebrand, J. A. (2009). "Anthropogenic and natural sources of ambient noise in the ocean." Marine Ecology Progress Series **395**: 20-May.

Hildebrand, J. A. (2009). "Metrics for characterizing the sources of ocean anthropogenic noise." Journal of the Acoustical Society of America **125**(4): 2517.

Hildebrand, J. A., et al. (2011). Passive Acoustic Monitoring for Marine Mammals in the SOCAL Naval Training Area 2010-2011, Inter-American Tropical Tuna Commission**:** 66.

Hildebrand, J. A., et al. (2012). Passive Acoustic Monitoring for Marine Mammals in the SOCAL Naval Training Area 2011-2012. Marine Physical Laboratory, Scripps Institution of Oceanography, University of California San Diego. **MPL Technical Memorandum 537**.

Holt, M. M. (2008). Sound exposure and Southern Resident killer whales (*Orcinus orca*): A review of current knowledge and data gaps. NOAA Technical Memorandum, U.S. Department of Commerce**:** 59.

Hooker, S. K., et al. (2001). "Behavioral reactions of northern bottlenose whales (Hyperoodon ampullatus) to biopsy darting and tag attachment procedures." Fishery Bulletin **99**(2): 303-308.

Horwood, J. (2009). Sei Whale: *Balaenoptera borealis*. Encyclopedia of Marine Mammals. W. F. Perrin, B. Wursig and J. G. M. Thewissen. San Diego, Academic Press**:** 1091-1097.

Hotchkin, C. F., et al. (2011). Source level and propagation of gunshot sounds produced by North Atlantic right whales (Eubalanea glacialis) in the Bay of Fundy during August 2004 and 2005. Nineteenth Biennial Conference on the Biology of Marine Mammals. Tampa, Florida**:** 136.

Houser, D. S., et al. (2001). "A bandpass filter-bank model of auditory sensitivity in the humpback whale." Aquatic Mammals **27**(2): 82-91.

Hoyt, E. (2001). Whale Watching 2001: Worldwide Tourism Numbers, Expenditures, and Expanding Socioeconomic Benefits. Yarmouth Port, MA, USA, International Fund for Animal Welfare,**:** i-vi; 1-158.

Hunt, K. E., et al. (2006). "Analysis of fecal glucocorticoids in the North Atlantic right whale (Eubalaena glacialis)." Gen Comp Endocrinol **148**(2): 260-272.

Hurrell, J. W. (1995). "Decadal trends in the North Atlantic Oscillation: Regional temperatures and precipitation." Science **269**: 676-679.

IPCC (2014). Climate change 2014: Impacts, adaptation, and vulnerability. IPCC Working Group II contribution to AR5, Intergovernmental Panel on Climate Change.

IPCC (2014). Climate Change 2014: Synthesis Report. Geneva, Switzerland, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)].

Isaac, J. L. (2008). "Effects of climate change on life history: Implications for extinction risk in mammals." Endangered Species Research.

Isojunno, S. and P. J. O. Miller (2015). "Sperm whale response to tag boat presence: biologically informed hidden state models quantify lost feeding opportunities." Ecosphere **6**(1).

Issac, J. L. (2009). "Effects of climate change on life history: Implications for extinction risk in mammals." Endangered Species Research **7**(2): 115-123.

IUCN (2012). "The IUCN red list of threatened species. Version 2012.2." from http://www.iucnredlist.org.

Ivashchenko, Y. V., et al. (2014). "Distribution of Soviet catches of sperm whales Physeter macrocephalus in the North Pacific." Endangered Species Research **25**(3): 249-263.

Iwata, H., S. Tanabe, N. Sakai, and R. Tatsukawa (1993). "Distribution of persistent organochlorines in the oceanic air and surface seawater and the role of ocean on their global transport and fate." Environmental Science and Technology

27: 1080-1098.

IWC (2001). "Report of the workshop on the comprehensive assessment of right whales." Journal of Cetacean Research and Management (Special Issue) **2**: 1-60.

IWC (2007). "Whale population estimates." from http://www.iwcoffice.org/conservation/estimate.htm Accessed 3/06/09.

IWC (2012). "International Whaling Commission: Whaling." from http://www.iwcoffice.org/whaling.

IWC (2012). Report of the IWC Workshop on the Assessment of Southern Right Whales. Panama City, Panama, IWC Scientific Committee**:** 39.

IWC (2017). Aboriginal subsistence whaling catches since 1985, International Whaling Commission.

IWC (2017). Catches under objection or under reservation since 1985, International Whaling Commission.

IWC (2017). Special permit catches since 1985, International Whaling Commission.

Jackson, J., et al. (2001). "Historical overfishing and the recent collapse of coastal ecosystems." Science **293**(5530): 629-638.

Jacobsen, J. K., et al. (2010). "Fatal ingestion of floating net debris by two sperm whales (*Physeter macrocephalus*)." Marine Pollution Bulletin **60**: 765-767.

Jacobsen, J. K., et al. (2010). "Fatal ingestion of floating net debris by two sperm whales (Physeter macrocephalus)." Marine Pollution Bulletin **60**(5): 765-767.

Jahoda, M., et al. (2003). "Mediterranean fin whale's (Balaenoptera physalus) response to small vessels and biopsy sampling assessed through passive tracking and timing of respiration." Marine Mammal Science **19**(1): 96-110.

Jenner, C. M. J. C. B. V. S. C. S. K. M. M. C. A. L. M. M. C. D. (2008). Mark recapture analysis of pygmy blue whales from the Perth Canyon, Western Australia 2000-2005. Santiago, Chile, International Whaling Commission Scientific Committee**:** 9.

Jensen, A. S. and G. K. Silber (2004). Large whale ship strike database, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources**:** 37.

Jones, M. L. and S. L. Swartz (2002). Gray whale, Eschrichtius robustus. Encyclopedia of Marine Mammals. W. F. P. B. W. J. G. M. Thewissen. San Diego, California, Academic Press**:** 524-536.

Kanda, N., et al. (2014). Long distant longitudinal migration of southern right whales suspected from mtDNA and microsatellite DNA analysis on JARPA and JARPAII biopsy samples, Paper SC.

Kaufman, G. A. and D. W. Kaufman (1994). "Changes in body-mass related to capture in the prairie deer mouse (Peromyscus maniculatus)." Journal of Mammalogy **75**(3): 681-691.

Keay, J. M., et al. (2006). "Fecal glucocorticoids and their metabolites as indicators of stress in various mammalian species: A literature review." Journal of Zoo and Wildlife Medicine **37**(3): 234-244.

Kenney, R. D., et al. (1985). Calculation of standing stocks and energetic requirements of the cetaceans of the northeast United States Outer Continental Shelf., NOAA Technical Memorandum NMFS-F/NEC-41. 99pp.

Ketten, D. R. (1992). The cetacean ear: Form, frequency, and evolution. Marine Mammal Sensory Systems. J. A. T. R. A. K. A. Y. Supin. New York, Plenum Press**:** 53-75.

Ketten, D. R. (1992). The marine mammal ear: Specializations for aquatic audition and echolocation. The Evolutionary Biology of Hearing. D. B. Webster, R. R. Fay and A. N. Popper (eds.). Springer-Verlag, New York, NY. p.717-750.

Ketten, D. R. (1997). "Structure and function in whale ears." Bioacoustics **8**: 103-135.

Ketten, D. R. (1998). Marine Mammal Auditory Systems: A Summary of Audiometroc and Anatomical Data and its Implications for Underwater Acoustic Impacts. NOAA Technical Memorandum, U.S. Department of Commerce**:** 74.

Ketten, D. R. and D. C. Mountain (2014). Inner ear frequency maps: First stage audiograms of low to infrasonic hearing in mysticetes. Fifth International Meeting on the Effects of Sounds in the Ocean on Marine Mammals (ESOMM - 2014). Amsterdam, The Netherlands**:** 41.

Kintisch, E. (2006). "As the seas warm: Researchers have a long way to go before they can pinpoint climate-change effects on oceangoing species." Science **313**: 776-779.

Kipple, B. and C. Gabriele (2004). Underwater noise from skiffs to ships. Fourth Glacier Bay Science Symposium. S. M. J. F. G. Piatt.

Kipple, B. and C. Gabriele (2007). Underwater noise from skiffs to ships. Fourth Glacier Bay Science Symposium**:** 172-175.

Kite-Powell, H. L., et al. (2007). Modeling the effect of vessel speed on right whale ship strike risk, NMFS.

Koehler, N. (2006). Humpback whale habitat use patterns and interactions with vessels at Point Adolphus, southeastern Alaska. Fairbanks, Alaska, University of Alaska, Fairbanks. **M.S.:** 64.

Krahn, M. M., et al. (2007). "Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales (*Orcinus orca*)." Marine Pollution Bulletin **54**(12): 1903-1911.

Krahn, M. M., et al. (2009). "Effects of age, sex and reproductive status on persistent organic pollutant concentrations in ''Southern Resident" killer whales." Marine Pollution Bulletin.

Kraus, S. D., et al. (2005). "North Atlantic right whales in crisis." Science **309**(5734): 561-562.

Kraus, S. D., et al. (2016). "Recent Scientific Publications Cast Doubt on North Atlantic Right Whale Future." Frontiers in Marine Science.

Lacy, R. C. (1997). "Importance of Genetic Variation to the Viability of Mammalian Populations." Journal of Mammalogy **78**(2): 320-335.

Laist, D. W., et al. (2001). "Collisions between ships and whales." Marine Mammal Science **17**(1): 35-75.

Lambert, E., et al. (2010). "Sustainable whale-watching tourism and climate change: Towards a framework of resilience." Journal of Sustainable Tourism **18**(3): 409-427.

Lande, R. (1991). "Applications of genetics to management and conservation of cetaceans." Report of the International Whaling Commission **Special Issue 13**: 301-311.

Laplanche, C., et al. (2005). Sperm whales click focussing: Towards an understanding of single sperm whale foraging strategies. Nineteenth Annual Conference of the European Cetacean Society. La Rochelle, France**:** 56.

Law, K. L., et al. (2010). "Plastic accumulation in the North Atlantic subtropical gyre." Science **329**(5996): 1185-1188.

Le Boeuf, B. J. and D. E. Crocker (2005). "Ocean climate and seal condition." BMC Biology **3**: 9.

Learmonth, J. A., et al. (2006). "Potential effects of climate change on marine mammals." Oceanography and Marine Biology: An Annual Review **44**: 431-464.

Leduc, R. G., et al. (2012). "Genetic analysis of right whales in the eastern North Pacific confirms severe extirpation risk." Endangered Species Research **18**(2): 163-167.

Leduc, R. G., et al. (2002). "Genetic differences between western and eastern gray whales (Eschrichtius robustus)." Journal of Cetacean Research and Management **4**(1): 1-5.

Li, W. C., et al. (2016). "Plastic waste in the marine environment: A review of sources, occurrence and effects." Sci Total Environ **566-567**: 333-349.

Lima, S. L. (1998). "Stress and decision making under the risk of predation." Advances in the Study of Behavior **27**: 215-290.

Lloyd, B. D. (2003). Potential effects of mussel farming on New Zealand's marine mammals and seabirds: A discussion paper, Department of Conservation.

Lockyer, C. H., et al. (1985). "Body condition in terms of anatomical and biochemical assessment of body fat in North Atlantic fin and sei whales." Canadian Journal of Zoology **63**(10): 2328-2338.

Lockyer, C. H. and R. J. Morris (1990). "Some observations on wound healing and persistence of scars in Tursiops truncatus." Report of the International Whaling Commission **Special Issue 12**: 113-118.

Luksenburg, J. and E. Parsons (2009). The effects of aircraft on cetaceans: implications for aerial whalewatching. Proceedings of the 61st Meeting of the International Whaling Commission.

Lusseau, D. (2004). "The hidden cost of tourism: Detecting long-term effects of tourism using behavioral information." Ecology and Society **9**(1): 2.

Lusseau, D. (2006). "The short-term behavioral reactions of bottlenose dolphins to interactions with boats in Doubtful Sound, New Zealand." Marine Mammal Science **22**(4): 802-818.

Lusseau, D., et al. (2004). "Parallel influence of climate on the behaviour of Pacific killer whales and Atlantic bottlenose dolphins." Ecology Letters **7**: 1068-1076.

Lyrholm, T. and U. Gyllensten (1998). "Global matrilineal population structure in sperm whales as indicated by mitochondrial DNA sequences." Proceedings of the Royal Society B-Biological Sciences **265**(1406): 1679-1684.

Macleod, C. D. (2009). "Global climate change, range changes and potential implications for the conservation of marine cetaceans: A review and synthesis." Endangered Species Research **7**(2): 125-136.

Macleod, C. D., et al. (2005). "Climate change and the cetacean community of north-west Scotland." Biological Conservation **124**(4): 477-483.

Madsen, P. T., et al. (2003). "Sound production in neonate sperm whales." Journal of the Acoustical Society of America **113**(6): 2988-2991.

Magalhaes, S., et al. (2002). "Short-term reactions of sperm whales (Physeter macrocephalus) to whale-watching vessels in the Azores." Aquatic Mammals **28**(3): 267-274.

Malme, C. I., et al. (1983). Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. Final report for the period of 7 June 1982 - 31 July 1983. Anchorage, Alaska, Department of the Interior, Minerals Management Service, Alaska OCS Office**:** 64.

Malme, C. I., et al. (1986). Behavioral responses of gray whales to industrial noise: Feeding observations and predictive modeling., Final Report for the Outer Continental Shelf Environmental Assessment Program, Research Unit 675. 207pgs.

Mancia, A., et al. (2008). "A transcriptomic analysis of the stress induced by capture-release health assessment studies in wild dolphins (Tursiops truncatus)." Molecular Ecology **17**(11): 2581-2589.

Mann, J. (1999). "Behavioral sampling methods for cetaceans: A review and critique." Marine Mammal Science **15**(1): 102-122.

Mann, J., et al. (2000). "Female reproductive success in bottlenose dolphins (Tursiops sp.): Life history, habitat, provisioning, and group-size effects." Behavioral Ecology **11**(2): 210-219.

Mantua, N. J. and S. R. Hare (2002). "The Pacific decadal oscillation." Journal of Oceanography **58**(1): 35-44.

Mantua, N. J., et al. (1997). "A Pacific interdecadal climate oscillation with impacts on salmon production." Bulletin of the American Meteorological Society **78**(6): 1069-1079.

Marcoux, M., et al. (2006). "Coda vocalizations recorded in breeding areas are almost entirely produced by mature female sperm whales (Physeter macrocephalus)." Canadian Journal of Zoology **84**(4): 609-614.

Marques, T. A., et al. (2011). "Estimating North Pacific right whale Eubalaena japonica density using passive acoustic cue counting." Endangered Species Research **13**(3): 163-172.

Mate, B., et al. (2007). "The evolution of satellite-monitored radio tags for large whales: One laboratory's experience." Deep Sea Research Part II: Topical Studies in Oceanography **54**(3): 224-247.

Mate, B. R., et al. (2016). Baleen (Blue and Fin) Whale Tagging in Southern California in Support of Marine Mammal Monitoring Across Multiple Navy Training Areas. Final Report. . Pearl Harbor, Hawaii, Submitted to Naval Facilities Engineering Command Pacific under Contract Nos. N62470-10-D-3011, Task Order KB29, and Contract No. N62470-15-D-8006, Task Order KB01, issued to HDR, Inc.

Mate, B.R., L. Irvine, and D.M. Palacios. 2017. The development of an intermediate-duration tag to characterize the diving behavior of large whales. Ecology and Evolution 7:585-595.

Matkin, C. O. and E. Saulitis (1997). "Restoration notebook: killer whale (*Orcinus orca*)." Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska.

Matthews, J., et al. (2001). "Vocalisation rates of the North Atlantic right whale (Eubalaena glacialis)." Journal of Cetacean Research and Management **3**(3): 271-282.

Matthews, J. N., et al. (2001). "Vocalisation rates of the North Atlantic right whale (Eubalaena glacialis)." Journal of Cetacean Research And Management **3**(3): 271-282.

Maybaum, H. L. (1990). "Effects of a 3.3 kHz sonar system on humpback whales, *Megaptera novaeangliae*, in Hawaiian waters." EOS **71**: 92.

McCauley, R. and C. Jenner (2010). "Migratory patterns and estimated population size of pygmy blue whales (Balaenoptera musculus brevicauda) traversing the Western Australian coast based on passive acoustics." IWC SC/62/SH26.

Mcdonald, M. A., et al. (2001). "The acoustic calls of blue whales off California with gender data." Journal of the Acoustical Society of America **109**(4): 1728-1735.

McDonald, M. A., et al. (2009). "Worldwide decline in tonal frequencies of blue whale songs." Endangered Species Research **9**(1): 13-21.

Mcdonald, M. A., et al. (1995). "Blue and fin whales observed on a seafloor array in the northeast Pacific." Journal of the Acoustical Society of America **98**(2 Part 1): 712-721.

Mcdonald, M. A., et al. (2006). "Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California." Journal of the Acoustical Society of America **120**(2): 711-718.

McDonald, M. A., et al. (2006). "Biogeographic characterisation of blue whale song worldwide: Using song to identify populations." Journal of Cetacean Research and Management **8**(1): 55-65.

McDonald, M. A. and S. E. Moore (2002). "Calls recorded from North Pacific right whales (Eubalaena japonica) in the eastern Bering Sea." Journal of Cetacean Research And Management **4**(3): 261-266.

Mckenna, M. F., et al. (2012). "Underwater radiated noise from modern commercial ships." Journal of the Acoustical Society of America **131**(2): 92-103.

McKenna, M. F., et al. (2013). "Relationship between container ship underwater noise levels and ship design, operational and oceanographic conditions." Scientific Reports **3**: 1760.

McMahon, C. R. and H. R. Burton (2005). "Climate change and seal survival: Evidence for environmentally mediated changes in elephant seal, Mirounga leonina, pup survival." Proceedings of the Royal Society of London Series B Biological Sciences **272**(1566): 923-928.

Mcmahon, C. R. and G. C. Hays (2006). "Thermal niche, large-scale movements and implications of climate change for a critically endangered marine vertebrate." Global Change Biology **12**(7): 1330-1338.

Mcsweeney, D. J., et al. (1989). "North Pacific humpback whale songs - a comparison of southeast Alaskan feeding ground songs with Hawaiian wintering ground songs." Marine Mammal Science **5**(2): 139-148.

Mearns, A. J. (2001). Long-term contaminant trends and patterns in Puget Sound, the Straits of Juan de Fuca, and the Pacific Coast. 2001 Puget Sound Research Conference. T. Droscher. Olympia, Washington, Puget Sound Action Team.

Mellinger, D. K. and C. W. Clark (2003). "Blue whale (Balaenoptera musculus) sounds from the North Atlantic." Journal of the Acoustical Society of America **114**(2): 1108-1119.

Mesnick, S. L., et al. (2011). "Sperm whale population structure in the eastern and central North Pacific inferred by the use of single-nucleotide polymorphisms, microsatellites and mitochondrial DNA." Mol Ecol Resour **11 Suppl 1**: 278-298.

Miksis-Olds, J. L. and S. M. Nichols (2016). "Is low frequency ocean sound increasing globally?" J Acoust Soc Am **139**(1): 501-511.

Miller, P. J. O., et al. (2004). "Sperm whale behaviour indicates the use of echolocation click buzzes 'creaks' in prey capture." Proceedings of the Royal Society of London Series B Biological Sciences **271**(1554): 2239-2247.

MMC (2007). Marine mammals and noise: A sound approach to research and management, Marine Mammal Commission.

Mohl, B., et al. (2003). "The monopulsed nature of sperm whale clicks." Journal of the Acoustical Society of America **114**(2): 1143-1154.

Moncheva, S. P. and L. T. Kamburska (2002). Plankton stowaways in the Black Sea - Impacts on biodiversity and ecosystem health. Alien marine organisms introduced by ships in the Mediterranean and Black seas. Istanbul, Turkey, CIESM Workshop Monographs**:** 47-51.

Mongillo, T. M., et al. (2012). "Predicted polybrominated diphenyl ether (PBDE) and polychlorinated biphenyl (PCB) accumulation in southern resident killer whales." Marine Ecology Progress Series **453**: 263-277.

Moore, M., et al. (2013). "Rope trauma, sedation, disentanglement, and monitoring-tag associated lesions in a terminally entangled North Atlantic right whale (*Eubalaena glacialis*)." Marine Mammal Science **29**(2): E98-E113.

Moore, S. E. and J. T. Clark (2002). "Potential impact of offshore human activities on gray whales (*Eschrichtius robustus*)." Journal of Cetacean Research and Management **4**(1): 19-25.

Morano, J. L., et al. (2012). "Acoustically detected year-round presence of right whales in an urbanized migration corridor." Conservation Biology **26**(4): 698-707.

Mullner, A., et al. (2004). "Exposure to ecotourism reduces survival and affects stress response in hoatzin chicks (Opisthocomus hoazin)." Biological Conservation **118**: 549-558.

Mundy, P. R. (2005). The Gulf of Alaska: Biology and Oceanography. Fairbanks, Alaska Sea Grant College Program, University of Alaska.

Mundy, P. R. and R. T. Cooney (2005). Physical and biological background. The Gulf of Alaska: Biology and oceanography. P. R. Mundy. Fairbanks, Alaska, Alaska Sea Grant College Program, University of Alaska**:** 15-23.

Mussoline, S. E., et al. (2012). "Seasonal and diel variation in North Atlantic right whale up-calls: Implications for management and conservation in the northwestern Atlantic Ocean." Endangered Species Research **17**(1-Jan): 17-26.

Muto, M. M., et al. (2016). "Alaska Marine Mammal Stock Assessments, 2015."

Muto, M. M., et al. (2017). Alaska Marine Mammal Stock Assessments, 2016. Seattle, Washington, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

Nadeem, K., et al. (2016). "Integrating population dynamics models and distance sampling data: A spatial hierarchical state-space approach." Ecology **97**(7): 1735-1745.

Nakamura, N., et al. (2009). "Mode shift in the Indian Ocean climate under global warming stress." Geophysical Research Letters **36**.

NAS (2017). Approaches to Understanding the Cumulative Effects of Stressors on Marine Mammals. Washington, District of Columbia, National Academies of Sciences, Engineering, and Medicine. The National Academies Press**:** 146.

Nedelec, S. L., et al. (2014). "Anthropogenic noise playback impairs embryonic development and increases mortality in a marine invertebrate." Sci Rep **4**: 5891.

NHT (2005). Southern right whale recovery plan 2005-2010, Australian Government Department of the Environment and Heritage.

NMFS (1991). Final recovery plan for the humpback whale (*Megaptera novaeangliae*). Silver Spring, Maryland, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources.

NMFS (1998). Recovery plan for the blue whale (Balaenoptera musculus). R. L. R. L. P. J. C. B. J. Reeves and G. K. Silber. Silver Spring, Maryland, National Oceanic and Atmospheric Administration, National Marine Fisheries Service**:** 42.

NMFS (2006). Biological Opinion on the issuance of Section 10(a)(1)(A) permits to conduct scientific research on the southern resident killer whale (Orcinus orca) distinct population segment and other endangered or threatened species. Seattle, Washington, Northwest Regional Office, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerice**:** 92.

NMFS (2010). Final recovery plan for the sperm whale (Physeter macrocephalus). Silver Spring, Maryland, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources.

NMFS (2010). Recovery plan for the fin whale (Balaenoptera physalus). Silver Spring, Maryland, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources**:** 121.

NMFS (2011). "Fin whale (*Balaenoptera physalus*) 5-Year Review: Evaluation and Summary."

NMFS (2012). "5-Year Review North Pacific Right Whale (*Eubalaena japonica*)."

NMFS (2013). Draft recovery plan for the North Pacific right whale (Eubalaena japonica). Silver Spring, Maryland, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources.

NMFS (2015). Biological Opinion on the US Navy's Northwest Training and Testing Activities. Silver Spring, Maryland, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS (2015). Biological Opinion on the US Navy's Training Exercises and Testing Activities in the Hawaii-Southern California Training and Testing Study Area. Silver Spring, Maryland, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS (2015). Southern right whale (Eubalaena australis) 5-year Review: Summary and Evaluation. Silver Spring, Maryland, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce**:** 56.

NMFS (2015). Sperm whale (Physeter macrocephalus) 5-year review: Summary and evaluation, National Marine Fisheries Service, Office of Protected Resources.

NMFS (2016). Cetacean Research at the AFSC's Marine Mammal Laboratory. Silver Spring, Maryland, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS (2016). Occurrence of Endangered Species Act (ESA) Listed Humpback Whales off Alaska, Alaska Region, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS (2016). Southern Resident Killer Whale (*Orcinus orca*) Stranding Event Expert Review Summary, September 21, 2016. Silver Spring, Maryland, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS (2016). West Coast Region's Endangered Species Act implementation and considerations about "take" given the September 2016 humpback whale DPS status review and species-wide revision of listings, West Coast Region, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS (2017). Biological and Conference Opinion on the Issuance of Permit No. 18786-01 to the Marine Mammal Health and Stranding Response Program and Implementation of the Marine Mammal Health and Stranding Response Program (2017 Reinitiation). Silver Spring, Maryland, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS (2017). Biological and Conference Opinion on the Issuance of Permit No. 20465 to NMFS Alaska Fisheries Science Center Marine Mammal Laboratory for Research on Cetaceans. Silver Spring, Maryland, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS (2017). Biological and Conference Opinion on United States Navy's Surveillance Towed Array Sensor System Low Frequency Active Sonar Routine Training, Testing, and Military Operations from August 2017 through August 2022. Silver Spring, Maryland, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS (2017). Biological Opinion on the US Navy's Gulf of Alaska Training Activities and Associated NMFS Regulations and Letter of Authorization (April 2017 - April 2022). Silver Spring, Maryland, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS (2017). "North Pacific Right Whale (*Eubalaena japonica*) Five Yar Review: Summary and Evaluation." 39.

NOAA (2013). Draft guidance for assessing the effects of anthropogenic sound on marine mammals: acoustic threshold levels for onset of permanent and temporary threshold shifts, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NOAA (2016). Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing. Silver Spring, Maryland, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NOAA (2018). Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. Silver Spring, Maryland, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

Noda, K., et al. (2007). "Relationship between transportation stress and polymorphonuclear cell functions of bottlenose dolphins, Tursiops truncatus." Journal of Veterinary Medical Science **69**(4): 379-383.

Noren, D. P. and J. A. Mocklin (2012). "Review of cetacean biopsy techniques: Factors contributing to successful sample collection and physiological and behavioral impacts." Marine Mammal Science **28**(1): 154-199.

Norman, S. A., et al. (2004). "Cetacean strandings in Oregon and Washington between 1930 and 2002." Journal of Cetacean Research And Management **6**(1): 87-99.

Norman, S.A., K.R. Flynn, A.N. Zerbini, F.M.D. Gulland, M.J. Moore, S. Raverty, D.S. Rotstein, B.R. Mate, C. Hayslip, D. Gendron, R. Sears, A.B. Douglas, and J. Calambokidis. 2017. Assessment of wound healing of tagged gray (Eschrichtius robustus) and blue (Balaenoptera musculus) whales in the eastern North Pacific using long-term series of photographs. Marine Mammal Science. 33. http://doi.wiley.com/10.1111/mms.12443.

Norman, S. A., et al. (in review). "Quantitative assessment of wound healing of tagged gray (*Eschrichtius robustus*) and blue (*Balaenoptera musculus*) whales in the eastern North Pacific using long term series of photographs." Marine Mammal Science.

Norris, K. S. and G. W. Harvey (1972). A theory for the function of the spermaceti organ of the sperm whale. Animal Orientation and Navigation. S. R. Galler**:** 393-417.

Nowacek, D., et al. (2003). North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alarm signal. Environmental Consequences of Underwater Sound (ECOUS) Symposium. San Antonio, Texas.

Nowacek, D. P., et al. (2016). "Studying cetacean behaviour: new technological approaches and conservation applications." Animal Behaviour.

Nowacek, D. P., et al. (2004). "North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alerting stimuli." Proceedings of the Royal Society of London Series B Biological Sciences **271**(1536): 227-231.

Nowacek, D. P., et al. (2007). "Responses of cetaceans to anthropogenic noise." Mammal Review **37**(2): 81-115.

Nowacek, S. M. W., R. S.; Solow, A. R. (2001). "Short-term effects of boat traffic on bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida." Marine Mammal Science **17**(4): 673-688.

NRC (2003). National Research Council: Ocean noise and marine mammals. Washington, D.C., National Academies Press.

NRC (2003). Ocean Noise and Marine Mammals. Washington, District of Columbia, National Research Council of the National Academies of Science. The National Academies Press.

NRC (2005). Marine mammal populations and ocean noise. Determining when noise causes biologically significant effects. Washington, District of Columbia, National Research Council of the National Academies of Science. The National Academies Press.

NRC (2008). Tackling marine debris in the 21st Century. Washington, District of Columbia, National Research Council of the National Academies of Science. The National Academies Press**:** pp. 224.

O'connor, S., et al. (2009). Whale Watching Worldwide: Tourism numbers, expenditures and expanding economic benefits, a special report from the International Fund for Animal Welfare. Yarmouth, Massachusetts, International Fund for Animal Welfare.

Ohsumi, S. and S. Wada (1974). "Status of whale stocks in the North Pacific, 1972." Report of the International Whaling Commission **24**: 114-126.

Oleson, E. M., et al. (2007). "Blue whale visual and acoustic encounter rates in the Southern California Bight." Marine Mammal Science **23**(3): 574-597.

Oleson, E. M., et al. (2007). "Behavioral context of call production by eastern North Pacific blue whales." Marine Ecology Progress Series **330**: 269-284.

Oleson, E. M., et al. (2007). "Temporal separation of blue whale call types on a southern California feeding ground." Animal Behaviour **74**(4): 881-894.

Palka, D. (2012). "Cetacean abundance estimates in US northwestern Atlantic Ocean waters from summer 2011 line transect survey."

Parks, S. E. (2003). "Response of North Atlantic right whales (Eubalaena glacialis) to playback of calls recorded from surface active groups in both the North and South Atlantic." Marine Mammal Science **19**(3): 563-580.

Parks, S. E. (2009). Assessment of acoustic adaptations for noise compensation in marine mammals, Office of Naval Research**:** 3.

Parks, S. E. and C. W. Clark (2007). Acoustic communication: Social sounds and the potential impacts of noise. The Urban Whale: North Atlantic Right Whales at the Crossroads. S. D. K. R. Rolland. Cambridge, Massahusetts, Harvard University Press**:** 310-332.

Parks, S. E., et al. (2005). North Atlantic right whales shift their frequency of calling in response to vessel noise. Sixteenth Biennial Conference on the Biology of Marine Mammals. San Diego, California**:** 218.

Parks, S. E., et al. (2007). "Short- and long-term changes in right whale calling behavior: The potential effects of noise on acoustic communication." Journal of the Acoustical Society of America **122**(6): 3725-3731.

Parks, S. E., et al. (2005). "The gunshot sound produced by male North Atlantic right whales (Eubalaena glacialis) and its potential function in reproductive advertisement." Marine Mammal Science **21**(3): 458-475.

Parks, S. E., et al. (2012). "Characteristics of gunshot sound displays by North Atlantic right whales in the Bay of Fundy." Journal of the Acoustical Society of America **131**(4): 3173-3179.

Parks, S. E., et al. (2011). "Individual right whales call louder in increased environmental noise." Biology Letters **7**(1): 33-35.

Parks, S. E., et al. (2010). "Changes in vocal behavior of individual North Atlantic right whales in increased noise." Journal of the Acoustical Society of America **127**(3 Pt 2): 1726.

Parks, S. E., et al. (2012). Changes in vocal behavior of North Atlantic right whales in increased noise. The Effects of Noise on Aquatic Life. A. N. P. A. Hawkings, Springer Science**:** 4.

Parks, S. E., et al. (2007). "Anatomical predictions of hearing in the North Atlantic right whale." Anatomical Record: Advances in Integrative Anatomy and Evolutionary Biology **290**(6): 734-744.

Parks, S. E., et al. (2003). Sound production by North Atlantic right whales in surface active groups. Fifteenth Biennial Conference on the Biology of Marine Mammals. Greensboro, North Carolina**:** 127.

Parks, S. E., et al. (2006). "Acoustic Communication in the North Atlantic Right Whale (*Eubalaena glacialis*) and Potential Impacts of Noise." EOS, Transactions, American Geophysical Union **87**(36): Ocean Sci. Meet. Suppl., Abstract OS53G-03.

Parks, S. E. and P. L. Tyack (2005). "Sound production by North Atlantic right whales (Eubalaena glacialis) in surface active groups." Journal of the Acoustical Society of America **117**(5): 3297-3306.

Parks, S. E., et al. (2009). "Variability in ambient noise levels and call parameters of North Atlantic right whales in three habitat areas." Journal of the Acoustical Society of America **125**(2): 1230-1239.

Parsons, E. C. M. (2012). "The Negative Impacts of Whale-Watching." Journal of Marine Biology **2012**: 1-9.

Parsons, K., et al. (2003). "Comparing two alternative methods for sampling small cetaceans for molecular analysis." Marine Mammal Science **19**(1): 224-231.

Patenaude, N. J., et al. (2007). "Mitochondrial DNA diversity and population structure among southern right whales (Eubalaena australis)." Journal of Heredity **98**(2): 147-157.

Patenaude, N. J., et al. (2002). "Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea." Marine Mammal Science **18**(2): 309-335.

Patterson, B. and G. R. Hamilton (1964). Repetitive 20 cycle per second biological hydroacoustic signals at Bermuda. Marine Bio-acoustics. W N Tavolga ed. Pergamon Press Oxford. p.125-145. Proceedings of a Symposium held at the Lerner Marine Laboratory Bimini Bahamas April.

Pavan, G., et al. (2000). "Time patterns of sperm whale codas recorded in the Mediterranean Sea 1985-1996." Journal of the Acoustical Society of America **107**(6): 3487-3495.

Payne, K. (1985). "Singing in humpback whales." Whalewatcher **19**(1): 3-6.

Payne, K., et al. (1983). Progressive changes in the songs of humpback whales (*Megaptera novaeangliae*): A detailed analysis of two seasons in Hawaii. Communication and Behavior of Whales. R. Payne. Boulder, CO, Westview Press**:** 9-57.

Payne, P., et al. (1986). "The distribution of the humpback whale, Megaptera novaeangliae, on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel, Ammodytes americanus." Fisheries Bulletin **84**: 271-277.

Payne, P. M., et al. (1990). "Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in selected prey." Fishery Bulletin **88**: 687-696.

Payne, R. and D. Webb. (1971). "Orientation by means of long range acoustic signaling in baleen whales." Annals of the New York Academy of Sciences **188**(1): 110-141.

Payne, R. S. and S. Mcvay (1971). "Songs of humpback whales. Humpbacks emit sounds in long, predictable patterns ranging over frequencies audible to humans." Science **173**(3997): 585-597.

Pecl, G. and G. Jackson (2008). "The potential impacts of climate change on inshore squid: biology, ecology and fisheries." Reviews in Fish Biology and Fisheries **18**: 373-385.

Pershing, A. J., et al. (2001). "Oceanographic responses to climate in the Northwest Atlantic." Oceanography **14**(3): 76-82.

Peters, R. H. (1983). The Implications of Body Size, Cambridge University Press.

Petrochenko, S. P., et al. (1991). "Sounds, souce levels, and behavior of gray whales in the Chukotskoe Sea." Sov. Phys. Acoust. **37**(6): 622-624.

Pitman, R. L. (2003). "Good whale hunting." Natural History **December 2003/January 2004**: 24-26, 28.

Poloczanska, E. S., et al. (2009). Vulnerability of marine turtles in climate change. Advances in Marine Biology. New York, Academic Press. **56:** 151-211.

Popper, A. N., et al. (2014). "Does man-made sound harm fishes?" Journal of Ocean Technology **9**(1): 11-20.

Popper, A. N., et al. (2014). ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. SpringerBriefs in Oceanography**:** 76.

Price, C. S., et al. (2017). Protected Species Marnine Aquaculture Interactions, NOAA Technical Memorandum 85.

Price, C. S. and J. A. Morris (2013). "Marine cage culture and the environment: Twenty-first century science informing a sustainable industry."

Pughiuc, D. (2010). "Invasive species: Ballast water battles." Seaways.

Raaymakers, S. (2003). "The GEF/UNDP/IMO global ballast water management programme integrating science, shipping and society to save our seas." Proceedings of the Institute of Marine Engineering, Science and Technology Part B: Journal of Design and Operations(B4): 2-10.

Raaymakers, S. and R. Hilliard (2002). Harmful aquatic organisms in ships' ballast water - Ballast water risk assessment. Alien marine organisms introduced by ships in the Mediterranean and Black seas. Istanbul, Turkey, CIESM Workshop Monographs**:** 103-110.

Ramp, C., et al. (2015). "Adapting to a warmer ocean--seasonal shift of baleen whale movements over three decades." PLoS One **10**(3): e0121374.

Rankin, S., et al. (2005). "Vocalisations of Antarctic blue whales, *Balaenoptera musculus intermedia*, recorded during the 2001/2002 and 2002/2003 IWC/SOWER circumpolar cruises, Area V, Antarctica." Journal of Cetacean Research and Management **7**(1): 13-20.

Reeb, D. and P. B. Best (2006). "A biopsy system for deep-core sampling of the blubber of southern right whales, Eubalaena australis." Marine Mammal Science **22**(1): 206-213.

Reilly, S. B., et al. (2013). "*Balaenoptera physalus*. The IUCN Red List of Threatened Species." The IUCN Red List of Threatened Species 2013: e.T2478A44210520.

Reisinger, R. R., et al. (2014). "Satellite tagging and biopsy sampling of killer whales at subantarctic Marion Island: Effectiveness, immediate reactions and long-term responses." PLoS One **9**(10): e111835.

Rendell, L., et al. (2012). "Can genetic differences explain vocal dialect variation in sperm whales, Physeter macrocephalus?" Behav Genet **42**(2): 332-343.

Rendell, L. and H. Whitehead (2004). "Do sperm whales share coda vocalizations? Insights into coda usage from acoustic size measurement." Animal Behaviour **67**(5): 865-874.

Richardson, W. J., et al. (1995). Assessment of potential impact of small explosions in the Korea Strait on marine animals and fisheries, LGL Ltd. Environmental Research Associates, BBN Systems and Technologies.

Richardson, W. J., et al., Eds. (1985). Behavior, disturbance responses and distribution of bowhead whales (*Balaena mysticetus*) in the eastern Beaufort Sea, 1980-84: A summary. Bryan, Texas, LGL Ecological Research Associates, Inc.

Richardson, W. J., et al. (1995). Marine Mammals and Noise. San Diego, California, Academic Press, Inc.

Richardson, W. J., et al. (1995). Marine Mammals and Noise. San Diego, California, Academic Press, Inc.

Richter, C., et al. (2006). "Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand." Marine Mammal Science **22**(1): 46-63.

Richter, C. F., et al. (2003). "Sperm whale watching off Kaikoura, New Zealand: Effects of current activities on surfacing and vocalisation patterns." Science for Conservation **219**.

Rivers, J. A. (1997). "Blue whale, Balaenoptera musculus, vocalizations from the waters off central California." Marine Mammal Science **13**(2): 186-195.

Robbins, J., et al. (2016). Evaluating Potential Effects of Satellite Tagging in Large Whales: A Case Study with Gulf of Maine Humpback Whales, Report to the National Fish and Wildlife Foundation Grant #23318.

Robinson, R. A., et al. (2005). Climate change and migratory species. BTO Research Report 414. Norfolk, U.K. , Defra Research, British Trust for Ornithology**:** 306.

Rockwood, R. C., et al. (2017). "High mortality of blue, humpback and fin whales from modeling of vessel collisions on the U.S. West Coast suggests population impacts and insufficient protection." PLoS One **12**(8): e0183052.

Rohrkasse-Charles, S., et al. (2011). Social context of gray whale Eschrichtius robustus sound activity. Nineteenth Biennial Conference on the Biology of Marine Mammals. Tampa, Florida**:** 255.

Rolland, R. M., et al. (2012). "Evidence that ship noise increases stress in right whales." Proc Biol Sci **279**(1737): 2363-2368.

Roman, J. and S. R. Palumbi (2003). "Whales before whaling in the North Atlantic." Science **301**(5632): 508-510.

Romero, L. M. (2004). "Physiological stress in ecology: lessons from biomedical research." Trends in Ecology and Evolution **19**(5): 249-255.

Rosenbaum, H. C., et al. (2000). "World-wide genetic differentiation of Eubalaena: Questioning the number of right whale species." Molecular Ecology **9**(11): 1793-1802.

Ross, D. (1976). Mechanics of Underwater Noise. New York, Pergamon Press.

Ross, D. (1993). "On ocean underwater ambient noise." Acoustics Bulletin **18**: 8-May.

Ross, D. (2005). "Ship Sources of Ambient Noise." IEEE Journal of Oceanic Engineering **30**(2): 257-261.

Ross, P. S. (2002). "The role of immunotoxic environmental contaminants in facilitating the emergence of infectious diseases in marine mammals." Human and Ecological Risk Assessment **8**(2): 277-292.

Royer, T. C. (2005). "Hydrographic responses at a coastal site in the northern Gulf of Alaska to seasonal and interannual forcing." Deep-Sea Research Part Ii-Topical Studies in Oceanography **52**(1-2): 267-288.

Saji, N. H., et al. (1999). "A dipole mode in the tropical Indian Ocean." Nature **401**(6751): 360-363.

Samaran, F., et al. (2010). "Source level estimation of two blue whale subspecies in southwestern Indian Ocean." Journal of the Acoustical Society of America **127**(6): 3800-3808.

Samuels, A., et al. (2000). A review of the literature pertaining to swimming with wild dolphins., Final report to the Marine Mammal Commission. Contract No. T74463123. 58pp.

Sapolsky, R. M., et al. (2000). "How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions." Endocrine Reviews **21**(1): 55-89.

Scheidat, M., et al. (2004). "Behavioural responses of humpback whales (Megaptera novaeangliae) to whalewatching boats near Isla de la Plata, Machalilla National Park, Ecuador." Journal of Cetacean Research and Management **6**(1): 63-68.

Scheidat, M., et al. (2006). Harbour porpoise (Phocoena phocoena) abundance in German waters (July 2004 and May 2005). St. Kitts and Nevis, West Indies, International Whaling Commission Scientific Committee**:** 11.

Seyboth, E., et al. (2016). "Southern Right Whale (Eubalaena australis) Reproductive Success is Influenced by Krill (Euphausia superba) Density and Climate." Scientific Reports **6**.

Shane, S. H. (1994). "Occurrence and habitat use of marine mammals at Santa Catalina Island, California from 1983-91." Bulletin of the Southern California Academy of Sciences **93**: 13-29.

Shane, S. H. (1995). "Behavior patterns of pilot whales and Risso's dolphins off Santa Catalina Island, California." Aquatic Mammals **21**(3): 195-197.

Silber, G. K. (1986). "The relationship of social vocalizations to surface behavior and aggression in the Hawaiian humpback whale (*Megaptera novaeangliae*)." Canadian Journal of Zoology **64**(10): 2075-2080.

Simao, S. M. and S. C. Moreira (2005). "Vocalizations of a female humpback whale in Arraial do Cabo (Rj, Brazil)." Marine Mammal Science **21**(1): 150-153.

Simmonds, M. P. (2005). Whale watching and monitoring: some considerations. Cambridge, United Kingdom, Unpublished paper submitted to the Scientific Committee of the International Whaling Commission SC/57/WW5.

Simmonds, M. P. and W. J. Eliott. (2009). "Climate change and cetaceans: Concerns and recent developments." Journal of the Marine Biological Association of the United Kingdom **89**(1): 203-210.

Simmonds, M. P. and S. J. Isaac (2007). "The impacts of climate change on marine mammals: Early signs of significant problems." Oryx **41**(1): 19-26.

Simmonds, M. P. and S. J. Isaac (2007). "The impacts of climate change on marine mammals: Early signs of significant problems." Oryx **41**(1): 19-26.

Sirovic, A., et al. (2007). "Blue and fin whale call source levels and propagation range in the Southern Ocean." Journal of the Acoustical Society of America **122**(2): 1208-1215.

Sirovic, A., et al. (2012). "Temporal separation of two fin whale call types across the eastern North Pacific." Marine Biology **160**(1): 47-57.

Smith, J. N., et al. (2008). "Songs of male humpback whales, Megaptera novaeangliae, are involved in intersexual interactions." Animal Behaviour **76**(2): 467-477.

Smultea, M. A., et al. (2008). "An unusual reaction and other observations of sperm whales near fixed-wing aircraft." Gulf and Caribbean Research **20**: 75-80.

Solan, M., et al. (2016). "Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties." Sci Rep **6**: 20540.

Sole, M., et al. (2016). "Evidence of Cnidarians sensitivity to sound after exposure to low frequency noise underwater sources." Sci Rep **6**: 37979.

Southall, B. L., et al. (2007). "Marine mammal noise exposure criteria: initial scientific recommendations." Aquatic Mammals **33**(4): 411-521.

Southall, B. L., et al. (2016). "Experimental field studies to measure behavioral responses of cetaceans to sonar." Endangered Species Research **31**: 293-315.

Spielman, D., et al. (2004). "Most species are not driven to extinction before genetic factors impact them." Proc Natl Acad Sci U S A **101**(42): 15261-15264.

Sremba, A. L., et al. (2012). "Circumpolar diversity and geographic differentiation of mtDNA in the critically endangered Antarctic blue whale (Balaenoptera musculus intermedia)." PLoS One **7**(3): e32579.

St. Aubin, D. J. and J. R. Geraci (1988). "Capture and handling stress suppresses circulating levels of thyroxine (T4) and triiodothyronine (T3) in beluga whale, Delphinapterus leucas." Physiological Zoology **61**(2): 170-175.

St. Aubin, D. J., et al. (1996). "Dolphin thyroid and adrenal hormones: Circulating levels in wild and semidomesticated *Tursiops truncatus*, and influence of sex, age, and season." Marine Mammal Science **12**(1): 1-13.

Stabeno, P. J., et al. (2004). "Meteorology and oceanography of the northern Gulf of Alaska." Continental Shelf Research **24-Jan**(8-Jul): 859-897.

Stafford, K. M., et al. (1998). "Long-range acoustic detection and localization of blue whale calls in the northeast Pacific Ocean (*Balaenoptera musculus*)." Journal of the Acoustical Society of America **104**(6): 3616-3625.

Stafford, K. M. and S. E. Moore (2005). "Atypical calling by a blue whale in the Gulf of Alaska." Journal of the Acoustical Society of America **117**(5): 2724-2727.

Stafford, K. M., et al. (2001). "Geographic and seasonal variation of blue whale calls in the North Pacific (*Balaenoptera musculus*)." Journal of Cetacean Research and Management **3**(1): 65-76.

Stenseth, N. C., et al. (2002). "Ecological effects of climate fluctuations." Science **297**(5585): 1292-1296.

Stimpert, A. K., et al. (2007). "'Megapclicks': Acoustic click trains and buzzes produced during night-time foraging of humpback whales (Megaptera novaeangliae)." Biology Letters **3**(5): 467-470.

Strayer, D. L. (2010). "Alien species in fresh waters: Ecological effects, interactions with other stressors, and prospects for the future." Freshwater Biology **55**: 152-174.

Sutherland, W. J. and N. J. Crockford (1993). "Factors affecting the feeding distribution of red breasted geese, Branta ruficollis, wintering in Romania." Biological Conservation **63**: 61-65.

Swingle, W. M., et al. (1993). "Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia." Marine Mammal Science **9**(3): 309-315.

Sydeman, W. J., et al. (2009). "Seabirds and climate in the California Current - A synthesis of change." CalCOFI Rep **50**.

Szesciorka, A. R., et al. (2016). "Testing tag attachments to increase the attachment duration of archival tags on baleen whales." Animal Biotelemetry **4**(1).

Taylor, A. H., et al. (1998). "Gulf Stream shifts following ENSO events." Nature **393**: 68.

Terdalkar, S., et al. (2005). "Bio-economic risks of ballast water carried in ships, with special reference to harmful algal blooms." Nature, Environment and Pollution Technology **4**(1): 43-47.

Thode, A., et al. (2007). "Observations of potential acoustic cues that attract sperm whales to longline fishing in the Gulf of Alaska." Journal of the Acoustical Society of America **122**(2): 1265-1277.

Thomas, P. O., et al. (2016). "Status of the world's baleen whales." Marine Mammal Science **32**(2): 682-734.

Thompson, P. O., et al. (1986). "Sounds, source levels, and associated behavior of humpback whales, Southeast Alaska." Journal of the Acoustical Society of America **80**(3): 735-740.

Thompson, P. O., et al. (1996). "Underwater sounds of blue whales, Balaenoptera musculus, in the Gulf of California, Mexico." Marine Mammal Science **12**(2): 288-293.

Thompson, P. O., et al. (1992). "20-Hz pulses and other vocalizations of fin whales, *Balaenoptera physalus*, in the Gulf of California, Mexico." Journal of the Acoustical Society of America **92**(6): 3051-3057.

Thompson, T. J., et al. (1979). Mysticete sounds. Behavior of Marine Animals: Current Perspectives in Research Vol. 3: Cetaceans. H. E. Winn and B. L. Olla. New York, NY, Plenum Press**:** 403-431.

Thomson, C. A. and J. R. Geraci (1986). "Cortisol, aldosterone, and leukocytes in the stress response of bottlenose dolphins, Tursiops truncatus." Canadian Journal of Fisheries and Aquatic Sciences **43**(5): 1010-1016.

Thomson, D. H. and W. J. Richardson (1995). Marine mammal sounds. Marine Mammals and Noise. W. J. Richardson, C. R. J. Greene, C. I. Malme and D. H. Thomson. San Diego, Academic Press**:** 159-204.

Thomson, D. H. and W. J. Richardson (1995). Marine mammal sounds. Marine Mammals and Noise. W. J. Richardson, J. C. R. Greene, C. I. Malme and D. H. Thomson. San Diego, California, Academic Press.

Trumble, S.J., S.A. Norman, D.D. Crain, F. Mansouri, Z.C. Winfield, R. Sabin, C.W. Potter, C.M. Gabriele, S. Usenko. 2018. Baleen whale cortisol levels reveal a physiological response to 20th century whaling. Nature Communications 9:1-8.

Tyack, P. (1983). "Differential response of humpback whales, Megaptera novaeangliae, to playback of song or social sounds." Behavioral Ecology and Sociobiology **13**(1): 49-55.

Tyack, P. L. (1999). Communication and cognition. Biology of Marine Mammals. J. E. R. I. S. A. Rommel. Washington, Smithsonian Institution Press**:** 287-323.

Tyson, R. B. and D. P. Nowacek (2005). Nonlinear dynamics in North Atlantic right whale (Eubalaena glacialis) vocalizations. Sixteenth Biennial Conference on the Biology of Marine Mammals. San Diego, California**:** 286.

U.S. Navy (2010). Annual Range Complex Exercise Report 2 August 2009 to 1 August 2010 U.S. Navy Southern California (SOCAL) Range Complex and Hawaii Range Complex (HRC).

U.S. Navy (2012). Marine Species Monitoring for the U.S. Navy’s Southern California Range Complex- Annual Report 2012. Pearl Harbor, HI, U.S. Pacific Fleet, Environmental Readiness Division, U.S. Department of the Navy.

Unger, B., et al. (2016). "Large amounts of marine debris found in sperm whales stranded along the North Sea coast in early 2016." Marine Pollution Bulletin **112**(1): 134-141.

Van Der Hoop, J., et al. (2013). "Assessment of management to mitigate anthropogenic effects on large whales." Conservation Biology **27**(1): 121-133.

Van der Hoop, J. M., et al. (2013). "Assessment of management to mitigate anthropogenic effects on large whales." Conservation Biology **27**(1): 121-133.

Van Waerebeek, K., et al. (2007). "Vessel collisions with small cetaceans worldwide and with large whales in the Southern Hemisphere, an initial assessment." Latin American Journal of Aquatic Mammals **6**(1): 43-69.

VanBlaricom, G. R., et al. (1993). "Discovery of withering syndrome among black abalone Haliotis cracherodii Leach, 1814, populations at San Nicolas Island, California. ." Journal of Shellfish Research **12**: 185-188.

Vanderlaan, A. S. and C. T. Taggart (2007). "Vessel collisions with whales: the probability of lethal injury based on vessel speed." Marine Mammal Science **23**(1): 144-156.

Vanderlaan, A. S. M., et al. (2003). "Characterization of North Atlantic right-whale (Eubalaena glacialis) sounds in the Bay of Fundy." IEEE Journal of Oceanic Engineering **28**(2): 164-173.

Veit, R. R., et al. (1996). "Ocean warming and long-term change in pelagic bird abundance within the California current system." Marine Ecology Progress Series **139**: 11-18.

Wade, P. R., et al. (2011). "The world's smallest whale population?" Biology Letters **7**(1): 83-85.

Wade, P. R., et al. (2016). Estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter mating and calving areas. International Whaling Commission Scientific Committee**:** SC/66b/IA/21.

Walker, B. G., et al. (2005). "Physiological and behavioral differences in magellanic Penguin chicks in undisturbed and tourist-visited locations of a colony." Conservation Biology **19**(5): 1571-1577.

Walker, K. A., et al. (2012). "A review of the effects of different marking and tagging techniques on marine mammals." Wildlife Research **39**(1): 15-30.

Waring, G. T., et al. (2008). U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2007. Woods Hole, Massachusetts, National Marine Fisheries Service Northeast Fisheries Science Center**:** 388.

Waring, G. T., et al. (2016). US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2015. Woods Hole, Massachusetts, National Marine Fisheries Service Northeast Fisheries Science Center**:** 501.

Waring, G. T., et al. (2016). "US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2015."

Watkins, W. A. (1977). "Acoustic behavior of sperm whales." Oceanus **20**: 50-58.

Watkins, W. A. (1981). "Activities and underwater sounds of fin whales (*Balaenoptera physalus*)." Scientific Reports of the Whales Research Institute Tokyo **33**: 83-118.

Watkins, W. A. (1986). "Whale Reactions to Human Activities in Cape-Cod Waters." Marine Mammal Science **2**(4): 251-262.

Watkins, W. A., et al. (1985). "Sperm whale acoustic behaviors in the southeast Caribbean." Cetology **49**: 1-15.

Watkins, W. A., et al. (1981). "Radio tracking of finback (Balaenoptera physalus), and humpback (Megaptera novaeangliae) whales in Prince William Sound, Alaska, USA." Deep Sea Research Part I: Oceanographic Research Papers **28**(6): 577-588.

Watkins, W. A. and W. E. Schevill (1975). "Sperm whales (Physeter catodon) react to pingers." Deep Sea Research and Oceanogaphic Abstracts **22**(3): 123-129 +121pl.

Watkins, W. A. and W. E. Schevill (1977). "Spatial distribution of Physeter catodon (sperm whales) underwater." Deep Sea Research **24**(7): 693-699.

Watkins, W. A., et al. (1987). "The 20-Hz signals of finback whales (Balaenoptera physalus)." Journal of the Acoustical Society of America **82**(6): 1901-1912.

Watters, D. L., et al. (2010). "Assessing marine debris in deep seafloor habitats off California." Marine Pollution Bulletin **60**: 131-138.

Weilgart, L. and H. Whitehead (1993). "Coda communication by sperm whales (*Physeter macrocephalus*) off the Galápagos Islands." Canadian Journal of Zoology **71**(4): 744-752.

Weilgart, L. S. (2007). "The impacts of anthropogenic ocean noise on cetaceans and implications for management." Canadian Journal of Zoology **85**: 1091-1116.

Weilgart, L. S. and H. Whitehead (1997). "Group-specific dialects and geographical variation in coda repertoire in South Pacific sperm whales." Behavioral Ecology and Sociobiology **40**(5): 277-285.

Weinrich, M. T., et al. (1991). "Behavioural responses of humpback whales (*Megaptera novaeangliae*) in the southern Gulf of Maine to biopsy sampling." Reports of the International Whaling Commission (Special Issue 13): 91-97.

Weinrich, M. T., et al. (1992). "Behavioral reactions of humpback whales Megaptera novaeangliae to biopsy procedures." Fishery Bulletin **90**(3): 588-598.

Weir, C. R., et al. (2007). "The burst-pulse nature of 'squeal' sounds emitted by sperm whales (*Physeter macrocephalus*)." Journal of the Marine Biological Association of the U.K. **87**(1): 39-46.

Weirathmueller, M. J., et al. (2013). "Source levels of fin whale 20 Hz pulses measured in the Northeast Pacific Ocean." Journal of the Acoustical Society of America **133**(2): 741-749.

Weller, D. W. (2008). Report of the large whale tagging workshop, Marine Mammal Commission.

Weller, D. W., et al. (2009). "Birth-Intervals and Sex Composition of Western Gray Whales Summer."

Whitehead, H. (2009). Sperm whale: Physeter macrocephalus. Encyclopedia of Marine Mammals. W. F. P. B. W. J. G. M. Thewissen. San Diego, Academic Press**:** 1091-1097.

Whitehead, H., et al. (1997). "Past and distant whaling and the rapid decline of sperm whales off the Galapagos Islands. (Physeter macrocephalus)." Conservation Biology **11**(6): 1387-1396.

Whitehead, H. and L. Weilgart (1991). "Patterns of visually observable behaviour and vocalizations in groups of female sperm whales." Behaviour **118**(3/4): 275-295.

Wiggins, S. M., et al. (2005). "Blue whale (Balaenoptera musculus) diel call patterns offshore of southern California." Aquatic Mammals **31**(2): 161-168.

Wilcove, D. S., et al. (1998). "Quantifying threats to imperiled species in the United States." BioScience **48**(8): 607-615.

Wilcox, C., et al. (2015). "Understanding the sources and effects of abandoned, lost, and discarded fishing gear on marine turtles in northern Australia." Conservation Biology **29**(1): 198-206.

Wiley, D. N., et al. (1995). "Stranding and mortality of humpback whales, *Megaptera novaeangliae*, in the mid-Atlantic and southeast United States, 1985-1992." Fishery Bulletin **93**(1): 196-205.

Wiley, D. N., et al. (2016). "Vessel strike mitigation lessons from direct observations involving two collisions between noncommercial vessels and North Atlantic right whales (Eubalaena glacialis)." Marine Mammal Science.

Willi, Y., et al. (2006). "Limits to the Adaptive Potential of Small Populations." Annual Review of Ecology, Evolution, and Systematics **37**(1): 433-458.

Williams, R. M., et al. (2002). "Behavioural responses of killer whales (Orcinus orca) to whale-watching boats: Opportunistic observations and experimental approaches." Journal of Zoology **256**(2): 255-270.

Williamson, M. J., et al. (2016). "The effect of close approaches for tagging activities by small research vessels on the behavior of humpback whales (*Megaptera novaeangliae*)." Marine Mammal Science.

Winn, H. E., et al. (1970). Sounds of the humpback whale. Proceedings of the 7th Annual Conference on Biological Sonar and Diving Mammals. Stanford Research Institute Menlo Park CA. p.39-52.

Wisdom, S., et al. (1999). Development of sound production in gray whales, Eschrichtius robustus. Thirteenth Biennial Conference on the Biology of Marine Mammals. Wailea, Maui, Hawaii**:** 203-204.

Wisdom, S., et al. (2001). "Development of behavior and sound repertoire of a rehabilitating gray whale calf. (Eschrichtius robustus)." Aquatic Mammals **27**(3): 239-255.

Wursig, B., et al. (1998). "Behaviour of cetaceans in the northen Gulf of Mexico relative to survey ships and aircraft." Aquatic Mammals **24**(1): 41-50.

Zoidis, A. M., et al. (2008). "Vocalizations produced by humpback whale (*Megaptera novaeangliae*) calves recorded in Hawaii." The Journal of the Acoustical Society of America **123**(3): 1737-1746.

19 Appendix – Permit Terms and Conditions

The text below was taken directly from the proposed permit provided to us in the consultation initiation package from the Permits and Conservation Division. The final permit may have minor changes that will not affect this opinion.

Permit No. 21585

Expiration Date: December 15, 2023
Reports Due: March 31st, annually

PERMIT TO TAKE PROTECTED SPECIES[1] FOR SCIENTIFIC PURPOSES

I. Authorization

This permit is issued to Oregon State University, 2030 Southeast Marine Science Drive,

Newport, Oregon 97365, (hereinafter “Permit Holder;”; Responsible Party: Bruce Mate, Ph.D.), pursuant to the provisions of the Marine Mammal Protection Act of 1972 as amended (MMPA; 16 U.S.C. 1361 *et seq*.); the regulations governing the taking and importing of marine mammals (50 CFR Part 216); the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 *et seq*.); the regulations governing the taking, importing, and exporting of endangered and threatened species (50 CFR Parts 222-226); and the Fur Seal Act of 1966 (16 U.S.C. 1151 *et seq*.).

II. Abstract

The objectives of the permitted activity, as described in the application, are to 1) characterize spatial and temporal distribution of cetaceans throughout their range, 2) identify migration routes, home ranges and core areas, 3) characterize foraging behavior, 4) identify ecological relationships to help explain movement patterns, and 5) opportunistically study pinnipeds encountered during cetacean research.

[1] “Protected species” include species listed as threatened or endangered under the ESA, and marine mammals.

III. Terms and Conditions

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

A. Duration of Permit

1. Personnel listed in Condition C.1 of this permit (hereinafter "Researchers") may conduct activities authorized by this permit through December 15, 2023. This permit may be extended by the Director, National Marine Fisheries Service (NMFS) Office of Protected Resources or the Chief, Permits and Conservation Division (hereinafter Permits Division), pursuant to applicable regulations and the requirements of the MMPA and ESA.

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

   a. If serious injury or mortality[2] of protected species occurs.

   b. If authorized take[3] is exceeded in any of the following ways:

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

[2] This permit does not allow for unintentional serious injury and mortality caused by the presence or actions of researchers up to the limit in Table 1 of Appendix 1. 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 or invasive tagging; and deaths or injuries sustained by animals while attempting to avoid researchers. Note that for marine mammals, a serious injury is defined by regulation as any injury that will likely result in mortality.

[3] 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.

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

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

c. Following incident reporting requirements at Condition E.2.

3. The Permit Holder may continue to possess biological samples[4] acquired[5] under this permit after permit expiration without additional written authorization provided a copy of this permit is kept with the samples and they are maintained as specified in this permit.

B. Number and Kinds of Protected Species, Locations and Manner of Taking

1. The table in Appendix 1 outlines the authorized species and stock or distinct population segment (DPS) authorized; number of animals to be taken; number of animals from which parts may be received, imported and exported; and the manner of take, locations, and time period.

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

3. The Permit Holder may use visual images and audio recordings collected under this permit, including those authorized in Table 1 of Appendix 1, in printed materials (including commercial or scientific publications) and presentations provided the images and recordings are accompanied by a statement indicating that the activity was conducted pursuant to NMFS ESA/MMPA Permit No. 21585. This statement must accompany the images and recordings in all subsequent uses or sales.

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

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

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

    b. Non-essential personnel/activities will not influence the conduct of permitted activities or result in takes of protected species.

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

    d. The Permit Holder and Researchers do not require compensation from the individuals in return for allowing them to accompany Researchers.

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

<u>Counting and Reporting Takes</u>

a. Count and report a take of a cetacean regardless of whether you observe a behavioral response to the permitted activity.

b. For all cetacean approaches[6] in water and attempts to remotely biopsy or tag, count and report 1 take per cetacean per day.

    i. If all of your Level A harassment biopsy or tagging attempts on a single day are unsuccessful but do not make contact with the animal, count the take against your Level B harassment take row.

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

ii. If any of your Level A harassment attempts on a single day are unsuccessful but <u>make contact</u> with the animal, count the take for the day against your sampling or tagging take row.

c. During manned aerial surveys flown at an altitude lower than 1,000 feet, count and report 1 take per cetacean or pinniped observed per day, regardless of the number of passes.

d. For pinnipeds on land, count 1 take per animal per day for those animals that react to the research activities in the following ways:

i. Movements of twice the animal's body length or more;

ii. Changes of direction greater than 90 degrees; or

iii. Retreats (flushes) to the water.

<u>General</u>

e. Approach animals cautiously and retreat if behaviors indicate that the approach may interfere with reproduction, feeding, or other vital functions.

f. Immediately terminate efforts if animals exhibit avoidance and/or evasive behaviors.

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

i. Immediately terminate efforts if animals exhibit signs that the activity may be interfering with pair-bonding or other vital functions;

ii. Do not position the research vessel between the mother and calf;

iii. Approach mothers and calves gradually to minimize or avoid any startle response;

iv. Discontinue an approach if a calf is actively nursing; and

v. Whenever possible, sample the calf first to minimize the mother's reaction when sampling mother/calf pairs.

For killer whale research in the inland waters of Washington state

h. No more than one permitted marine research vessel may be within 200 yards of the same individual or group of Southern Resident killer whales at the same time.

i. To comply with ESA regulations (50 CFR 224.103) prohibiting vessel approaches within 200 yards of killer whales in the inland waters of Washington without a permit, this permit authorizes approaches within 200 yards of killer whales for scientific research. Take numbers are not required under this permit for these approaches between 200 to 50 yards. Takes are required for approaches within 50 yards of killer whales, and researchers must count and report them as indicated at Condition B.5.b.

For research in the inland waters of Washington state and/or research on humpbacks in Hawaii:

j. Vessels engaged in research activities must fly a clearly visible triangular pennant at all times. Use a yellow pennant with minimum dimensions of 18"H x 26"L and the permit number displayed in 6" high black numerals.

Aerial Surveys

k. Aerial flights must not be conducted over pinnipeds on land.

l. Researchers must conduct manned aerial surveys at an altitude of 300 m. The aircraft may descend to no lower than 150 m for detailed photographs.

General Conditions for Remote Procedures (Biopsy sampling and Tagging)

m. Researchers may attempt (deploy or discharge/fire) each procedure on an animal up to 3 times a day.

n. Discontinue an attempt to biopsy sample or tag if an animal exhibits repetitive, strong, adverse reactions to the activity or vessel.

o. Researchers may biopsy sample and tag an individual on the same day.

Data Collection and Sharing

p. To the maximum extent possible, Researchers must collect photos or high-resolution video simultaneously when biopsy sampling, and tagging to identify the individual and the sampling/tagging location on each individual.

q. Share photos and videos in a timely manner with researchers who maintain catalogs or databases for the subject species for purposes such as photo-ID or population monitoring (See Condition E.5 for reporting requirements).

r. Additional data and/or sample sharing requirements may be added at the discretion of the Permits Division for protected species as data needs are identified. These may include, but are not limited to, data needs related current population status, disease outbreaks, or unusual mortality events (UME).

s. We recommend that Researchers share telemetry data in a timely manner with the research community in a database such as the Animal Telemetry Network (ATN; https://ioos.noaa.gov/project/atn/).

Protocol Modifications

t. The Permit Holder or Principal Investigator (PI) must notify the Permits Division before implementing any change to protocols to determine if additional authorization is required. This may include, but is not limited to:

i. Modifications to sterilization or Institutional Animal Care and Use Committee (IACUC) requirements,

ii. Increases in a biopsy tip's size or depth of penetration, or

iii. Increases in a tag's mass, footprint, depth of penetration, or number of anchors.

Biopsy Sampling

Biopsy Sterilization and Disinfection

u. Biopsy tips must be sterile[7] before every use. Sterilization must follow your IACUC approved protocol.

i. Researchers can reuse contaminated[8] tips that are only high-level disinfected[9] (vs sterile) as a last resort during the same field trip.

ii. For high-level disinfection, the biopsy tips must be cleaned with soap and water, soaked in a 10% bleach solution for at least 20 minutes (or similar high-level disinfection solution[10], e.g., 6% hydrogen peroxide or 2% glutaraldehyde), rinsed, allowed to air dry or dried with a sterile cloth, and then placed in sterile packaging until use. Disinfected biopsy tips must be kept in individual packages until use, and any manipulation of the tips must be conducted wearing gloves. High-level disinfection solutions should be changed weekly or per manufacturer directions.

[7] Sterilization = destroys or eliminates all forms of microbial life and is carried out by physical or chemical methods (CDC 2008). These methods must follow the IACUC-approved protocol for sterilization (e.g., gas or cold sterilization).

[8] Contaminated = e.g., missed attempt, contacts seawater, physical contact, etc.

[9] Disinfection = eliminates many or all pathogenic microorganisms, except bacterial spores, on inanimate objects usually by liquid chemicals (CDC 2008).

[10] FDA 2015. FDA-Cleared Sterilants and High Level Disinfectants with General Claims for Processing Reusable Medical and Dental Devices - March 2015. Available online here: https://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/ReprocessingofReusableMedicalDevices/ucm437347.htm

Biopsy Target Animals and Age-classes

v. Researchers may biopsy sample adults and juveniles greater than approximately 1 year old and females accompanied by non-neonate calves. However, Researchers must not biopsy sample a calf less than approximately 1 year old except for blue whales.

Exception for blue whales: Researchers may biopsy calves longer than 10 meters.

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

Biopsy Sampling Location and Frequency

x. Do not attempt to biopsy sample a cetacean anywhere forward (cranial) of the pectoral fin.

y. Animals may be biopsy sampled up to 3 times over the course of a year.

Tagging

z. Authorized tag types include:

i. Non-recoverable fully-implantable tags; and

ii. Recoverable fully-implantable tags.

Tagging Sterilization

aa. Fully-implantable tags must be sterile[11] before every use. Sterilization must follow your IACUC approved protocol.

[11] Sterilization = destroys or eliminates all forms of microbial life and is carried out by physical or chemical methods (CDC 2008). These methods must follow the IACUC-approved protocol for sterilization (e.g., gas or cold sterilization).

i. Researchers must cease tagging efforts if all sterile fully-implantable tags are contaminated[3].

ii. Note that isopropyl alcohol is not approved to sterilize tags in the field. Contaminated tags must be re-sterilized following the IACUC-approved protocol (i.e. gas sterilization) described in your application.

bb. Handling or manipulation of the sterile tags before deployment should be performed with sterile surgical gloves or other sterilized equipment.

Tagging Target Animals and Age-classes

cc. Researchers may tag adults and juveniles greater than approximately 1 year old and females accompanied by non-neonate calves. However, Researchers must not tag a calf less than approximately 1 year old except for blue whales.

Exception for blue whales: Researchers may tag calves longer than 10 meters.

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

ee. Avoid tagging of animals in obviously poor health or exhibiting species-specific body condition parameters indicating compromised health such as, but not limited to:

i. Noticeable reductions in body mass in the post-cranial region (i.e., exhibiting a nuchal fat pad depression);

ii. Prominent vertebral column;

iii. Visible ribs;

iv. Excessive skin lesions, parasites or cyamids;

v. Behaving abnormally; or

vi. Immunocompromised populations or otherwise compromised individuals.

Tagging Location and Frequency

ff. Avoid tagging a cetacean anywhere forward (cranial) of the pectoral fin or below (ventral) the lateral vertebral processes.

gg. Where authorized in Table 1, Researchers may deploy 2 tags (one recoverable and one non-recoverable) at one time on the same animal.

hh. Animals that receive a tag may be biopsy sampled in subsequent field seasons in the same permit year for post-tag monitoring.

Post-tag Monitoring

ii. Researchers must make reasonable efforts to opportunistically monitor animals instrumented with fully-implantable tags through tracking and resightings (photographic/video or genetic) to assess:

i. The location on the body and condition of the tag (including breakage);

ii. Tag wound reaction and healing (e.g., severity of swelling, depressions, and coloration);

iii. Animal health and behavior;

iv. Fecundity (presence of calf); and

v. Survival.

jj. Results of post-tag monitoring must be provided in annual reports as indicated in Conditions at E.3.

Non-target Species

kk. This permit does not authorize takes of any protected species not identified in Appendix 1, including those species under the jurisdiction of the United States Fish and Wildlife Service (USFWS). 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.

ll. *North Atlantic Right Whales*

i. If a right whale is seen, Researchers must maintain a distance of at least 460 meters (500 yards) from the animal.

ii. Report all right whale sightings to the NMFS Sighting Advisory System:

a. In any location to the U.S. Coast Guard on channel 16.

b. From VA to ME to (978) 585-8473.

c. From NC to FL to (904) 237-4220.

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

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

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

i. Species and, where known, age and sex;

ii. Date of collection, acquisition, or import;

iii. Type of sample (e.g., blood, skin, bone);

iv. Origin (i.e., where collected or imported from); and

v. Legal authorization for original sample collection or import.

c. Biological samples belong to the Permit Holder and may be temporarily transferred to Authorized Recipients identified in Appendix 2 without additional written authorization, for analysis or curation related to the objectives of this permit. The Permit Holder remains responsible for the samples, including any reporting requirements.

d. The Permit Holder may request approval of additional Authorized Recipients for analysis and curation of samples related to the permit objectives by submitting a written request to the Permits Division specifying the following:

i. Name and affiliation of the recipient;

ii. Address of the recipient;

iii. Types of samples to be sent (species, tissue type); and

iv. Type of analysis or whether samples will be curated.

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

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

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

C. Qualifications, Responsibilities, and Designation of Personnel

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

a. Principal Investigator – Bruce Mate, Ph.D. (See Appendix 2 for authorized activities).

b. Co-Investigators –See Appendix 2 for list of names and corresponding activities.

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

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

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

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

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

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

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

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

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

c. Individuals included for training purposes.

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

5. Permitted activities may be conducted aboard vessels or aircraft, or in cooperation with individuals or organizations, engaged in commercial activities, provided the commercial activities are not conducted simultaneously with the permitted activities.

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

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

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

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

   a. The online system at https://apps.nmfs.noaa.gov;

   b. An email attachment to the permit analyst for this permit; or

   c. A hard copy mailed or faxed to the Chief, Permits Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Room 13705, Silver Spring, MD 20910; phone (301)427-8401; fax (301)713-0376.

D. Possession of Permit

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

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

   a. Engaged in a permitted activity.

   b. A protected species is in transit incidental to a permitted activity.

   c. A protected species taken under the permit is in the possession of such persons.

3. A duplicate copy of this permit must accompany or be attached to the container, package, enclosure, or other means of containment in which a protected species or

protected species part is placed for purposes of storage, transit, supervision or care.

E. Reporting

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

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

        i. The online system at https://apps.nmfs.noaa.gov;

        ii. An email attachment to the permit analyst for this permit; or

        iii. A hard copy mailed or faxed to the Chief, Permits Division.

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

2. Incident Reporting

    a. If a serious injury or mortality occurs, or authorized takes have been exceeded as specified in Condition A.2, the Permit Holder must:

        i. Contact the Permits Division by phone (301-427-8401) as soon as possible, but no later than 2 business days of the incident;

        ii. Submit a written report within 2 weeks of the incident as specified below; and

        iii. Receive approval from the Permits Division before resuming work. 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.

    b. The incident report must include 1) a complete description of the events, and 2) identification of steps that will be taken to reduce the potential for additional serious injury and research-related mortality or exceeding authorized take.

c. Include results of post-tag monitoring efforts (See Condition B.5.ii).

3. Annual reports describing activities conducted during the previous permit year (from January 1st to December 31st) must:

a. Be submitted by March 31st each year for which the permit is valid, and

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

c. The narrative report must also provide data on Southern Resident killer whale behavioral responses to approaches between 200 and 50 yards, and within 50 yards.

d. Include results of post-tag monitoring as described in B.5.ii.

e. Include a tabular and narrative accounting of activities for parts (Appendix 4).

4. A joint annual/final report including a discussion of whether the objectives were achieved must be submitted by March 31, 2024 or, if the research concludes prior to permit expiration, within 90 days of completion of the research.

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

F. Notification and Coordination

1. NMFS Regional Offices are responsible for ensuring coordination of the timing and location of all research activities in their areas to minimize unnecessary duplication, harassment, or other adverse impacts from multiple researchers.

2. The Permit Holder must ensure written notification of planned field work for each project is provided to the NMFS Regional Offices listed below at least two weeks prior to initiation of each field trip/season.

   a. Notification must include the following:

      i. Locations of the intended field study and/or survey routes;

      ii. Estimated dates of activities; and

      iii. Number and roles of participants (for example: PI, CI, boat driver, Research Assistant "in training").

   b. Notification must be sent to the following Assistant Regional Administrators for Protected Resources as applicable to the location of your activity:

      For activities in AK, Arctic Ocean, and the Bering, Beaufort, and Chukchi Seas: Alaska Region, NMFS, P.O. Box 21668, Juneau, AK 99802-1668; phone (907)586-7235; fax (907)586-7012;

      For activities in WA, OR, CA, and the Southern Ocean:

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

      Email (*preferred*): WCR.research.notification@noaa.gov;

      For activities in HI, American Samoa, Guam, and Northern Mariana Islands:

Pacific Islands Region, NMFS, 1845 Wasp Blvd., Building 176, Honolulu, HI 96818; phone (808)725-5000; fax (808)973-2941

Email (*preferred*): nmfs.pir.research.notification@noaa.gov;

For activities in NC, SC, GA, FL, AL, MS, LA, TX, PR, and USVI:

Southeast Region, NMFS, 263 13th Ave South, St. Petersburg, FL 33701; phone (727)824-5312; fax (727)824-5309

Email (*preferred*): nmfs.ser.research.notification@noaa.gov; and

For activities in ME, VT, NH, MA, NY, CT, NJ, DE, RI, MD, and VA: Greater Atlantic Region, NMFS, 55 Great Republic Drive, Gloucester, MA 01930; phone (978)281-9328; fax (978)281-9394

Email (*preferred*): NMFS.GAR.permit.notification@noaa.gov.

3. Researchers must coordinate their activities with other permitted researchers to avoid unnecessary disturbance of animals or duplication of efforts. Contact the applicable Regional Offices listed above for information about coordinating with other Permit Holders.

G. Observers and Inspections

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

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

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

H. Modification, Suspension, and Revocation

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

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

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

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

   c. In response to a written request[12] from the Permit Holder;

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

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

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

I. Penalties and Permit Sanctions

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

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

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

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

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

J. Acceptance of Permit

1. In signing this permit, the Permit Holder:

   a. Agrees to abide by all terms and conditions set forth in the permit, all restrictions and relevant regulations under 50 CFR Parts 216, and 222-226, and all restrictions and requirements under the MMPA, and the ESA;

   b. Acknowledges that the authority to conduct certain activities specified in the permit is conditional and subject to authorization by the Office Director; and

   c. Acknowledges that this permit does not relieve the Permit Holder of the responsibility to obtain any other permits, or comply with any other Federal, State, local, or international laws or regulations.

________________________________ ____________________

Donna S. Wieting Date Issued

Director, Office of Protected Resources

National Marine Fisheries Service

________________________________ ____________________

Bruce Mate, Ph.D. Date Effective

Oregon State University

Responsible Party and Principal Investigator

Appendix 1: Tables Specifying the Kinds of Protected Species, Locations, and Manner of Taking

Table 1. Authorized annual takes of marine mammals in all U.S. waters and international waters worldwide. Males and females may be taken during aerial and vessel surveys. Tagged whales may be approached multiple times per year for post-tag monitoring and observation. DPS= Distinct population segments.

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
1	Dolphin, Atlantic spotted	Range-wide	All	50	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
2	Dolphin, Atlantic white-sided	Range-wide	All	1,000	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
3	Dolphin, bottlenose	Range-wide	All	500	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
4	Dolphin, clymene	Range-wide	All	500	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
5	Dolphin, common, long-beaked	Range-wide	All	1,000	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	

[13] Takes = the maximum number of animals, not necessarily individuals, that may be targeted for research annually for the suite of procedures in each row of the table.

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
6	Dolphin, common, short-beaked	Range-wide	All	1,000	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
7	Dolphin, Fraser's	Range-wide	All	1,000	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
8	Dolphin, northern right whale	Range-wide	All	3,000	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
9	Dolphin, Pacific white-sided	Range-wide	All	2,000	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
10	Dolphin, pantropical spotted	Range-wide	All	3,000	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
11	Dolphin, Risso's	Range-wide	All	150	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
12	Dolphin, rough-toothed	Range-wide	All	200	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
13	Dolphin, spinner	Range-wide	All	1,000	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
14	Dolphin, striped	Range-wide	All	3,000	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
15	Dolphin, white-beaked	Range-wide	All	1,000	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
16	Narwhal	Range-wide	All	400	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
17	Porpoise, Dall's	Range-wide	All	100	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
18	Porpoise, harbor	Range-wide	All	100	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
19	Sea lion, California	Range-wide	All	200	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
20	Sea lion, Steller	Range-wide: Includes Western U.S. Stock (NMFS Endangered)	All	40	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
21	Seal, bearded	Range-wide: Includes Beringia and Okhostsk DPS (NMFS Threatened)	All	20	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
22	Seal, gray	Range-wide	All	20	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
23	Seal, Guadalupe fur	Range-wide (NMFS Threatened)	All	100	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
24	Seal, harbor	Range-wide	All	1,000	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
25	Seal, harp	Range-wide	All	100	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
26	Seal, Hawaiian monk	Hawaiian Islands (NMFS Endangered)	All	100	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
27	Seal, hooded	Range-wide	All	100	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
28	Seal, northern elephant	Range-wide	All	200	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
29	Seal, Northern fur	Range-wide	All	200	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
30	Seal, ribbon	Range-wide	All	20	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
31	Seal, ringed	Range-wide: Includes Ladoga and Saimaa DPS; (NMFS Endangered); Arctic, Baltic, and Okhotsk DPS (NMFS Threatened)	All	20	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
32	Seal, spotted	Range-wide: Includes Southern DPS (NMFS Endangered)	All	20	Harass	Incidental disturbance; Observation, monitoring; Observations, behavioral; Photograph/Video	
33	Whale, Baird's beaked	Range-wide	All	50	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
34	Whale, beluga	Range-wide: Includes Cook Inlet DPS (NMFS Endangered)	All	400	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
35	Whale, Blainville's beaked	Range-wide	All	12	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
36	Whale, blue	Range-wide (NMFS Endangered)	Non-neonate	48	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year.
37			Non-neonate	2	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Up to 2 individuals may receive 2 tag types per year.
38			All	300	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.
39			Adult/ Juvenile	20	Harass/ Sampling	Collect, sloughed skin; Import/export/receive, parts; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
40	Whale, bowhead	Range-wide (NMFS Endangered)	All	50	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
41	Whale, Bryde's	Range-wide (Excludes Gulf of Mexico subspecies)	Adult	23	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Excludes Gulf of Mexico subspecies. Only one tag per individual per year.
42			Adult	2	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Excludes Gulf of Mexico subspecies. Up to 2 individuals may receive 2 tag types per year.
43			All	200	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Excludes Gulf of Mexico subspecies. Whales may be approached multiple times per year for post-tag monitoring and observation.

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
44			Adult	20	Harass/ Sampling	Collect, sloughed skin; Import/export/receive, parts; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Excludes Gulf of Mexico subspecies.
45	Whale, Cuvier's beaked	Range-wide	All	25	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
46	Whale, Deraniyagala's beaked	Range-wide	All	5	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
47	Whale, dwarf sperm	Range-wide	All	10	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
48	Whale, Eden's	Range-wide	All	10	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
49	Whale, false killer	Range-wide: Includes Main Hawaiian Islands Insular DPS (NMFS Endangered)	All	300	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
50	Whale, fin	Range-wide (NMFS Endangered)	Adult/ Juvenile	48	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year.

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
51			Adult/ Juvenile	2	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Up to 2 individuals may receive 2 tag types per year.
52			Adult/ Juvenile	20	Harass/ Sampling	Collect, sloughed skin; Import/export/receive, parts; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	
53			All	300	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.
54	Whale, Gervais' beaked	Northern Gulf of Mexico Stock	All	10	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
55	Whale, ginkgo-toothed beaked	Range-wide	All	10	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
56	Whale, gray	Eastern North Pacific	Adult/ Juvenile	2	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Up to 2 individuals may receive 2 tag types per year.

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
57			Adult/ Juvenile	48	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year.
58			Adult/ Juvenile	20	Harass/ Sampling	Collect, sloughed skin; Import/export/receive, parts; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	
59			All	300	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.
60	Whale, gray	Western North Pacific (Korean) (NMFS Endangered)	Adult/ Juvenile	6	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year. Not to exceed 20 individuals of the life of the permit.
61			All	200	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
62	Whale, Hubbs' beaked	Range-wide	All	10	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
63	Whale, humpback	Range-wide: Includes Arabian Sea, Cape Verde Northwest Africa, Central America, Western North Pacific DPS (NMFS Endangered Mexico DPS (NMFS Threatened)	Adult/ Juvenile	48	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year.
64			Adult/ Juvenile	2	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Up to 2 individuals may receive 2 tag types per year.
65			Adult/ Juvenile	20	Harass/ Sampling	Collect, sloughed skin; Import/export/receive, parts; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	
66	Whale, humpback		All	500	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
67	Whale, killer	Range-wide: Includes Southern Resident DPS (NMFS Endangered)	All	50	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
68	Whale, Lesser beaked	Range-wide	All	10	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
69	Whale, Longman's beaked	Range-wide	All	10	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
70	Whale, melon-headed	Range-wide	All	800	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
71	Whale, minke	Range-wide	All	20	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
72	Whale, northern bottlenose	Range-wide	All	12	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
73	Whale, Perrin's beaked	Range-wide	All	10	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
74	Whale, pilot, long-finned	Range-wide	All	400	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
75	Whale, pilot, short-finned	Range-wide	All	200	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
76	Whale, pygmy killer	Range-wide	All	200	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
77	Whale, pygmy sperm	Range-wide	All	10	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
78	Whale, right, North Pacific	Range-wide (NMFS Endangered)	Adult/ Juvenile	5	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year. Not to exceed 15 individuals of the life of the permit.
79			All	100	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
80	Whale, right, southern	Range-wide (NMFS Endangered)	All	300	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.
81			Adult/ Juvenile	48	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year.
82			Adult/ Juvenile	2	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Up to 2 individuals may receive 2 tag types per year.
83			Adult/ Juvenile	20	Harass/ Sampling	Collect, sloughed skin; Import/export/receive, parts; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	
84	Whale, sei	Range-wide (NMFS Endangered)	All	50	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
85	Whale, Sowerby's beaked	Range-wide	All	10	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
86	Whale, sperm	Range-wide (NMFS Endangered)	Adult/ Juvenile	48	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Only one tag per individual per year.
87			Adult/ Juvenile	2	Harass/ Sampling	Acoustic, passive recording; Acoustic, sonar for prey mapping; Collect, sloughed skin; Import/export/receive, parts; Instrument, implantable (e.g., satellite tag); Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	Up to 2 individuals may receive 2 tag types per year.
88			Adult/ Juvenile	20	Harass/ Sampling	Collect, sloughed skin; Import/export/receive, parts; Observations, behavioral; Photo-id; Photograph/Video; Sample, skin and blubber biopsy	
89			All	300	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	Whales may be approached multiple times per year for post-tag monitoring and observation.
90	Whale, Stejneger's beaked	Range-wide	All	15	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	
91	Whale, True's beaked	Range-wide	All	10	Harass	Acoustic, passive recording; Incidental harassment; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video	

Line	Species	Stock/ Listing Unit	Life Stage	No. Takes[13]	Take Action	Procedures	Details
92	Cetacean, unidentified	N/A	All	50	Import/ export/ receive only	Import/export/receive, parts	Import/export of cetacean biopsies or sloughed skin samples collected in foreign waters under separate permits.

Appendix 2: NMFS-Approved Personnel and Authorized Recipients for Permit No. 21585.

The following individuals are approved personnel pursuant to the terms and conditions under Section C (Qualifications, Responsibilities, and Designation of Personnel) of this permit.

Name	Role	Activity			
		Vessel surveys including photograph/video, observations, and passive acoustic recording	Aerial surveys	Biopsy	Tag deployment
Bruce Mate	Responsible Party and Principal Investigator	X	X		X
Ladd Irvine	Co-Investigator	X	X	X	X
Daniel Palacios	Co-Investigator	X	X	X	X
Barbara Lagerquist	Co-Investigator	X	X	X	
Craig Hayslip	Co-Investigator	X		X	

Biological samples authorized for collection or acquisition in Table 1 of Appendix 1 may be transferred to the following Authorized Recipients for the specified disposition, consistent with Condition B.6 of the permit:

Authorized Recipient	Sample Type	Disposition
Dr. Scott Baker's Cetacean Conservation and Genomics Laboratory (CCGL) at the OSUMMI. Newport, OR	Skin and blubber	Analysis and curation

Appendix 3. NOAA Office of National Marine Sanctuaries (ONMS) Sanctuary and Monument Permit Contact Information.

Site	Mailing Address	Contact Numbers	Permit Contact(s)
ONMS Headquarters Office Silver Spring, Maryland	NOAA Office of National Marine Sanctuaries 1305 East-West Highway (N/NMS2) SSMC4 Silver Spring, MD 20910	wk 240-533-0605 fax 301-713-0404 wk 240-533-0679 fax 301-713-0404	Vicki Wedell Vicki.Wedell@noaa.gov
Channel Islands National Marine Sanctuary	Channel Islands Nat'l Marine Sanctuary University of California Santa Barbara Ocean Science Education Building 514, MC 6155 Santa Barbara, CA 93106	wk 805-893-6424 cell 805-705-1790 wk 805-893-6435	Sean Hastings Sean.Hastings@noaa.gov Jackie Buhl Jackie.Buhl@noaa.gov
Cordell Bank National Marine Sanctuary	Cordell Bank National Marine Sanctuary P.O. Box 159 Olema, CA 94950	wk 415-464-5265 fax 415-663-0315	Lilli Ferguson Lilli.Ferguson@noaa.gov
Florida Keys National Marine Sanctuary	Florida Keys National Marine Sanctuary 33 East Quay Road Key West, FL 33040	wk 305-809-4714 fax 305-293-5011	Joanne Delaney Joanne.Delaney@noaa.gov
Flower Garden Banks National Marine Sanctuary	Flower Garden Banks National Marine Sanctuary 4700 Avenue U, Building 216 Galveston, TX 77551	wk 409-621-5151 x 111 fax 409-621-1316	Emma Hickerson (Research permits) Emma.Hickerson@noaa.gov
Gray's Reef National Marine Sanctuary	Gray's Reef National Marine Sanctuary 10 Ocean Science Circle Savannah, GA 31411	wk 912-598-2382 fax 912-598-2367	Kimberly Roberson Kimberly.Roberson@noaa.gov
Greater Farallones National Marine Sanctuary *(Including Monterey Bay National Marine Sanctuary Northern Management Area)*	Greater Farallones National Marine Sanctuary 991 Marine Drive The Presidio San Francisco, CA 94129	wk 415-970-5255 fax 415-561-6616 wk 415-970-5247 fax 415-561-6616	Max Delaney Max.Delaney@noaa.gov Karen Reyna (Alternate contact) Karen.Reyna@noaa.gov

Site	Mailing Address	Contact Numbers	Permit Contact(s)
Hawaiʻian Islands Humpback Whale National Marine Sanctuary	Hawaiʻian Islands Humpback Whale National Marine Sanctuary 6600 Kalaniana'ole Highway, Suite 301 Honolulu, HI 96825	wk 808-397-2651 x 251 fax 808-397-2650	Malia Chow Malia.Chow@noaa.gov
Monitor National Marine Sanctuary	*Monitor* National Marine Sanctuary c/o The Mariners' Museum 100 Museum Drive Newport News, VA 23606	wk 757-591-7333	Tane Casserley Tane.Casserley@noaa.gov
Monterey Bay National Marine Sanctuary	Monterey Bay National Marine Sanctuary 99 Pacific Street, Building 455A Monterey, CA 93940	wk 831-647-1286 fax 831-647-4250	Sophie DeBeukelaer Sophie.DeBeukelaer@noaa.gov
National Marine Sanctuary of American Samoa	National Marine Sanctuary of American Samoa P.O. Box 4318 Pago Pago, AS 96799	wk 684-633-6500 x 226 cell 684-252-9786 fax 684-633-7355	Joseph Paulin Joseph.Paulin@noaa.gov
Olympic Coast National Marine Sanctuary	Olympic Coast National Marine Sanctuary 115 East Railroad Avenue, Suite 301 Port Angeles, WA 98362	wk 360-406-2076 fax 360-457-8496	George Galasso George.Galasso@noaa.gov
Papahānaumokuākea Marine National Monument	Papahānaumokuākea Marine National Monument NOAA/IRC NOS/ONMS/PMNM 1845 Wasp Boulevard, Building 176 Honolulu, HI 96818	wk 808-725-5805 fax 808-455-3093 wk 808-725-5831 fax 808-455-3093 wk 808-725-5823 fax 808-455-3093	Tia Brown Tia.Brown@noaa.gov Justin Rivera Justin.Rivera@noaa.gov Pua Borges-Smith (Alternate contact) Pua.Borges-Smith@noaa.gov
Stellwagen Bank National Marine Sanctuary	Stellwagen Bank National Marine Sanctuary 175 Edward Foster Road Scituate, MA 02066	wk 203-882-6515 fax 203-882-6572 wk 781-545-8026 x 207 fax 781-545-8036	Alice Stratton Alice.Stratton@noaa.gov Ben Cowie-Haskell (Alternate contact) Ben.Haskell@noaa.gov
Thunder Bay National Marine Sanctuary	Thunder Bay National Marine Sanctuary 500 West Fletcher Street Alpena, MI 49707	wk 989-356-8805 x 16 fax 989-354-0144	Russ Green Russ.Green@noaa.gov